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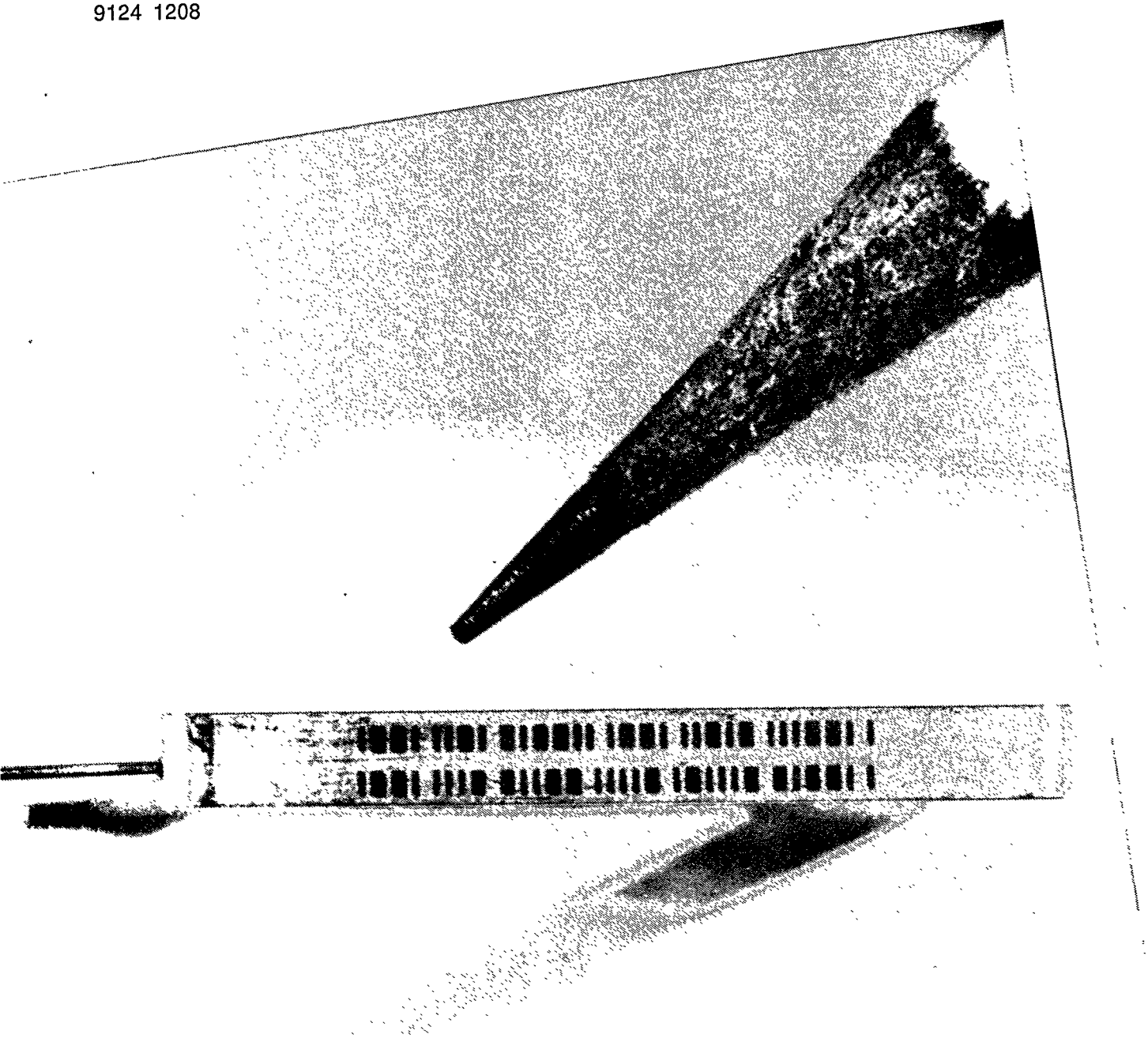
Bar Codes for Log Accountability



BAR CODES FOR LOG ACCOUNTABILITY

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Log Accountability

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PROBLEM STATEMENT

From the time they are gathered in the woods until they are accounted for at some distant log yard, there are a number of opportunities for logs to become lost. Think about it: If a purchaser is operating more than one sale, a load may be improperly marked as to its origin. A load might depart a sale and not arrive at its designated scaling area. For a variety of reasons, it may be necessary to remove a log or two from a load en route. Unloaded logs selected for scaling are set aside and can be misplaced or mixed with other logs. And, these are but a few of the numerous ways logs can be lost. There is a desire to improve log accountability, and the Forest Service is currently investigating new technologies that might be used to enhance the process. One idea is to use bar-coded messages attached to each log. Information is needed to evaluate the pros and cons of this approach.

