

FINANCIAL BENEFITS OF TELEMATICS AND MACHINE CONTROL

GNSS and Heavy Equipment



Heavy equipment represents a major capital cost for companies in industries such as construction and agriculture. In recent years Global Navigation Satellite System (GNSS) technology, which uses signals from US Global Positioning System and the Russian Glonass satellite system constellations, has been used to improve fleet efficiency. Many companies may hesitate to invest in the technology because management is unaware of its benefits. Such hesitation has only increased during the current global economic downturn. However, recent evidence has emerged to demonstrate the measurable impact GNSS technology may have on company profits.

Equipment telematics, the wireless exchange of electronic information for fleet monitoring, provides managers with powerful analytical tools to improve security, maintenance, utilisation, job costing and productivity.

Equipment Telematics

Telematics systems detect machine engine operation and wirelessly communicate the data to a web-based network for real-time monitoring; the data also can be compiled by software for periodic in-depth analysis (Figures 1 and 2).

These systems can detect when a dozer is idling or running at a higher number of revolutions per minute (RPM) while moving dirt, indicating, for example, how productive the machine is. Excessive idling time can also translate into a low ratio of fuel consumption to actual productive work. Total engine run time, or high-RPM operation, can be compiled and notifications set up at management-defined intervals to indicate the need for preventative maintenance, not just on the engine but on components and items such as hydraulic fluid. Machine servicing thus occurs at the best intervals, optimising the company's equipment and labour assets.

GNSS

Using GNSS these systems can also detect where a vehicle is. Such positioning data can be useful for alerting management of equipment theft, the location of a lost machine or unauthorised use. In addition to tracking vehicles, these systems can be used to establish geofences (Figure 3) and alert management via text message or email when a machine has gone beyond a boundary, helping management to minimise insurance costs.

Profitability Factors

Telematics has recently been shown to positively impact two factors in particular that significantly affect profitability. The first is utilisation. Management can generate fleet-wide reports to reveal, for example, how many backhoes were operated for less than three hours the previous week. Topcon reports that one customer determined via telematics that it was renting two machines at a cost of about EUR6,900

per month without once operating the machines. Analysis of idling time compared with productive time presents management with an operator training opportunity. Arguably the most useful function of analysing machine productivity with telematics is that it provides an opportunity for more accurate project estimating, which sets rates that allow recovery of equipment capital costs while maintaining overall project profit margins.

The second factor involves fuel costs. These have constituted an increasing percentage of operational costs over the past few years. According to Topcon, T.J. Lambrecht Construction, a large US excavating and grading contractor that operates about five hundred construction machines and the Tierra system, reduced its fuel costs by thousands of dollars per year just by using telematics to monitor engine idling time throughout its fleet.

Machine Control

No technology has had a greater impact on excavation and grading work in the past few years than GNSS machine control. Still, it is estimated that less than 10% of the world's heavy equipment has been outfitted for machine-control operation. These systems use a GNSS antenna and receiver box mounted on a machine such as a dozer, grader or excavator. Satellites send positioning data to another antenna/receiver combination at a stationary base-station. Positioning data is also sent to the machine. Some contractors subscribe to a cellular network that provides positioning corrections using cellular technology, replacing a base-station and eliminating setup time for the latter. The stationary base and machine work together provide real-time kinetic (RTK) position information, revealing the machine's three-dimensional location on the site. Software compares the machine's position to the design grade, built from site plans, at a given location. The control box updates positioning data and sends signals to the hydraulic valves. Other sensors inform the control box of certain machine conditions; for example, a dozer is equipped with a slope (tilt) sensor on the blade to measure the cross-slope of the cutting edge. 'Indicate systems' like Topcon's 3-D systems provide visual guidance for machine operators, who manually control the machine to cut or fill to the desired grade (Figure 4). In a fully automatic system, the blade is automatically positioned for elevation and slope.

