In pursuit of precision

It may be a while before the new art of precision forestry is practised widely, but eventually it could help save forestry from self-destruction

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BUDDHIST monks in Japan are said to manage the trees around their temples on a cutting cycle of a thousand years. They have growth records for individual trees stretching back centuries.

Could all forestry be like that? Sustainable forest management must surely be within reach when we know what is happening in the forest at such a fine scale.

Mostly, though, forestry is not very precise, or accurate: foresters tend to rely on rules-of-thumb in the preparation and implementation of management plans. In the last few decades, too, loggers have mostly used the very blunt instrument of the bulldozer to go about their business.

Monks don't have a particularly high demand for timber, nor for profit, and few of us can live like monks. In the harsher world of commerce, timber must compete in the market with a whole lot of alternatives. To make a profit, companies extract the timber as quickly and as cheaply as possible; in effect, they reduce the precision of forest management in order to increase the efficiency with which they make money. But perhaps the coming of precision forestry will change all that.

Defining precision forestry

Perversely, a precise definition of this new approach is elusive, although several alternatives were put forward at the 'First international conference on precision forestry' convened recently in Seattle, USA. In one speaker's mind, precision forestry was the linking of forest management to precise locations in the field using advanced methods of information technology. Another defined it as 'the use of increasingly high-resolution data to make forest management decisions at an increasingly fine scale'. Others spoke of linking information about the forest stand and individual trees with the chain of timber supply. Precision forestry is new because many of the data collection, storage and communication technologies are new, at least to forestry.

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The technologies

Indeed, a casual observer would be forgiven for thinking that precision forestry was the exclusive domain of techno-nerds. Certainly, it is awash with acronyms—LIDAR, GIS, GPS, CT, and so on. This is what some of them mean:

GIS: a basic prerequisite for precision forestry is the ability to store and analyse the vast quantities of data that can now be collected. Geographic information systems have been in widespread use in forestry agencies for a decade or more and are now a reasonably mature technology. They are computer-based applications for the acceptance, storage, analysis, retrieval and display of spatial data; that is, data which are somehow described in terms of their geographic location. Without GIS, many precision forestry technologies would be useless because there would be no way of handling the data they collect.

GPS: global positioning systems have also been around for a while and are used routinely in aircraft and ship navigation and increasingly in car navigation systems. They could be used in forestry. For example, Professor Gero Becker from Germany outlined an 'ideal' harvesting system on privately owned land in which harvesters are equipped with a GPS, digital maps of harvesting areas and other technologies. The map contains information such as tree characteristics, property boundaries, and the location of features such as swamps, drainage lines and buffer zones. The operator sees this information on his display inside the cabin; the GPS gives the harvester's location, so the ownership of each tree can be recorded on the harvester's computer even when property boundaries are not clearly marked in the field. During harvesting, the harvester automatically takes length and diameter measurements of the stem every 10 cm; these stem profiles are matched by the onboard computer with the buyer's demand tables so that cross-cutting can be executed according to the buyer's exact needs. Each log is then 'tagged' with this information using barcodes or microchips while simultaneously the information is relayed to the mill and the owner via wireless communication. Thus, even before the log is taken physically out of the forest, buyers—and owners—have access to a wide range of information on the product. Other links in the supply chain—forwarders, processors, and so on—would use similar tools in their operations.

One of the drawbacks of GPS is that it is not particularly accurate under a heavy canopy (such as in most forests). Joel Gillet spoke of a system that combines a GPS with an inertial navigation system containing gyros and accelerometers that track the course of the vehicle or person carrying the device in 3-dimensional space; when conditions allow, the device 'checks' its position using the GPS. The accuracy of this sort of system is increasing but the cost is probably prohibitive at this stage.

LIDAR: LIDAR (**li**ght **d**etection **a**nd **r**anging) is a relatively new addition to the suite of remote sensing technologies now available. It works by emitting an infrared laser light pulse and recording the time it takes for the pulse to strike a target and return to a receiver. From this time it is possible to calculate the distance to the object, because we know that the light pulse travels at 3×10^8 m per second and distance = velocity divided by time. By sending out thousands of pulses a second, aircraft-mounted LIDAR can quickly gather large quantities of data about the terrain over which it passes.

This technology has a number of potential applications in forestry. Mounted onto aircraft—fixed wing or helicopter—it can be used to survey forests, producing digital terrain models and estimates of tree and stand height, stand density, and tree and stand volume. One paper presented at the conference investigated the use of a LIDAR-generated digital terrain model for road design; it can provide fast and accurate estimates of earthworks and may eliminate or at least reduce the need for ground surveys. LIDAR can also be used for such diverse purposes as tree height measurement and logging planning.

CT scanners: computerised tomography scanners are rather different tools of precision forestry. In widespread use in medicine, these instruments use x-rays to produce high-resolution density maps of internal structures. When applied to logs they can distinguish grain patterns and knots and other defects; such information could help saw and veneer mills to optimise both the recovery of timber and its aesthetic qualities. Tim Rayner of InVision Technologies suggested that CT scanners could be used to grade logs prior to sale; making the information available to prospective buyers, perhaps via the internet, would be a powerful marketing tool.