The objective of this paper is to present an overview as of mid-August 1991 that (1) addresses the resources necessary to begin the development cycle and progress through assembly of prototype systems, and (2) speculates on what costs might be, should broad-scale use occur. The goal is to provide a brief overview of bar-coding equipment and how the more promising of that equipment might be used in a systematic manner to enhance the accounting of logs harvested from National Forests. The scope of this report is limited and based on a 3-week interaction with local vendors.

GENERAL TECHNICAL DISCUSSION

Bar coding helps to eliminate errors and automate the data recording process. Serial numbers, measurement points, and software commands can be bar coded to speed up inventorying, reduce the chances of error, and enhance the security and accountability of a wide range of raw materials, finished goods, and processes. The use of bar coding appears to be readily adaptable to the accounting of products coming from an individual timber sale area. Very little up-front development expense would be required. Two approaches can be considered:

1. The benefits of placing a label containing a *site-specific* code on the product in the woods appear to be (a) improved security simply by being attached and even more so when the message can only be read by authorized personnel, and (b) automating some of the information the scaler records if he is using a data logger.

2. The benefits of placing a label containing *tree-specific* codes in the woods appear to be (a) information about that tree could be recorded on data loggers and put in a data base for use throughout the milling process, and (b) the security of each tree is enhanced.

These benefits would be traded-off with the time required for a worker to attach a label. Attaching a bar code to a tree or log takes time, no matter how short. Attaching something firmly to each tree or log can never be as fast as spraying paint or hitting a log with a branding hammer. Each bar-coded message will add a few cents to the cost of doing business, and tools and needed software/hardware will also increase fixed costs by some minuscule amount. However, with the maturity of a wide range of bar-code products, costs have become very reasonable. This has allowed a wide range of business persons to use bar coding on a routine basis.

ATTACHING BAR CODES

The market appears to offer three ways to attach a bar code to a log: Strapping, stapling, and pasting labels. As to the latter, with the limited investigation completed to date, nothing promising in adhesives for labels was discovered. (The most promising adhesives used by contractors to attach bar-code labels to stucco appeared totally inadequate for attachment to logs in the woods.) On the other hand, both strapping and stapling appear to offer promise.

Strapping

Strapping appears to hold the most promise for marking trees standing in the woods, and could be readily used for boundary and wildlife marking and substituted for techniques such as spray painting. As envisioned, the cruiser would have a roll of strapping attached to his/her belt and carry a battery-powered hand tool to tension and seal the strap on the tree (see fig. 1).

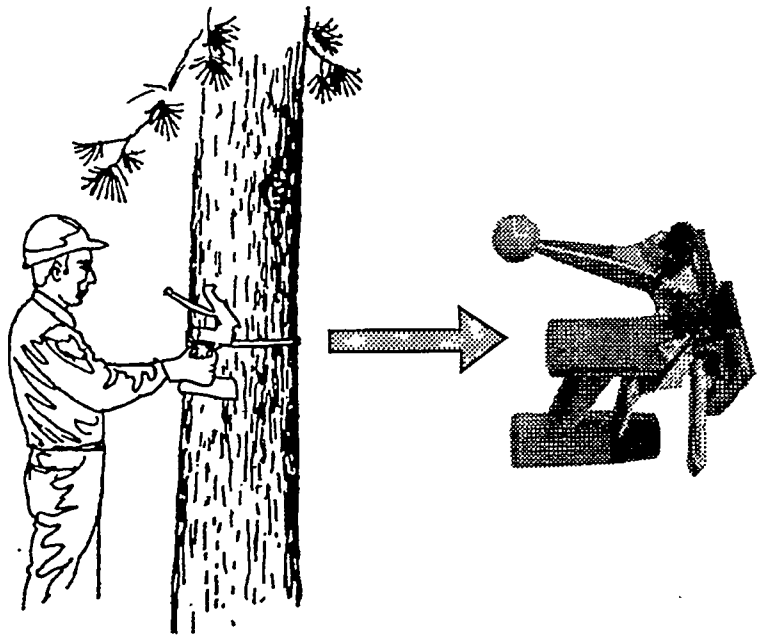

Figure 1. Tree marking straps.

