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Forestry Solutions

PROJECT REPORT

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LOG TAGGING SYSTEMS

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EXECUTIVE SUMMARY

Paint and crayon are the main methods of identifying logs in New Zealand. However, in the last ten years barcodes have also been used. Log tagging is presently carried out for reasons of inventory management, downstream processing of stem-length wood, and as a necessary part of the log export business. This report reviews some existing log tagging systems, and examines the potential for alternative methods of individual log identification, including Radio Frequency Identification (RFID).

Conclusions

- There are a number of reasons why individual logs might be tagged. These include inventory management, forest estate planning, and efficient timber processing.

- The use of barcode tags is established in some parts of the forest industry (export logs, FCF's Webb Road facility), but there are advantages to be gained through use of RFID because of robust construction and readability. Disadvantages include cost, the need to remove tags before processing, and special readers.

- It is certain that increased use of RFID in other industries, especially in livestock management and the freight industry in the next few years, will result in lower unit costs. This will make the RFID option for tagging more attractive. Solutions for application at harvesting, and removal at the processing site may then be developed.

- The issue of tagging logs will soon be a case of when, and what system to use, rather than whether to tag at all.

INTRODUCTION

The advance of individual identification technology, and its application in other industries, presents some opportunities for the forestry sector.

That items in the log and timber product "manufacturing" business will eventually be individually identified seems beyond doubt, particularly given the adoption of increasingly sophisticated resource planning software and its need for up-to-date production and inventory data.

The key question is: is there currently a clear demand for individual log ID (ILID)? Given that proceeding now may stimulate a demand for individual log data, other key questions relate to who benefits, and how.

The main beneficiaries of ILID would presumably be the supplier (or forest owner) and the primary customer (sawmill or processing plant). Exploiting the benefits depends, for the supplier, on answers to several questions, such as:

- is there a need for inventory management at this level, ie. the Stock Keeping Unit (SKU)?
- can the data be utilised to aid more efficient transport scheduling?
- can ILID data be used to further differentiate the product, thereby possibly increasing its value to the supplier and the processor (and justify additional sorting costs)
- is log utilisation data available to the supplier (feedback)?
- can log utilisation data be used to value, plan, and market the existing and future forest?

From the processor's point of view, the answers to these questions are required:

- is there a need for inventory management at this level?
- can ILID-associated data be used to increase processing efficiency and value recovery? If so, will this justify paying more for logs (ie. does the processor have the capacity to monitor lumber outturn on a log-by-log basis)?
- will further differentiated logs (sorted to tighter specifications) increase processing efficiency and value recovery?

ILID is a two-edged sword in that there may be advantages for both supplier and customer in retaining an ill-defined log sale system. The supplier is presently able to provide a mix of high and low quality logs at a suitable price, and the customer is able to use expertise to cut the most profitable products from each log. Conversely, with ILID, both parties may, in a sense, be disadvantaged, as their options become more restricted.

Possibly the most pertinent question in today's demanding competitive climate is: if there is a marketing advantage in ILID, can an organisation afford not to exploit it?

This review of log tagging systems includes the following:

- Other forms of identification used in different industries
- Reasons for log identification : past and present
- Existing identification systems
- Current requirements
- Future needs
- Log tagging options and systems

The extent to which various forms of identification (ID) may be cost-effective is not addressed in this report.

Some forms of identification used in different industries

Historically, the identification of individual items has been confined to high value products such as cars, cameras etc. Typically, these were, and still are, identified for reference by a stamped or engraved serial number. The individual identification of more commonplace items or consumables for the purpose of inventory management has occurred more recently.

The key development has been the invention of barcoding. Barcoding in its earliest form was first initiated by the requirements of the rail-freight industry to track railcars. In 1967, a Sylvania colour-code system was chosen for freight car control throughout North America. A sister company to Sylvania, Computer Identics, then developed a Helium-Neon laser scanning source in place of the white light system used in the rail industry. The development of a laser scanner made possible the application of barcoding systems in a wide range of different industries (Collins and Whipple, 1990).

With technological development, individual product identification via barcoding, and more recently, radio frequency tags (RFID) has been used to enable control of large manufacturing, production and distribution systems using computerised methods (Dawe, 1996). To some extent, the adoption of identification systems in large areas of industry and commerce (such as retailing and marketing) is driving the introduction of identification systems in other areas (Dawe, 1997).

Another driver is the adoption of sophisticated management software such as Enterprise Resource Planning (ERP) products by companies competing globally and with eve-decreasing profit margins. This management software needs accurate, up-to-date inventory data to function properly (FTD, 1997a). The increasing use of the Supply Chain Management (SCM) approach in a wide range of industries, with its focus on customer satisfaction through closer relationships, and out-sourcing of supply functions, is also driving product identification.

In 1992, the USDA Forest Products Identification and Tracking Group (FPIT) ranked the most promising tree or asset accountability methods using criteria such as: value protected, application costs, reliability, information provided, field practicality, range of tracking problems addressed, and regional coverage (Simonson, 1992).

The listing of the top five (from most to least promising) was:

1. Radio Frequency tags (RFID)
2. Unique Reflector Identifiers
3. Log tags (bar-coded)
4. Dye
5. Array tags

Both barcode labels and Radio Frequency transponders (RF tags) have been tested for some forestry applications by the USDA Forest Service at San Dimas (Besse, 1991,1994; Besse and Kempf 1996;Garrett, 1997). Barcoded paper tags were found to be easy to attach, with inexpensive methods. The paper tags used were not pulpable, as they incorporated a Mylar coating for protection. It was recommended that pulpable paper tags be sourced, and more advanced attachment tools be tested.