Microchips: How can a log be cut, transported and milled without losing its information? One idea is to tag it with a microchip that is attached to the log at felling; information can be added as it progresses along the production line. The same idea could be applied to living trees: a microchip attached to a tree could collect information about that tree's growth over time and then transmit it periodically—providing it has a source of power, such as a long-life battery—to a remote receiver. Fanciful? Maybe, but the technology is almost there.

More than the sum of parts: for it to be something special, precision forestry will need to be more than a few new technologies. Its real promise lies in its ability to improve the forestry process, not only helping to collect information but to use it for better and more transparent decision-making.

Applying it to the tropics

What role might precision forestry play in the tropics? In natural forests, a great deal more precision could be brought to bear on management with limited use of the new technologies. For example, regulations in some tropical countries require that each tree in a logging compartment be measured and mapped before logging (a level of precision unknown in many temperate logging operations). GIS and, perhaps, GPS systems could be—and, in some cases, are being—used to help plan reduced impact logging operations, increasing the accuracy of such information and its availability.

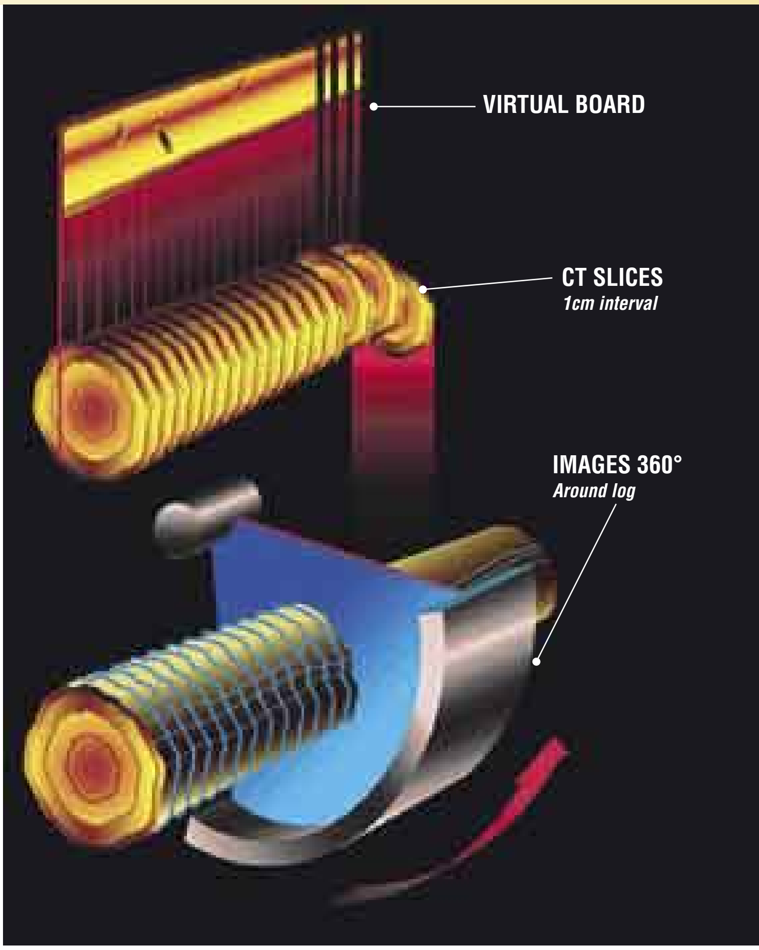
Precision forestry at the high-tech end of the scale will only become feasible in natural forests when the value of the forest is sufficient to warrant the investment. It might work, for example, if only timber of the highest value is to be extracted: precision forestry technologies could be used to identify individual trees of particular species with remote sensing, to monitor their growth and other ecological factors, to plan minimal impact logging activities, and to market the timber. But currently such a regime is far-fetched.

Perhaps the most likely near-term role for precision forestry is in plantations. Trees grow quickly in the tropics: applying precision forestry would help bring about the data management and quality control necessary for tropical plantations to compete with—and to out-compete—the generally better organised plantations in the temperate regions. The key question is cost, although this will come down as the technologies mature and become more widely adopted.

The future

The Seattle conference was, according to its organisers, the first of its kind. It was a low-key event, attended by about 100 researchers and technology brokers but very few timber merchants, policymakers or forest owners and almost no one from the tropics. Precision forestry is an idea ahead of its time: even in agriculture, where agribusiness has been hawking the technologies for years, only 5% of farmers in the United States have adopted them. This is partly because of the cost versus the benefit: none of these technologies comes cheap, and the pay-off, if there is one, may not be immediately recognisable either on the balance sheet or on the ground.

But the forestry sector has suffered in the past for its lack of innovation and adaptability. It has been caught in a paralysing dilemma between pleasing accountants (and shareholders) on one hand and the environmental movement on the other. Forest management at an increasingly fine scale should bring benefits to the environment. At the same time, better information about the resource will aid operational efficiency and may eventually increase profits. The technologists still have some issues to work through before the bean-counters and greenies will jump on board. The challenge for tropical foresters is to be in the driver's seat when they do.



Virtual milling: a CT scanner can be used to generate longitudinal 'virtual' boards, which can be used, in turn, to maximise timber recovery and to aid marketing. *Image courtesy Tim Rayner, Invision Technologies, Inc.*