Four Savings

A major indicator of the financial benefit of any capital investment is 'payback', or how long it takes to generate enough profit to equal the investment cost. Beyond this point the investment should only increase overall company profit. Although the savings vary according to differences between machines, workers and jobsites, the contractor can determine payback on machine-control technology by focusing on four areas of savings provided.

- **Production:** when a dozer requires fewer passes to get a site to within specifications, this can result in faster project completion and lower construction costs for project owners. The operator can cut or fill with confidence and avoid rework. The time savings also yield savings in materials, labour and fuel. Two recent advancements in machine control are further increasing production savings. The Topcon 3D-MC2 system uses an inertial sensor to provide blade position readings up to a hundred times per second, an increase of roughly five times over conventional GNSS, enabling twice the productivity of other systems and four times the productivity of grading without the use of machine control. The Topcon Millimeter GPS+ system combines laser and GNSS, making it suitable for precise fine grading.
- **Materials:** grading to specifications can save on material costs. The contractor uses less soil, base material and asphalt or concrete when machine control gets the grade closer to specification than conventional grading methods. The machine-control technology provider's analysis determined that grading 0.006 metre of EUR13-per-metric-ton material closer to specification through the use of the 3D-MC2 system resulted in a savings of about EUR1,870 per kilometre.
- **Labour:** machine-control technology can drastically reduce the need for grade checking, either by the contractor's own personnel or by third-party services. This can save several thousand dollars in construction costs. Most contractors have established hourly rates for equipment plus labour. The contractor should determine what his hourly rate will be for a GNSS rover and operator and compare the cost with that of a surveying crew. The machine-control technology provider's cost analysis determined that reducing the distance between fine-grading stakes by half and the number of stakes per station by two-thirds, possible through the use of machine control, reduced the staking cost from about EUR3,300 to about EUR560 per mile.
- **Fuel:** one of the largest impacts on profitability for every earthmoving operation today is fuel costs. Recording a machine's fuel costs per hour, both with and without machine control, is perhaps the best way to determine the impact of the technology.

Calculating Payback

The contractor must also incorporate the cost of a machine-control system when estimating a project. A fully automatic system costs more than an indicate system. To determine the cost of operating any GNSS-enabled piece of heavy equipment, a simple calculation based on percentage of investment will suffice.

Payback periods vary greatly with the business skill of the contractor and the scale of projects. It is not uncommon for contractors to report that the cost of technology was recovered from savings realised on a single project. One machine-control technology provider conducted an analysis of reductions in site-work time and the corresponding savings that machine control can provide. According to the analysis, reducing the number of grader passes necessary to get to grade with a conventional system saved more than EUR12,000 on one site-work project and allowed a payback of the investment cost in just days (see Table 1).

| Production Savings | Material Savings | Staking Savings | |
|---|--|---|-----------------------------------|
| Length (metres): 300 | Project size in square metres: 30,000 | Project size in square metres: 30,000 | Total Savings: €12,631 (1.9 days) |
| Width (metres): 100 | Thickness of material saved: 0.005 metre | Number of surveyors: 2 | System cost: €62,500 |
| Number of passes to get to grade: 8 | Cost per metric ton*: €12.85 | Rate per hour: €104 | System payback: 9.4 days |
| Average crew cost per day: €2,430 | Total Material Savings: €3,624 | Square metres staked per eight-hour day: 10,000 | |
| Crew Cost for project: €6,075 | | Number of lifts requiring staking: 2 | |
| Number of days to grade project: 2.5 | | Total staking cost: €9,984 | |
| With machine control, number of passes reduced by: 2 | | With machine control, staking reduced by 75% | |
| Increase in productivity: 25% | | Savings in staking costs: €7,488 | |
| Production Savings: €1,519 (in 1.9 days) | | | |
| * (Calculation based on material weight of 1,880 kilograms per cubic metre) | | | |

Competitive Contractor

Many contractors stay competitive by using the profit generated from the increased productivity as a buffer against inflationary costs. The true advantage of reducing costs makes it possible for small operators to compete at the bid table with larger companies that may be shying away from advanced technology.