In the US forest products industry, barcoding has been increasingly used in response to demands from distributors of finished products. When applied in other areas of their businesses, they reported increased productivity, and the ability to quantify the results of competitive strategies. These often involved effective quality control programmes (Selby, 1994). One Oregon-based sortyard has been using barcode tags to manage inventory for the past nine years.

RFID has found application in the US transport industry, where rail cars, trucks, containers and individual cars have been fitted with RF tags. A likely application for cars in the future is a user-pays system for road-use. ID cards and key-ring RF tags are also being used, particularly in the retail petrol market. Other uses comprise anti-theft systems in shops and libraries. Considerable use is being made in the area of both domestic and farmed animal identification, as well as for factory automation.

One application for barcode identification in forestry, has been developed by SGS Forestry, and is called LOGTRAK. Implemented in several countries by government authorities for management of harvesting of their national indigenous timber estates, the LOGTRAK system tracks product from the standing tree to conversion, or export of logs. It is used to control the logging industry operating in state-owned forests, and to ensure that levies or taxes are paid.

New Zealand's, Allflex, who make plastic animal tags, market an RFID tag for farm animals, such as dairy cows. Allflex have acquired the agricultural application rights for Texas Instruments (TIRIS) RF tags in the Pacific and South East Asia.

An example of identification issues being addressed is that of the New Zealand meat industry: There are powerful lobby groups and regulatory agencies overseeing New Zealand's export markets that are demanding high levels of product quality accountability, both of their own agricultural industry, and of potential importers. Within the European Community, every processed product will have to be traceable to its origin. As well as incurring the cost of identification throughout the entire chain, this development could also present new opportunities for value-added marketing through product differentiation. In addition, it may provide a mechanism for collecting process management data, which will help make the industry more efficient and responsive.

These developments are being matched in Australia. In Victoria, the Ministry of Agriculture is anticipating having all cattle tagged with RFID, with one million being tagged in the next two years.

Identification in the forest industry

In the forest industry, logs have long been identified by company, logging crew, logtype, and more recently, by felling date. Individual tagging of logs with barcodes has been carried out for a number of years as part of the JAS (Japanese Agricultural Standard) scaling requirements for log exports to Asia (IEN, 1992). In addition, in some companies, packets of sawn timber for all customers, and individual mouldings for supply to US merchandising outlets are barcoded to enable rapid identification and assimilation of data into the retailer's inventory management system. Fletcher Challenge Forests Limited is currently using stem and log identification in its Kaingaroa Processing Plant and Webb Road Logyard (FTD, 1997).

Log identification is also allied to the weighbridge-docket system which tracks individual loads, ensuring that the load-source harvesting contractor is paid for tonnage supplied, and log-buying customers are invoiced for volume delivered. The log markings complement this system, because, once delivered, individual logs can be sourced to the harvesting contractor that produced them.

At the 1997 Liro "Logistics - for the Forest Industry" conference, it was said that the forest industry produces "stuff", and not "things". This is because the focus has been placed on the resultant engineered product. The need to match "stuff" characteristics to end-uses is inverting this truism. A log, precisely selected for its properties is no less a "thing" than the end-product, precisely machined, for a specific purpose as defined by a customer.

Reasons for log identification - past and present

Presently, in radiata pine plantation forestry, logs are identified chiefly at two points in the log supply chain: The skid (source), and/or at an intermediate log yard (sorting, storage) before reaching the customer. Identification of logs usually excludes pulp logs for domestic consumption.

Historical reasons

At the Conversion Planning (CP) Conference in 1986 (FRI, 1986) the FRI's CP project team outlined its progress. There had previously been a need identified, namely to sort or grade by apparent log quality in order to match an identified end-use (and so differentiate the log product). Although modified by the industry, most of the team's grading recommendations have since been applied. Accordingly, logs are now graded by specifications that can be used to match a specific end-use.

Other reasons for log identification are that logging crew ID and company name marking enable some traceability, brand recognition, and facilitate billing and accounting (Kirk, 1992). Additionally, log grade volumes can be monitored for reconciliation of predicted volumes of product with actual volumes harvested. Other reasons for log identification are the increased numbers of product types - a result of the need to capture value; and associated higher log values.

The need has arisen for accurate stock information to reduce overruns and subsequent downgrading for one-off orders because forest owners have moved to Just in Time (JIT) management systems.

More recently

In addition to the log grade, company brand, and crew number, a sample of non-pulp logs are marked with the felling date to indicate log "freshness". All export logs are identified with barcodes, usually at the port, and scaled as part of the sale process, and for inventory management.

Existing identification systems

Identification systems in use by New Zealand forestry companies range from basic crayon or stencil marking, to the use of more sophisticated barcode tags (Figure 1) and readers involving RF communication to a central computer.