The tension and strength would be sufficient to ensure that the strap would not move or be broken during skidding if the tree were harvested. The critical link in implementing the broad-scale use of this technology appears to be the time it would take to tension and seal the strap. Tool design would be critical, with the goal being that at the end of the day nearly as many trees would be "strapped" as "marked." The strapping can be manufactured with custom symbols, such as the Forest Service shield or miniature retroreflective mirrors for rapid laser identification.

Inexpensive manual or PC-generated printers can be made available at any level, down to Districts, to print bar codes and other information on the strapping. Hand-held printers can even be taken to the woods to print detailed bar codes on strapping or on labels that could then be attached to a tree (see fig. 2).

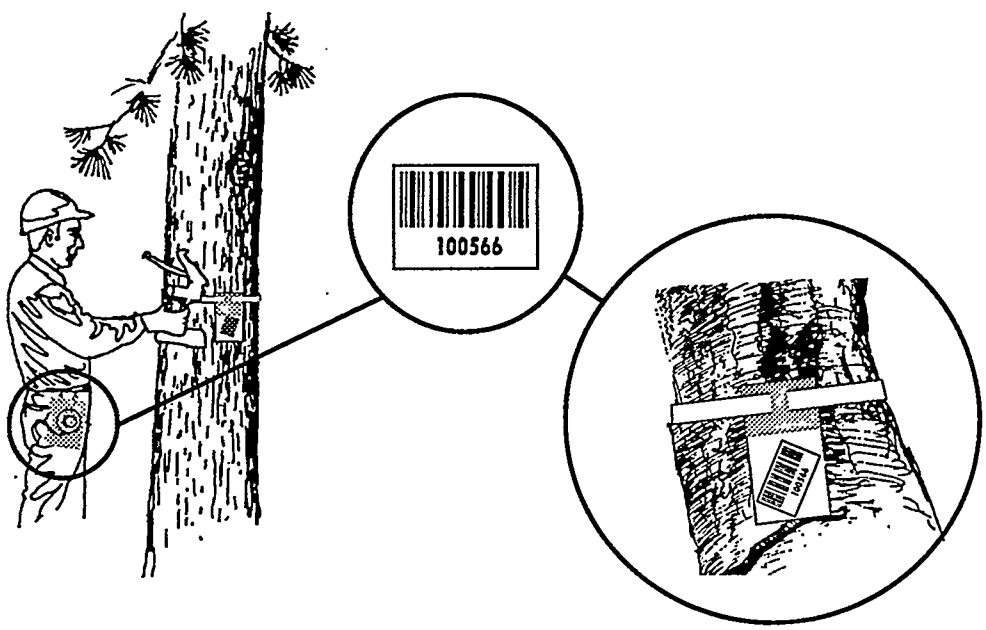

Figure 2. Idea for attaching tree-specific tags.

The strapping "clamp" can have a distinctive seal (see fig. 3) and each clamping device can be inventoried, controlled, and be unique. A wide array of strapping colors can be made available for varying uses—such as boundaries, wildlife, trees, different sales in the same area, etc. Strapping costs could be as little as 0.6 cent for a 1-foot diameter tree.

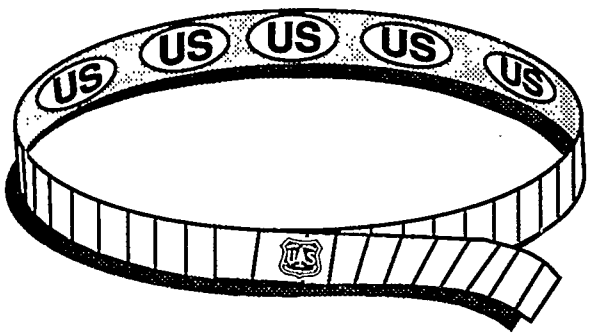

Figure 3. Custom seal for Forest Service use only.

