GEOSPATIAL Technologies 101

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Forestry has entered the information age! Did you miss this headline? To many foresters, technology is not new to the management of timberland. We have been using a broad group of technologies for several years, including remote sensing (the capture and analysis of remotely sensed data such as aerial photography), database and mapping systems (i.e., geographic information systems or GIS), global positioning systems (GPS), and communications systems. Collectively, this group of technologies is referred to as the geospatial industry. In fact, as it relates to the central technology (GIS), the forest products industry was one of the early adopters. Today, practical applications continue to evolve rapidly and it is no longer if you are using geospatial tools, but how that truly impacts your bottom line.

To some, using technology investments wisely remains an elusive proposition and can lead to the sense of throwing good money after bad. Often termed the "productivity paradox", technology investments are made to improve the precision of the information, become more efficient, or to better utilize complex information from outside sources; but at times, organizations implement new technology without increasing profits.

A quick search of Wikipedia on the internet provides a list of possible explanations for the paradox:

- The tendency—at least initially—of computer technology to be used for applications that have little impact on overall productivity.
- Inefficiencies arising from running manual paper-based and computer-based processes in parallel, requiring two separate sets of activities and human effort to mediate between them—usually considered a technology alignment problem.
- Poorly designed interfaces that confuse users, prevent or slow access to time-saving facilities, are internally inconsistent both with each other and with terms used in work processes.
- Outdated hardware and related boot image control standards that forced users into endless fixes as operating systems and applications clash.
- Technology change driven by companies that profit directly from more rapid upgrades.
- An emphasis on presentation technology at the direct expense of core business processes and learning.
- The blind assumption that introducing new technology must be good.

Naturally, forest landowners want to make good management decisions about their forests and avoid making knee-jerk purchases of "cool gadgets." A little history on how far we have come using this technology in forestry might help frame the questions to ask before buying.

GENERATION 1: Software Age

In forestry, the first generation of computerized geospatial technology focused primarily on the development of GIS software using primitive Computer Aided Design (CAD) packages as initial guides. Investments were primarily made by large corporations with large land bases who recognized the need to provide more information in a timelier manner. Systems cost millions of dollars to develop and deploy, requiring highly skilled centralized users to run the programs.

GENERATION 2: Data Age

As these complex software GIS programs were rolled out to large corporations, it became apparent that to truly leverage the investment in the technology required good data. Many of the original databases were built on an ad hoc basis adding bits and pieces of mapping data from various sources and accuracies, or for example, new timber cruise information as it became available. The cost of the software was high and at times corners were cut while compiling cruise information and digitizing maps. Many faced the "productivity paradox" as poor data required "scrubbing" before it could be used prudently. A great deal of time was spent creating and entering information but firms did not recognize the need for quality standards and so procedures had to be developed to update and add information.

Slowly organizations began to address these problems and improved the quality of information that was housed in their systems. GIS technology improved and started moving into the mid-sized integrated companies and forestry consulting firms.

Landowners benefited from the increased precision in the measured attributes of their forests. For example, with the aid of a well-developed GIS, populated with good data digitized from aerial photography, the forester could more accurately tell landowners how many acres of their property were productive and how many acres fell into streamside management zones, roads, food plots, etc. In the past, this could be done only by spending hours under a stereoscope using a wax pencil and dot grid to estimate acres from the same photograph.

With the advent of digital remotely-sensed data (i.e., photography/imagery, RaDAR, LiDAR), particularly imagery from the Landsat program, new algorithms and software were developed to analyze these large datasets. In the beginning, this development was mainly carried out by academia and the military. The result of this development meant that activities that had previously required hours of manual interpretation to yield forest type maps, for example, now required the selected digital dataset and minutes of processing time to yield map results of comparable quality.

The use of GIS technology reached a plateau in the private timberland management arena and for many was used primarily to publish maps that assisted foresters in communicating forest attributes in a colorful way to non-foresters, but did not yet streamline business processes.

GENERATION 3: User Age (Current)

There are new examples of geospatial technology everywhere: GPS receivers have moved from being big ticket items on fishing boats and aircraft to the present time, where they come standard in many automobiles. More importantly, the maps loaded into these little navigation tools are constantly improving, not only giving the user instructions on when to turn left, but also where the closest steak house is to the automobile's current location. Digital imagery (or photography) has become a norm and access to high quality imagery via the internet is constantly improving. Flashy online county level red state/blue state maps help us track election results and connect untrained users to statistical information in ways that are easier to understand because of powerful dynamic graphical presentations.