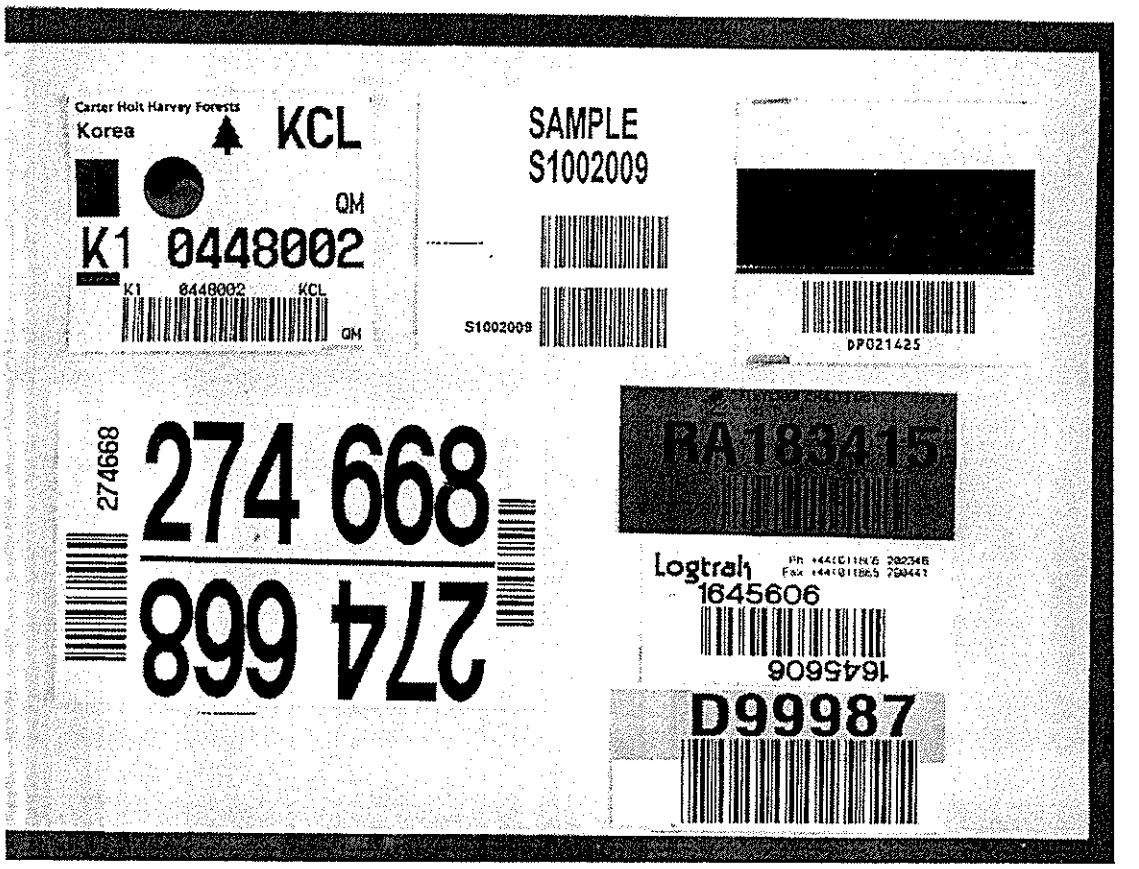


Figure 1. Barcode labels in use

Timberlands West Coast uses a combination of aluminium tag and barcode to track log products from native trees. Scaled merchantable volumes are compared with the allowable annual cut.

The most sophisticated system is currently Fletcher Challenge Forest's tree-length logging and merchandising operation at their Kaingaroa Processing Plant (FTD, 1997b). All logged tree lengths are tagged at the skid site, and carry source and butt quality information to be read by the merchandiser operator. Following processing into logs, each log is barcoded for inventory management purposes. In the nearby Webb Road logyard, incoming logs are scaled, barcoded and read, and read again on exit. Pulpable tags and non-metal staples are used. More recently, barcode labels have been fixed with pulpable wooden pins.

At all log-export ports, incoming logs are scaled and bar-coded on arrival, and read again just prior to loading.

Overseas, applications centre on prevention of theft of logs and control of the logging industry (SGS), and on inventory management in sort yards or at roadside locations.

Current requirements

Current requirements for identification appear to centre on inventory management at multiple locations (skids), and on efficient transport scheduling, by knowing precise volumes available at known locations, in close to real-time. That is, at frequent intervals, how many logs of a given grade are available for pickup at different locations, and how fresh are they, because there are freshness limits for some customers.

To a certain extent, there is a need for some operations, such as those utilising the new Timber Tech™ log optimising tool, to be able to track from the individual stem onwards (ie. a parent-child linkage). Information derived in real-time would be used for inventory management, but would have the potential to be used by both processors and foresters in order to correlate outturn and wood quality to seed source, site and silvicultural treatment.

It can be argued that a log should only be tagged if required by the customer, who may have to pay extra for the cost of tagging.

Future needs

Future needs for ILID will probably reflect the same traceability that exists in the manufacturing/retail sector. This will involve tracking tree components right through the cycle - from the felled tree through to the processor-customer - rather than traceability within only a part of it.

However, for the timber processing industry there will be information from outturn tracking in-mill that can be matched to cutting patterns and log characteristics as measured by scanner at log infeed. This will enable increased levels of value recovery at the processing stage, and process-based costing of sawn products.

There will be a need for more automated systems than those which presently involve barcode scanning.

Some considerations in defining a log tagging system

1. Which log products are to be tagged?

   It would make sense to track only non-pulp logs.

2. What level of information is to be tracked?

   ILID is the only system that allows detailed log inventory capture, and permits detailed planning and processing decisions to be made on the basis of log-associated data.

3. What is the purpose of the information - how is it to be used?

   For operational management, planning, and marketing.

4. How and where is the log to be tagged?

   There are two alternatives:

   - *at the skid-stockpile, where values such as SED can be associated with logs*
   - *at processing into logs, either by mechanised processor, or manually. Here the logs may be associated with the parent-tree, and a number of other log values such as LED, whorl spacing, largest knot, processing date, etc.*

5. Where and how are following readings made?

   Readings of tags should be made both prior to, and following every major operation to the log, including transportation. Scanning may involve specialised apparatus to give access to the tag. For instance, logs should be scanned as they are loaded onto the truck leaving the skid (possibly by the driver).