Strapping might also be used to maintain log load integrity. High tensile strength strapping with premarked bar codes can be installed at the landing with sufficient tension to ensure that a log could not be removed from the load, even after shifting as the load moves down the road. Strap integrity could be maintained until the load was scaled.

The strap material might be selected with a higher degree of elasticity, unlike steel, and each strap could be bar coded with a distinct load number. The ability of the strapping to remain intact during the truck unloading process could be evaluated, if this would be important to maintaining load integrity until scaling is complete.

Strapping the end of individual logs either in the woods or prior to loading at the landing or immediately after the logs are loaded on the truck appears less likely to be palatable to the industry and has operational hangups. In the woods it would be a new chore for either the sawyer or choker setter and, at the landing, it is envisioned that the deck hand would have to take far more time than with branding or simply painting the butt end.

Stapling

When considering the use of staples, one simple approach could be to paint the bar code directly on the staple at the District level (see fig. 4). Off-the-shelf hammers and staplers can be selected or a customized staple and/or hammer can be supplied and controlled by serial number for Forest Service only use. If a customized design is undertaken, one feature of tipping the stapler head 90 degrees can be considered for reaching in and stapling log ends that are buried (see fig. 5).

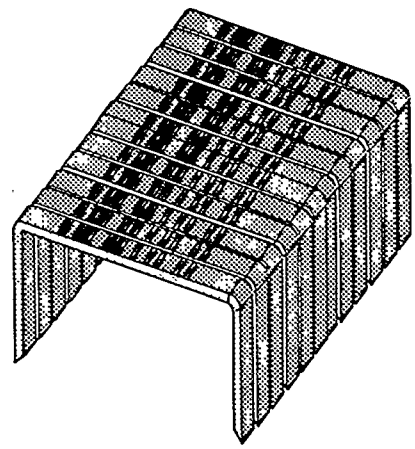

Figure 4. Paint-coated staple with bar code.

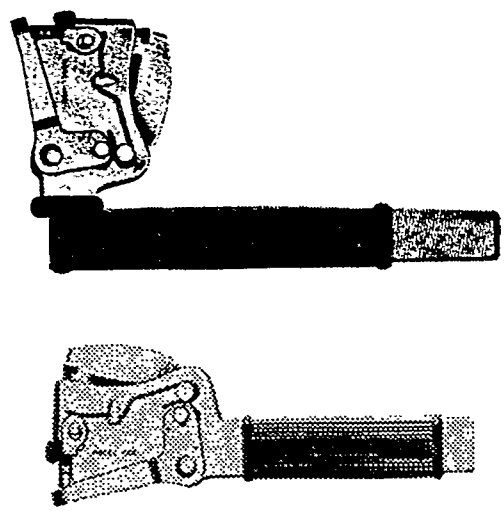

Figure 5. Adjustable stapler head.

A clause in the sale contract can require the purchaser to staple the butt and bark up and down the log, if desired. The staple hammer can be sealed so that only authorized persons can add staples. Accessories (see fig. 6) can be designed for the hammer to delineate the area near where the staple is seated for enhanced staple identification.

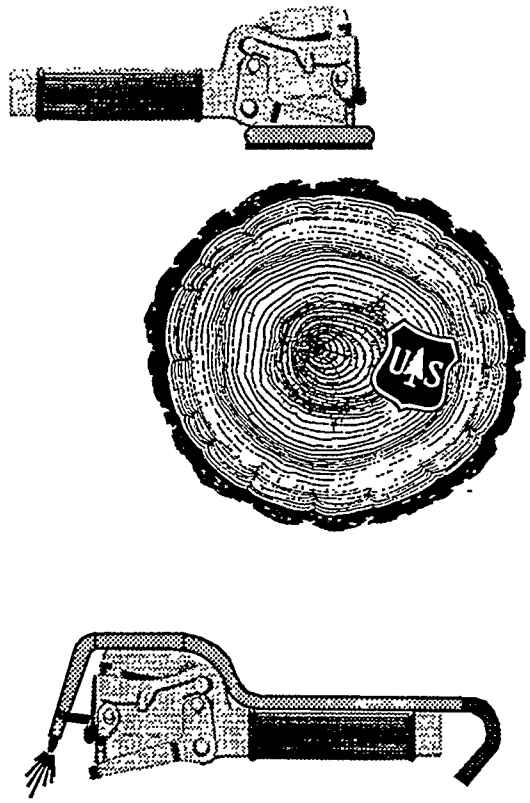

Figure 6. Ideas for locating the staple.