For the timberland owner, this has helped drive an explosion of high quality data and tools that are relatively inexpensive to acquire, thus driving down the total cost of deploying the technology. Just a few years ago, a forester had to commission custom aerial photography to map a property; today a quick search on the internet can produce a wide assortment of good quality digital imagery. GPS tools are much easier to use, more accurate, and interface seamlessly with GIS systems, helping to prevent conflicts between applications and tedious data conversion problems. Organizations have learned the importance of quality data and have implemented business processes to monitor and normalize the information housed within these systems. This has happened just in time, as the explosion in demand for geospatial technology and information outside forestry has forced the entire paradigm of centralized complex software applications managed by highly trained specialists to break down. Complex systems are being replaced by software that is more intuitive with better user interfaces and no command line driven processes requiring less training, easing the pains of implementation.

Advances have also been made in using these geospatial tools for complex analyses. Tools are available to help the forester schedule future harvests on an individual stand basis, then display and store the results in a GIS. These systems can be taught to avoid scheduling harvests on a variety of spatial constraints, like protecting endangered species habitat or to meet various certification standards. Applying change detection techniques to satellite image datasets are used to study regional wood supplies and land use changes.

GENERATION 4: Integrated Age (Future)

The future is exciting, to say the least, as newly developed software and geospatial systems continue to improve in user ease, functionality, power, and intelligence. We already see examples of integration. Most helicopter-based chemical applications are flown with the aid of GPS. It is already common to download that data into a GIS system to keep track of flight lines, tank mixes, and weather conditions during application. This type of integration will improve as more individuals and organizations are set up to handle this data. Similarly, precision forestry, much like precision agriculture, will enable savings in chemical and fertilizer applications. Smarter logging and trucking systems will improve the efficiencies of harvesting, providing both savings in time and fuel consumption. Foresters will routinely be able to upload GPS data directly into a harvester to provide the cutter with a heads-up display showing harvest boundaries, sensitive areas, streamside management zones, and protection trees. Some of this integration will occur without going to the office, as mobile devices increase in functionality with cellular and wireless data coverage areas increasing. Ultimately, nanotechnology could be integrated into seedlings which will enable trees to report everything from its overall health to its growth and when it should be harvested.

Implementing Geospatial Technology

So, you are ready to take advantage of some of the geospatial technology available in forestry. How do you begin? First understand that the vast majority of off-the-shelf GIS programs are simply shells to hold data. Think about it like word processing software; you open the software program and a blank page opens up. It is up to you to fill in the text, but keep in mind that you have background from your third grade English class where writers learn the proper rules of grammar to communicate ideas onto paper. Successful deployment of a GIS requires rules for creating and managing the data. If you are new to the technology, look for the applications that already have business logic and rules built into them to help you standardize information and make for a gentler learning curve.

Second, think carefully about integration. Sometimes you can purchase a great piece of inexpensive hardware that comes with powerful, easy-to-use software, but the data is built upon a proprietary platform. This can limit your ability to utilize data from other sources, limit information sharing with vendors, or limit database updating as new information becomes available. This is common with the maps that come with many recreational grade GPS devices. At the other end of the spectrum, we often see individuals spend too much up front not understanding all of the limitations and difficulties in setting up the systems they acquire. Do not forget one of the causes of the production paradox pointed out above is that, at times, technology change is driven by companies that profit directly from more rapid upgrades or overly complex systems. The same can hold true for systems that are too simplistic, as they tend to have proprietary data platforms.

Third, remember that not all digital imagery is the same. Higher resolution imagery for a given area requires more processing time and computing horsepower than lower resolution imagery. Often, very useful tasks like broad forest typing can be accomplished with lower resolution imagery. In addition, imagery, to be truly useful to a GIS, often needs to be orthorectified. An orthophoto is an aerial photograph that has been geometrically corrected such that the scale of the photograph is uniform. Unlike an uncorrected aerial photograph, an orthophoto can be used to measure true distances because it has been corrected for the displacement caused by the earth's surface as well as sensor itself. Simply using a scanner on aerial photographs does not provide the same quality data unless similar correction techniques are attempted.

The geospatial industry is impacting timberland management in many ways that landowners may not be aware of. At times, the sheer volume of information can be daunting, yet this technology has driven down the cost of timber management by making foresters, loggers, and manufacturers more efficient in running their businesses. It is not unusual to see larger landowners manage extensive holdings with less than half the staff that was required just a decade ago. We expect that similar efficiency gains will impact smaller landowners as knowledge of the technology, the cost of technology, the ease of the technology's use, the affordability of data, and the availability of data all improve. ◆