6. How and where is the tag removed (if necessary)?

   If necessary, to avoid pulp chip contamination, tag removal should occur immediately before timber processing, eg. at the mill (the final reading).

7. Can a tagging system be integrated seamlessly into a selected harvesting system, or will there need to be changes in method or equipment used?

   This will depend on the harvesting system concerned. Motor-manual systems may accommodate tagging more easily than fully mechanised ones.

8. Can the acquired data be integrated into a customer's system?

   This is up to the customer concerned, and depends on the software used.

SOME ALTERNATIVES TO ILID

If what is required is improved inventory management, this could be achieved in several ways, without individual log ID.

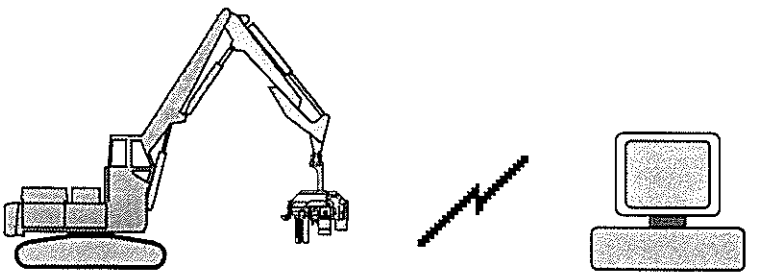
Basic motor-manual or mechanised processing system

A skid-worker counts logs in stacks at fixed intervals. There is a verbal RF link to the inventory management centre. Log numbers are converted using average volumes, and weighbridge tonnes are subtracted from skid-stack totals.

Timber Tech™ database system: motor-manual operations

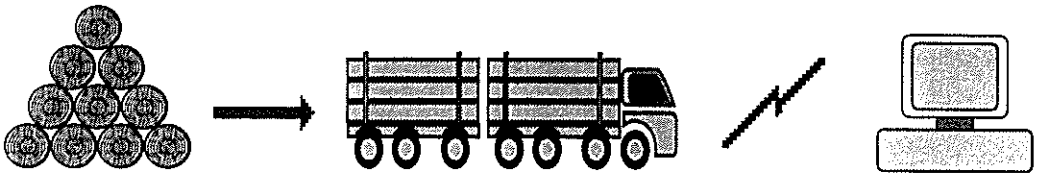
Optimal log assortments from individual stems (obtained through use of the Timbertech caliper) are recorded and transmitted via an RF link to a central database in either real-time or periodically. Individual logs, their characteristics and volumes are aggregated in the database which can make information available to customers (special orders) or for transport scheduling. Stocks can be calculated through subtraction of weighbridge weights/volumes.

Harvester processing with RF link



This system is operational in some Scandinavian operations, and intended for linkage of end-use mills to harvesters. Weighbridge tonnes or log-counts would be subtracted from harvester records.

Truck-based data carrier



Here, without RF data communication to central site, a programmable RF tag or data logger/transmitter on logging trucks is used to store data from the skid source, and transmit to a central site when within transmit range (Wootton, 1997).

Sort yards

Logs or stems are transported to a central processing yard (CPY) or central sorting yard (CSY) where logs are segregated automatically or scanned, and fleeted into customer-specific stacks based on individual log attributes. Such a yard can incorporate debarking and anti-sapstain treatment as well as dimensional scanning.

Table 1. Some advantages and disadvantages of different systems

System	Advantages	Disadvantages
Basic motor-manual or mechanised system	• simple • cheap • easily implemented	• no ILID
Timber Tech™ database system: motor-manual operations	• potential for real-time capture of log specific data	• no ILID • currently confined to low production, motor-manual operations
Harvester processing with RF link	• suited to SED sorting by customer data in real-time • accommodates rapid response to order changes	• no ILID • costly
Truck-based data-carrier	• cheap • reliable short-range transmission • could be integrated with ILID	• no ILID
Sort yards	• low level storage at skids • product differentiation • tighter specifications • improved transport management • improved inventory management	• no ILID • increased handling cost • high infrastructure cost

INDIVIDUAL LOG IDENTIFICATION (ILID)

An important requirement is compatibility with existing logging systems - motor-manual or mechanised processing. Application method - this presents one of the greatest challenges. For instance, application to logs on stacks is relatively straightforward, logs that have just been cross-cut or cut-to-length manually, or by mechanised methods, would be difficult to tag effectively.

Some requirements of an ILID system:

- Cost-effectiveness - since identification is a cost to the individual log product
- Reliability - 100% retention and readability - ID losses mean additional administration costs
- Compatibility with downstream processing eg. sawmilling, pulping processes
- Multi-site, chain-wide access - the ID system must be available to reading at all sites through which the product passes - eg. skid to sawmill. Three examples of existing problems relate to barcode tagged logs on trucks. The first is the loss of tags due to buffeting by wind and slipstream; the second is reading tags at both ends of the bolster, as logs are often "top and tailed' and have butts at both ends of the bolster-set. The third problem is one of access to tags that may be 3-4 metres above ground.

There are two main contenders for individual log identification: Barcoding and Radio Frequency Identification (RFID).

BARCODE LABELS

Barcode technology is the most established method of identifying individual items. Barcodes are manufactured in standard formats. They can be either one dimensional (1-D) (Figure 1) or two-dimensional (2-D) (Figure 2) and are used extensively in the retailing industry, including that of timber products. Barcode base material is available for harsh-environments. Although more commonly printed on paper, barcodes can be applied to many different kinds of substrate, even etched onto metal. Fixing methods include fast-setting glues, wooden pins (Figure 4) and plastic staples (Figure 3). Readers or scanners are widely available and are relatively cheap, and commonly linked to dataloggers and RF data transmitters. Bar-coded data is then concentrated in a database system available to computer networks.