Where a purchaser might have more than one sale, an accessory can be added to the hammer such that the hammer cannot be taken out of the immediate sale area without alerting local National Forest personnel.

Current technology will allow the Gettysburg Address (762 words) to be placed in bar code on a background area of 1 square inch. A staple 1/16-inch wide and 3/8-inch long can be fitted with a bar code that has up to 12 digits (see fig. 7). The staples can be painted at the time of manufacturer to create a pure white (or color), baked-on enamel, high-gloss background finish.

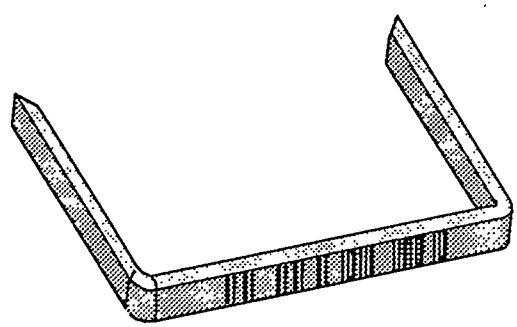

Figure 7. Bar-coded staple.

The scanner that reads this bar code can be equipped with a metal detector similar to hand-held security devices seen at airports. With this size of bar code on a staple, data can be scanned at distances up to 5 inches. In general, as the size of the bar code face increases, the cost of the scanner decreases and/or the distance between the scanner and the code can be increased. However, scanning beyond close proximity should be considered beyond the state-of-the-art.

Labels

There are a multitude of labeling products available to paint or ink the code on a broad array of backgrounds; however, a satisfactory adhesive for attaching labels to logs was not discovered. While labels are routinely used in environments as or more severe than the forest or the log yard they are not of much use if they will not stick in place or can be easily removed. Brochures sent by manufacturers in response to inquiries show illustrations of Weyerhaeuser, Packwood and Plum Creek Timber companies using printed labels on logs. They are routinely designed for extreme environments.

Labels can have pull tags (see fig. 8) and are available in weather-resistant "digestible" form such that they will dissolve during the kraft process, leaving no residue (according to suppliers literature). Still-in-all, labels that have fallen off by the time the scanner comes along are not of much use for our purposes.

Figure 8. Pull tabs used at mill in Canada.

OFF-THE-SHELF APPROACHES

If management chooses to implement this bar-code technology, there is a good chance that as it begins to be applied at the District level, no two applications will be exactly the same. It appears that whatever the application demands, some type of off-the-shelf bar-code products can be made available for trial use. Those of the more promising can be "customized" for broad-scale application.

DATA RETRIEVAL

When retrieving data from bar codes, there are a multitude of electronic devices available for reading, displaying, or recording the data. These can range from small hand-held devices (that only scan and then display the bar-code data) to sophisticated scanners (that feed the code into machine-readable data loggers).

HAND TOOL SECURITY

When considering the scenario where the purchaser has more than one sale in close proximity, a foolproof method of separating the sale codes is not currently available off-the-shelf. In this scenario, the purchaser applies the code to the logs immediately after loading them on the truck. Whether the code is fastened with adhesive, or staples, or the entire load is banded, there is nothing to prevent the purchaser from taking his tools and bar codes to another somewhat adjacent area. To rigidly account for product by sale area, special features have to be considered and the use of adhesive-backed labels should probably not be considered.

The most promising alternative to ensure that the bar code is applied at the specified site is to have a small radio transmitter mounted in the purchaser's staple hammer or strapping sealer. The transmitter provides a signal to a receiver which contains a normally open switch. When the signal disappears, the switch closes and sends a message over the Forest radio network that the tool has left the sales area. This will alert the District dispatcher, who could be trained to deal with such situations and can be instructed on proper actions desired by the timber staff.