Issues:

- pulpability of tags and fixing agents such as staples, pins and adhesives; or removal prior to processing
- readability of tags through obscuring agents, redundancy
- linked attributes of ILIDs
- reconciliation procedures for lost tags

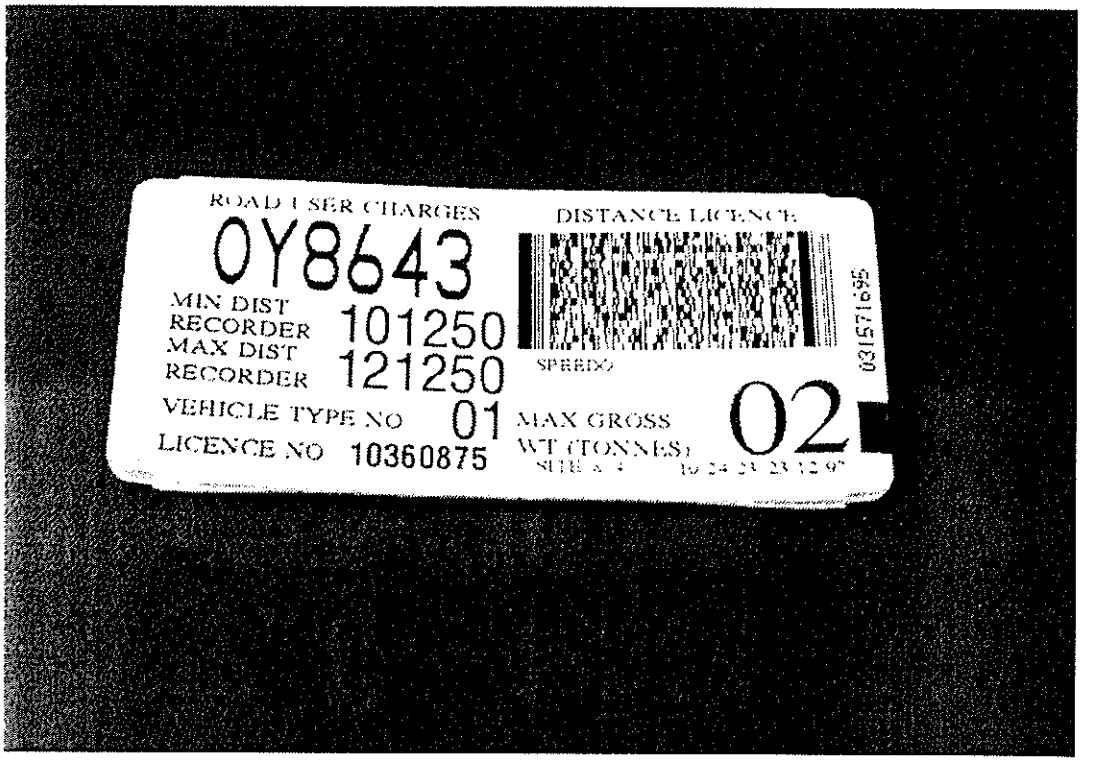


Figure 2. A 2-dimensional barcode, containing more information than a 1-D code

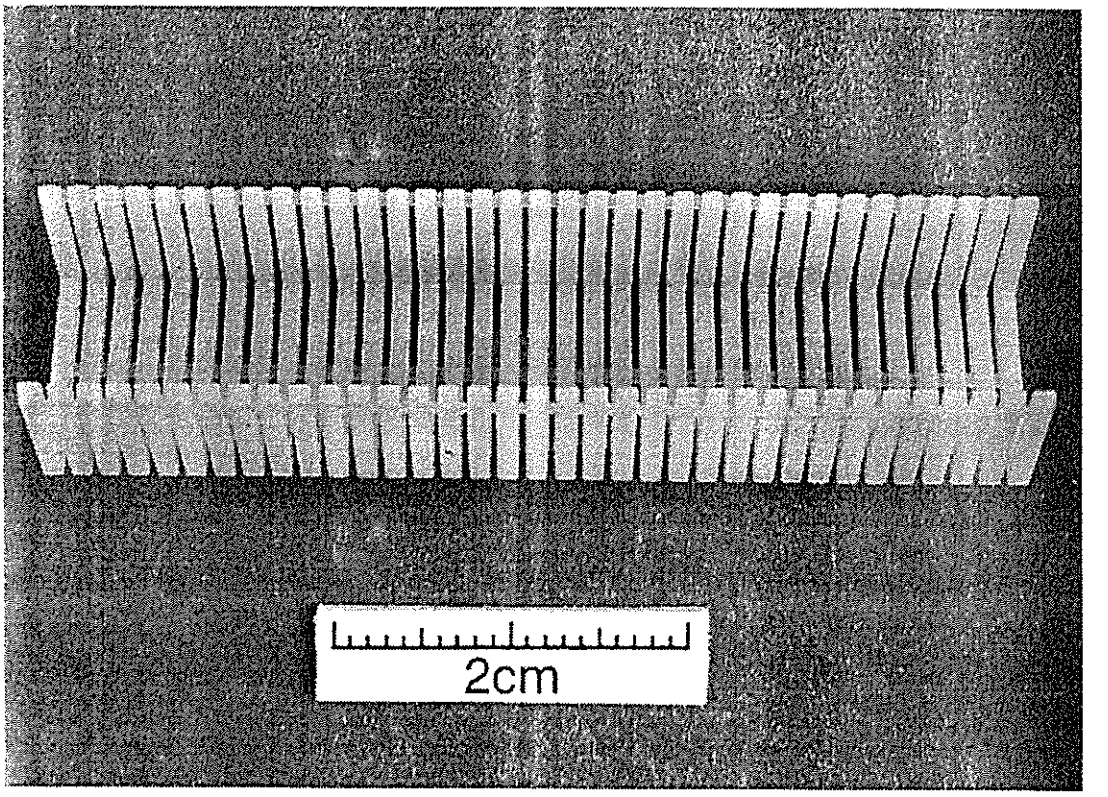


Figure 3. Raptor™ polymer staples

ARRAY TAGS

Barcodes are actually a form of array tag, but arrays are designed to be read photographically (Figure 4). They have the advantage that many different arrays can be read at once rather than sequentially. Their other advantages are either a high level of redundancy or a larger amount of data that can be held. The MORIS system (Advanced Imaging, 1996), developed by the New Zealand Forestry Corporation and now owned by the CNIFP (Central North Island Forest Partnership) is probably the only example of this technology in use. The system was originally designed for use on the wharves for export log inventory management, but has not been used for some months. One of the problems