RECOMMENDATIONS

Concepts and Approaches

Methods of securely fastening bar-coded messages on logs and trees in the woods improves accountability. They offer a simple form of moving sale-specific data with each log as it moves from the woods to the mill's debarker in a code that can only be read by selected personnel at a cost of only a few cents per applied message. Bar coding will add a small amount of time in the form of manual labor to install the message, and will require the development of an office management system and some minor hardware design. Since the message is "machine readable," security is enhanced when only preselected audiences with authorized scanning tools can decode. As a start, one office management system (or approach) and three field processes should be investigated.

(Concepts for office management systems are considered to be beyond the scope of this paper, and the use of bar codes at the local level will need to fit into existing methods and procedures as much as practical. The degree to which bar code will "fit" and be helpful is not addressed here.)

In *the first field process*, standard labels (see fig. 9) with or without removable tags would be backed with a special adhesive that bonds permanently to any log butt. The information on the label would be printed by the supplier, except for sale- or tree-specific codes that are to be printed in the District office by authorized personnel. These sale-specific labels would be installed as the log truck is loaded by the purchaser's representative and would replace present methods. Tags could be taken by the trucker, the scaler, and whoever else might need one.

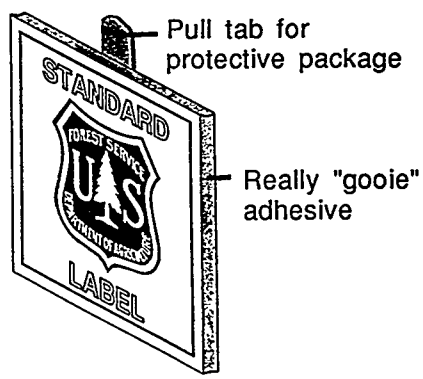

Figure 9. Permanently bonded labels.

In *the second field process*, a staple and a hand-held stapler would be selected. The staple would be purchased with the back painted, and authorized District personnel would be assigned a secured printer to place sale or boundary and leave tree specific codes on the staples. The staples could be installed in trees prior to harvest by District personnel, when desired, and in log butts by the purchaser's representative as the log truck is loaded. The purchaser's staple gun would also brand the butt as in current methods. The District could buy accessories for their stapler to spray paint above the point where the staple is installed. The District could buy accessories for the purchaser's stapler that would alert the dispatcher should the stapler leave the proximity of the sale area.

In *the third field process*, a plastic strap and a hand-held tensioner and bander would be selected. The strap would be available in two sizes—one small size having a tensile strength of approximately 250 pounds, and the other large with about 3,000 pounds of tensile strength. The strapping manufacturer would emboss the Forest Service shield every 6 inches on the back of the strap.

Authorized District personnel would be assigned a secured printer to place sale or boundary and leave tree codes continuously along the strapping. The small straps would be installed around trees prior to harvest similar to the way trees are currently painted by District personnel. The large straps would be installed by the purchaser's representative immediately after loading the logs on a truck.

The banders would be powered by a rechargable battery and would seal the strap with a Forest Service shield (see fig. 10). Each bander would have a serial number for control. An accessory could be purchased for the large bander to alert the District dispatcher should the tool leave the sale area.

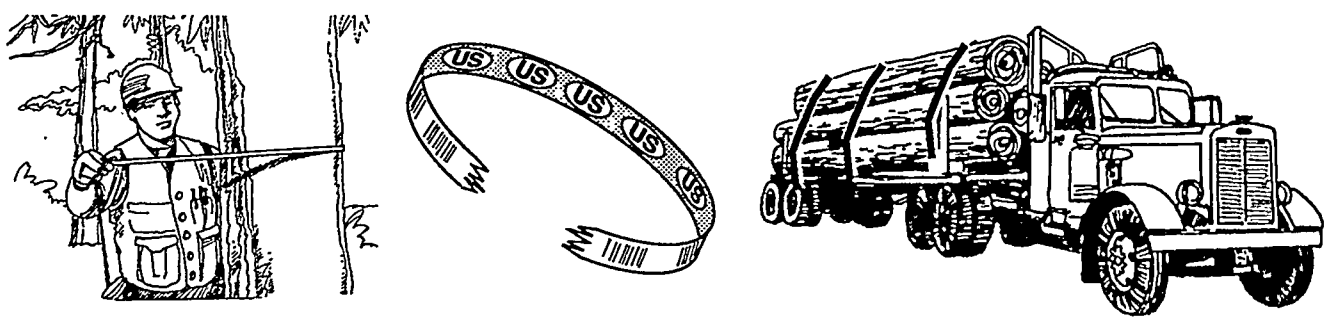

Figure 10. Example of a secured band.