experienced with the system relates to the camera's need to reference all four corners of the array; if there is a competing mark on the cut-face, the system can have difficulty completing the read sequence in a reasonable time period.

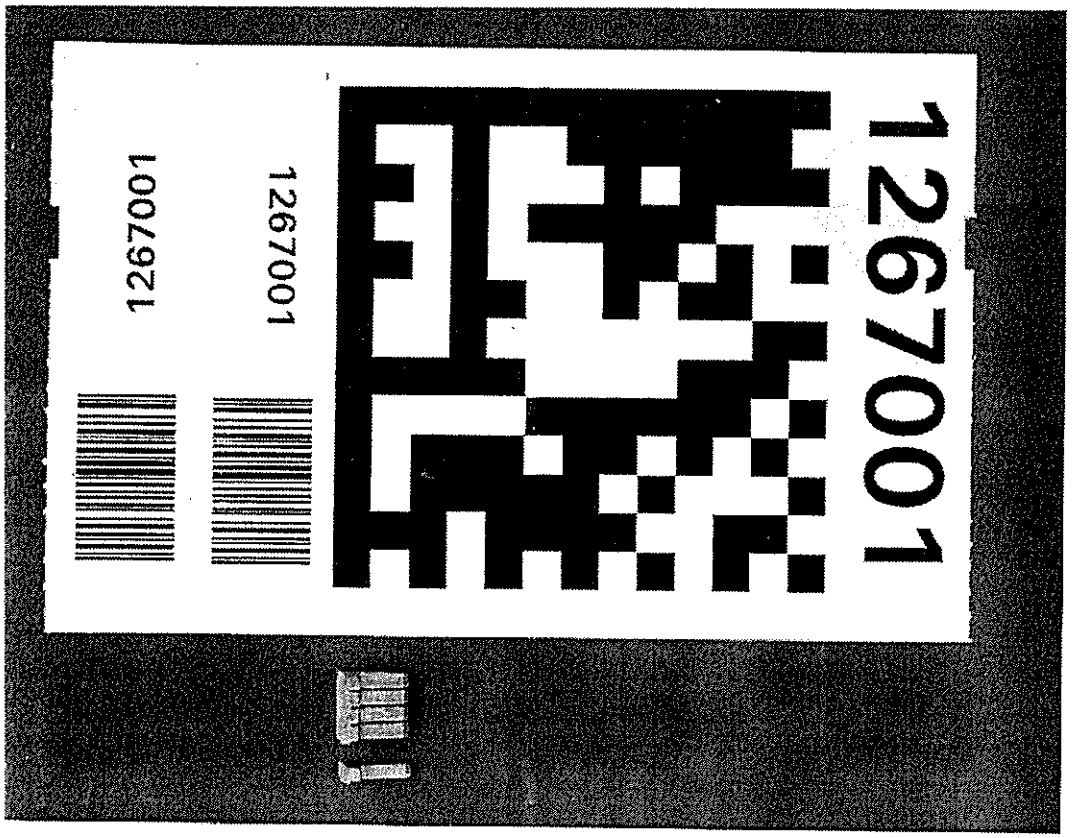


Figure 4. Array tag, with pulpable wooden pins for fixing

RADIO FREQUENCY TAGS (RFID)

RFID is one of the more recent developments in the area of automated data collection (ADC). The core component of an RFID system is a transponder. A transponder comprises both a receiver and a transmitter and is commonly encapsulated in either glass or plastic (Figure 5). The physical size of transponder units can vary from a few mm to cm in size (Figure 6), shaped like buttons, nails or a grain of rice, depending on the required performance.

Transponder tags work by utilising the radio frequency magnetic field of a reader or scanner, which powers the tag's transmitter. In the simplest tags, the transmitter emits a pre-programmed signal (such as a unique identifier). More sophisticated tags have memory capacity for storing data, and when interrogated, release it.

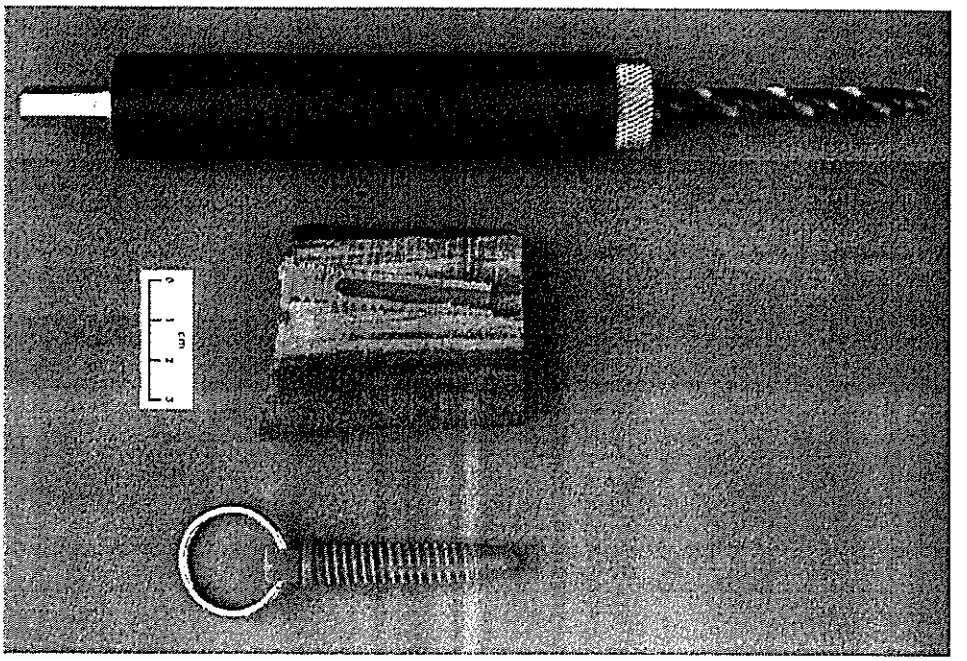


Figure 5. An RF tag casing with applicator, made by Rydex, USA for USDA trials

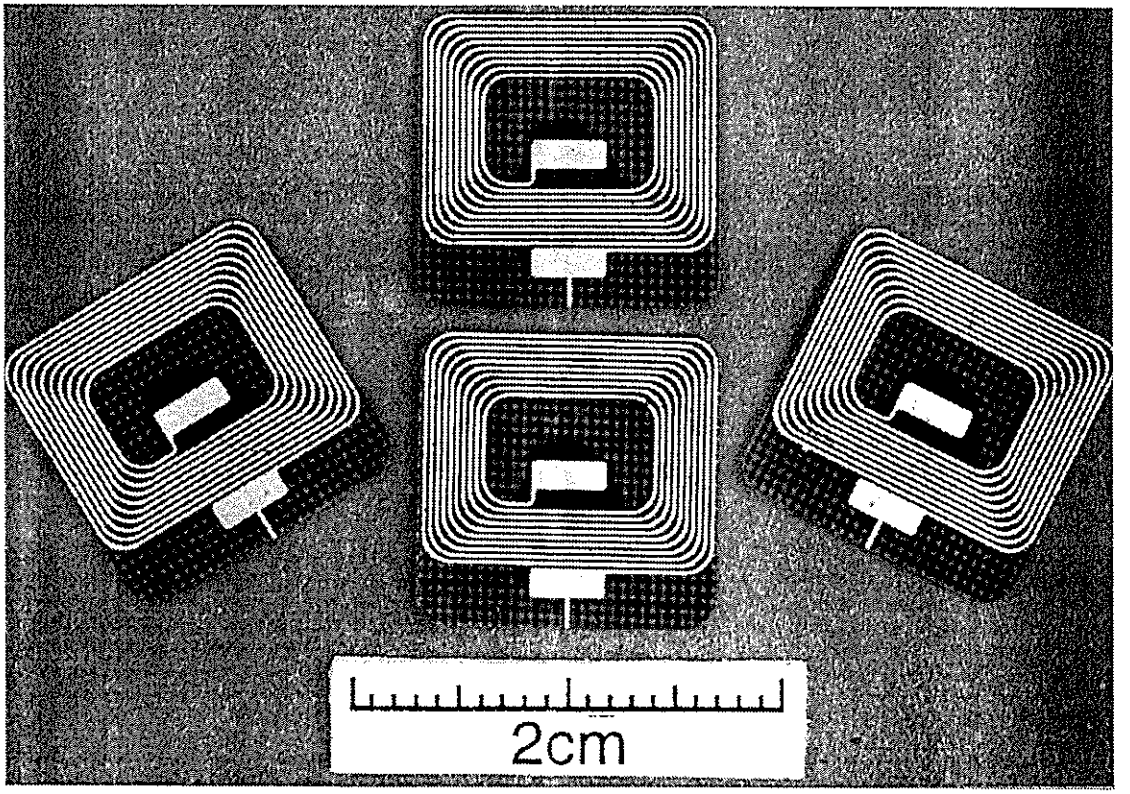


Figure 6. One configuration of RF tag (the visible portion is the antenna)

There are two basic types of transponder, read only, and read and write. The latter tend to be larger and more expensive than the former. Transponders can be active or passive, with active transponders obtaining power from an internal battery. Read-range is greater for active transponders and also for transponders working at higher frequencies (300Mhz - 9Ghz) which also have higher data transfer rates (Garrett, 1998). Read-range is also greater for scanner-tag combinations where larger antennas are used. Low and medium frequency units operate in the range 50 - 500Khz, and 1 - 30Mhz respectively. Tags are of two main types: FDX-B responding to continuous send-types or HDX, half duplex types, with better read ranges.

The transmitted pulse from the tag involves modulation of the incoming carrier signal by varying either frequency, phase or amplitude, and can be subject to the effects of electromagnetic interference or "noise". This is largely overcome by including error detection bits in the returned signal.