In retrieving, using and storing the data from the bar code, it is envisioned that all the hardware can be purchased off-the-shelf. New concepts or technological advancement are not necessary. The District would have hand-held scanners, powered by rechargable batteries, which would read and display the codes in their simplest form. The scanners would be compatible with popular electronic data loggers currently in use. A wand would be added to these initial scanners that could detect small metal objects (the staple) when stapling proves to be successful. Connectors and cables would also be available so the scanner could be used in conjunction with off-the-shelf data processing equipment in use by scalers.

PROTOTYPE DEVELOPMENT

Office Management System

A team of foresters and bar-code specialists should be organized under a Project Leader to outline a management system. This team would select District(s) for initial prototype testing and management system development. Participation in this process by the Technology

and Development Centers might cost $15,000 to $30,000 per year for a period of 3 to 5 years.

3 TO 5 YEARS
$45,000 TO $150,000

Label for Log Butts. A survey of major timber producers should be conducted to design a label that can be used most effectively by all parties involved. Concurrent with this, label and adhesive manufacturers need to be searched out to select the most promising approach for permanently attaching the label to the log. A market search of compatible bar-code scanners and District printers would need to be completed.

Engineering and associated development expense should be avoided in assembling a batch of prototype labels, and the process should be aborted if adequate bonding is not apparent during trial use. A prototype batch of labels and a few of the more promising scanners and a printer could be assembled, and labels could be installed on logs for trial use within 1 year with a budget of $40,000. Monitoring their use and life and writing a report could take another year or two, at an annual cost of $20,000 per year.

1 to 3 YEARS
$60,000 TO $80,000

Bar-Coded Staples. A survey of timber staffs at the local level should be conducted to allow evaluation of this concept from the grass roots. Ideas should be encouraged and the concept aborted if broad-scale support is not apparent. Concurrent with this, staple, scanner, and printer manufacturers would need to be contacted to select the best staple size and stapler and to prepare specifications to purchase a printer. Some development work on staples, a staple gun, and a printer is envisioned. A large batch of prototype staples and a few of the more promising staple hammers and scanners and one printer could be assembled. All the accessories for identifying where the staple is placed and for securing the location of the hammer would be deferred in assembling this prototype kit.

Staples could be available for installation within the first year at a cost of $43,000. Sealable staple hammers could be developed in the second year at minimal cost by the manufacturer. One might speculate that this could be done for as little as $25,000 with much of the funding used to purchase a supply of hammers. Adding the paint spraying, flagging, or branding attachment to the hammer would be more costly and take longer. One might speculate that this could be developed in 2 years at a cost of $100,000. Developing the capability to control the location of the staple gun and report to the dispatcher that it is missing would also take a year or so and cost upwards of $100,000. Developing metal detecting capability for the scanner in the second year would take a year, and one might speculate that this also would take $100,000 because it would require highly technical skills. Monitoring use, recommending changes, and reporting for a three year period might cost $25,000 per year.

1 TO 5 YEARS
$43,000 TO $418,000

Plastic Strapping with Bar Codes. Scanning, strapping, and printer manufacturers would be contacted to gather a clear understanding of product availability and select the best strap, hand banding devices, scanners, and printers. All of these products are readily available in the market place. During this investigation, the costs for embossing the Forest Service shield on the back of the strapping and for embedding the Forest Service shield in the seal would be gathered for consideration after successful prototype evaluation. Strapping, hand tools for banding, a printer, and a few scanners could be available for use within 6 months at a cost of $30,000.

Customizing the hand-held banding devices with serial numbers, and including the capability to emboss a shield over the joint, could take a year and cost $25,000 in up-front development cost. Providing an accessory for monitoring the proximity of the large bander used by the purchaser's representative would take a year and cost $100,000. The transmitter could be identical to the one envisioned with the staple hammer, but power could be provided by the bander which has

a rechargable battery. Monitoring use and life and reporting might cost as much as $25,000 per year for 2 years.

0.5 TO 2.5 YEARS
$30,000 TO $205,000

PRODUCTION COSTS

Table 1 illustrates an example of costs for bar coding on a District where 25 MM bd.ft. of timber are marked annually. The logs are estimated to average 500 bd.ft., meaning that a minimum of 50,000 bar-coded messages will be installed on logs. Another 5,000 will be used to mark boundaries and important leave trees. The table is broken down into fixed costs and variable costs and is separated into three columns based on how the messages are attached to the log. Manual labor is based on $25 per hour direct for the Forest Service and $40 for the purchaser's employees. Indirect and overhead expenses are ignored.

Table 1. PRODUCTION COSTS FOR BAR CODING

(NOTE: Modems, data loggers, software, and PC'S NOT included in estimate.)

Fixed-cost items	**Adhesive**	**Staple**	**Strapping**
Hand Tools	0	2,000	2,000
Accessories—radio	0	2,500	2,500
Accessories—brand	0	1,000	0
Accessories—paint	0	1,500	1,500
Printer	6,000	10,000	6,000
Scanners (12 ea.)	9,200	9,200	9,200
Total fixed costs	**$15,200**	**$26,200**	**$21,200**
Amortized over 3 years	**$~5,100/yr**	**$~8,700/yr**	**$~7,000/yr**
Variable Costs			
Materials w/10% waste	$36,000/yr	$ 6,100/yr	$ 725/yr
Printing labor (3 days)	500/yr	500/yr	500/yr
Installation labor—purchaser	8,500/yr	5,200/yr	42,00/yr
Installation labor—FS	N/A	1,250/yr	4,200/yr
Annual variable costs	**45,000/yr**	**13,050/yr**	**47,425/yr**
Annualized costs	**$50,100**	**$21,750**	**$54,425**
Cost per message	**$1.10**	**$0.40**	**$0.99**

Where Do We Go from Here?

The proposed activity outlined above has not begun and nothing is planned between now and the time that project assignments are made for future years. Nevertheless, a Forest in eastern Washington and South Dakota have been using bar codes in their timber sale program for some time. Advanceing bar-code technology from that point through the field testing of new adhesives for labels, and trial use of coded straps and staples appears to be the next logical phase of development from a service-wide viewpoint. A test plan for the first years development activity is shown in table 2. It is broken down according to labor, contract, and travel costs.

The chances of technical success appear promising because most key items are avaliable in broad-scale use. At this point in time, it appears that implementing bar-code technology into National Forest operations will undoubtedly succeed from a technical standpoint and would fail only if operating costs and/or resistance to change are the driving forces or if it were determined that there was little if any value in coding the message. The reader is asked to remember that this viewpoint is based on a very broad, limited overview of the subject.

Table 2. ACTION PLAN—FIRST YEAR

	Action item	Labor	Mat'l.	Travel
1.	Be on a team to outline mgmt. framework	$10,000	N/A	$6,700
2.	Conduct a survey of major timber producers to gather label design criteria	4,100	2,500	N/A
3.	Summarize findings from above; design label	4,100	N/A	N/A
4.	Survey market; purchase promising adhesive for trial use	5,000	3,300	N/A
5.	Select District; plan test; install labels; monitor for 6 mo; issue report	8,300	N/A	5,000
6.	Survey market; purchase 4 ea., 3 makes of portable scanners; have trial Dstrct. use	6,700	16,000	N/A
7.	Miscellaneous bar-code printing	800	1,600	N/A
8.	Survey market for staples, select size; purchase several cases; paint back; print bar code; purchase 4 staple hammers	8,300	2,500	N/A
9.	Select Dstrct.; plan test; install staples; monitor for 6 mo; issue report	8,300	N/A	5,000
10.	Survey field for thoughts about stapling and/or strapping codes	2,000	N/A	N/A
11.	Survey market; purchase 2 hand-held metal detectors	2,000	5,000	N/A
12.	Purchase strapping for tree & log load banding; print bar code on front/emblem on back; purchase 4 hand sealers	800	8,300	N/A
13.	Select field units; plan test; install strapping; do time & motion studies; monitor for 6 mo; issue report	8,300	N/A	5,000
	Subtotals	**$68,700**	**$39,200**	**$21,700**

Total $129,600