A basic form of RF tag is the L-C circuit embedded in library books. When excited by a continuous transmitter, they can trigger an alarm (if they have not been disabled by the issuing process). Another application is the anti-theft tag on retail clothing.

Issues:

- read-range of tag: read ranges for passive tags vary from 2-3 cm to fifteen metres, depending on the kind of tag and scanner used
- read selectivity: some readers can only read one tag at a time. However, tags and readers with "non collision or contention" capability are being trialled, and will be in production in mid-late 1998
- moving tags: a finite time is involved in reading a tag, this could limit travel speed of a moving tag (ISO compliant tags are slower to read)
- cost: Recent pricelists from one manufacturer gave a price of US$1.70 each for an order of 1 million units of small (18.5mm dia.*2.7mm), read only devices. Readers can cost from US$500 - 1500 depending on capability
- standards: for livestock there is ISO 11784/85 (code structure and read method for 64 bit read only tags). There are no standards for "industrial tags".

Table 2. A comparison of barcode and RF tags

Tag method	Advantages	Disadvantages
Barcode	• cheap • technology is proven • widely used	• labels are easily lost • codes can be obscured or degraded • reading sensitive to angle and light levels • pulpable tags are less weather resistant
RF tag	• tags (and carriers) can be made robust and long-lasting • can be read automatically • a number can be read "simultaneously" • some tags can be read at longer ranges than barcodes • some tags have write capability	• currently more costly than barcodes • need special readers • plastic/metal composition requires removal prior to pulping • read performance of some tags are prone to electro-magnetic interference or reflections from metal surfaces

CONCLUSIONS

There are a number of reasons why individual logs might be tagged. These include inventory management, forest estate planning, and efficient timber processing.

The use of barcode tags is established in some parts of the forest industry (export logs, FCF's Webb Road facility), but there are advantages to be gained through use of RFID because of robust construction and readability. Disadvantages include cost, the need to remove tags before processing, and special readers.

It is certain that increased use of RFID in other industries, especially in livestock management and the freight industry in the next few years, will result in lower unit costs. This will make the RFID option for tagging more attractive. Solutions for application at harvesting, and removal at the processing site may then be developed.

The issue of tagging logs will soon be a case of when, and what system to use, rather than whether to tag at all.

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APPENDIX 1 - BARCODE LABELS, TAGS, STAPLES, AND ASSOCIATED EQUIPMENT

	Phone	FAX	e-mail/web
TimbaTac Ltd Wooden staples (NEW ZEALAND)	07 348 3190		
Saito Barcode labels (NEW ZEALAND)	09 3779591	09 307 2017	
JJ and LJ Warburton Barcode labels (NEW ZEALAND)	07 576 2716	07 576 2716	
Walker Datavision Barcode labels (NEW ZEALAND)	09 522 3678	09 520 3447	gmckeNew Zealandie@wdv.co.New Zealand
Dy-Mark Barcode labels (NEW ZEALAND)	09 262 3643	09 262 3676	
Forest Enterprises Ltd (Raptor™ fibreglass staples) (NEW ZEALAND)	06 377 1585	06 377 1585	

APPENDIX 2 - RADIO FREQUENCY TAGS, READERS

	Phone	FAX	e-mail/web
Texas Instruments- TIRIS™	(972)917 1462		
EID Electronic Identification Devices Ltd (TROVAN™ by AEG/Telefunken)	(805)565 1288	(805)565 1127	www.trovan.com
Micron™ (USA)	(208)333 7481		www.micronncommunications.com
Metget RFID transponders (Sweden)	46(0)457 15800	46(0)457 15899	
Omron Electronics Ltd (NEW ZEALAND)	09 358 4400		
Indala Corporation (Motorola) (USA)	(408)383 4000		

APPENDIX 3 - INTEGRATORS (APPLICATIONS SPECIALISTS)

	Phone	FAX	e-mail/web
Texas Instruments - TIRIS (Aus)	03 95385200	03 95385222	chester-lennard@ti.com
id Systems (Motorola-Indala) (NEW ZEALAND, UK)	09 624 1616 44(0)161 232 1000	44(0)161 232 1010	www.idsys.demon.co.uk awhittaker@idsys.co.uk
SGS New Zealand Ltd (SGS Societe Generale de Surveillance) Logtrak system (NEW ZEALAND)	09 366 1754	09 366 1763	
AVID Identification Technology Co. (NEW ZEALAND, UK)	07 377 0449	07 377 0348	
Dallas Identification Ltd (Micron RFID) (NEW ZEALAND)	09 415 9499		
Portable Data Technologies (NORAND, Microcom, TIRIS) (NEW ZEALAND)	09 579 5669		
Unilink Automation Ltd (Husky Hunter) (NEW ZEALAND)	09 525 7002	09 525 7011	
Microchips Identification Systems Pty Ltd (EID, Trovan) (Aus)	03 970 6300		
Fujikura Europe Ltd (RFID systems) (UK)	01373 825582	01373 825824	speciality@fujikura.co.uk
Rydex Ltd (RFID systems) (USA)	(515)967 0294	(515)967 2207	www.RYDEX-RF/ID.com

APPENDIX 4 - MAGAZINES AND JOURNALS

	Phone	FAX	e-mail/web
ID Systems (USA)	(603) 924 9631	(603) 924 7408	www.idsystems.com editors@idsystems.com
Automatic I.D. News (USA)	800/346-0085	218/723-9576	www.autoidnews.com autoid@en.com