Smart Vehicles

AWASH IN SENSORS, MONITORS, COMPUTERS AND COMMUNICATION EQUIPMENT, TODAY'S HEAVY MACHINES ARE ABOUT MORE THAN MUSCLE.

BY ALEXANDER FARNSWORTH

It is indeed a brave new world, at least where industrial-strength vehicles are concerned. There are forestry machines that can walk and huge bucket loaders that can be remotely diagnosed over the Internet. And the future promises still more, including autonomous satellite-controlled mining trucks and wheat harvesters that farm by the foot and not the acre. At the Kiruna iron ore mine in northern Sweden, operators already control huge boring machines from displays situated in an office. Even ore extraction is remotely controlled.

Fueling these developments in heavy machinery are concerns about increasing productivity, conserving energy, reducing emissions and increasing operator comfort and safety. There are also regulations in many countries governing emissions and noise levels. The tools that off-highway vehicle designers use to design more efficient, user-friendly machines include wireless communication technology, the Internet, logistics, industrial design, electrohydraulics and old-fashioned engineering.

In general, the electronic components on a backhoe, bucket loader or wheat harvester are used to coordinate engine speed and hydraulic output to provide just the right level of power. The desired result is better machine control, fuel savings and longer component life. Other reasons for sophisticated electronic systems include monitoring onboard systems and communicating directly with the customer or the head office.

"The trend is toward more automation and increasing the amount of data that is sent between the machine, the office and the machine," says Juha Vainio, research and development manager at the harvesting and forwarder division of forestry equipment manufacturer Timberjack. "If a saw mill wants 1,500 cubic meters of 5.8 meter-long spruce logs, it can send this information via modem or phone directly to the harvester, which will cut exactly what the mill wants. But there is also a trend towards lighter machines and more environmentally friendly engines."

A household name for forestry specialists, Timberjack is at the forefront of innovative harvesting technology. In addition to advanced measuring systems, Timberjack has developed an insect-like walking machine that crawls around the forest on six articulated limbs, thereby minimizing the ground disturbance. This futuristic machine is still a prototype.

For some machines, the future has already arrived. *Hydraulics and Pneumatics* magazine reported in its April 2001 issue that the LBX Company, maker of Link-Belt equipment, launched an excavator with a fully electronic control system. This system eliminates mechanical linkages and throttle motors, resulting in a quieter, smoother and more fuel-efficient engine. It also regulates engine performance for the optimum balance of speed, power and fuel efficiency.

According to the trade press, many of these enhancements are attributable to the development of hardier and more environment-proof sensors. After all, bulldozers, tractors, forestry machines – all heavy machinery – work in abrasive environments with dust, sand, water, snow and huge variations in temperature.

THE GLOBAL CATERPILLAR group also has some nifty technology. Weighing in at about twice the tonnage of a fully loaded Boeing 747, the Caterpillar 797 mining truck is the biggest ever made – it weighs 615 tons and carries 360 tons – and is also one of the most intelligent.

Eight onboard computers and an array of sensors provide up to 170 inputs of data per second on everything from oil pressure to transmission torque to tire temperature. These data are used to enhance the truck's performance and productivity, and even to predict a component failure before it happens.

With Global Positioning Satellite (GPS) technology, operators of mining and earth-moving equipment can work more productively. Thanks to a visual display in the cab, operators can see real-time color-coded images of where soil needs to be removed and where it needs to be placed.

Other advanced GPS applications include systems that can keep a truck or a loader on the most efficient route around a mine or a quarry. In addition, Caterpillar's Minestar system allows companies to follow the current condition of their equipment over the Internet via a password-protected Web site.

The Deere Company has similar systems. The Deere Trax monitoring system combines wireless communication with GPS, allowing heavy equipment managers to know the exact location of all the machines in their fleet and how many hours they have been running.

There has also been a trend to incorporate high technology into farming machinery. By combining GPS technology with extensive data analysis, tractors and harvesters can manage their crops better in a number ways.

Precision agriculture, as it is called, keeps the machinery moving in a straight line across a field even at night. This parallel tracking technology, developed by Deere, remembers each pass through a field and the machine's location, to optimize the yield from the field.

While there has been fanciful talk about operatorless machines that drive themselves with the help of GPS systems, such

THE CATERPILLAR 797 MINING TRUCK BOASTS EIGHT ONBOARD COMPUTERS AND AN ARRAY OF SENSORS THAT PROVIDE UP TO 170 INPUTS OF DATA PER SECOND.

PHOTO COURTESY OF CATERPILLAR

TECHNOLOGY SUCH AS COMPUTERS, MONITORS, SENSORS AND COMMUNICATION EQUIPMENT CAN BE FOUND IN MOST OF TODAY'S HEAVY MACHINES.

PHOTO ALEXANDER FARNSWORTH

machines are unlikely to turn up soon, says Paul Torgersen, product-planning manager at Volvo Construction Equipment.

"The possibility is there, but it has to be for very special applications," he says. "To have a fully automated machine remotely controlled from somewhere else would require the machine to perform many repetitive movements. This is rare in a construction machine."

But when automation does get here, it will change things completely, says *OEM Magazine*. In a white paper on technology convergence, it states: "The basic structural geometry of the machine, such as lines of sight, is configured already in the design stage. Removing the operator will in time radically change the way equipment looks, functions and costs."

One factor fueling the drive to build autonomous machines is that the machines could work longer per shift than a comparable truck with an operator. The key technology in this is of course GPS, although one of the most probable applications would be in hauling trucks in underground mines, where GPS reception tends to be poor.

The fact that people are behind the controls of a construction machine is still undoubtedly what drives most developments. It is a question of ergonomics. For example, Volvo uses an automatic power shift transmission in one of its wheel loaders to ensure that it is always in the right gear, in addition to providing smooth shifting between forward and reverse.

In the past, the controls of heavy machinery would typically consist of a forest of sticks between the operator's legs. Today, the operators of logging machines, earth-moving machinery such as wheel loaders, and wheat harvesters are more likely to be comfortably ensconced in a sound-insulated cab, while their arms rest on ergonomically designed armrests. A series of finger-controlled toggles and switches do all the work.

While there are some far-flung futuristic ideas circulating in the heavy machinery trade press – a new technology that focuses music or speech into a listener's personal space has already attracted the likes of Daimler Chrysler. Most of these developments are concerned with increasing a machine's performance and productivity.

"It is a 'What came first, the chicken or the egg?' problem," comments Volvo Construction Equipment's Paul Torgersen. "Is it the customer that is demanding these developments, or is it the technology itself? You have to wonder sometimes."

Either way, progress can't be stopped. The global SKF ball-bearing group is currently developing drive-by-wire technology that uses electrical cables and actuators to do the work of a vehicle's wheel and steering column. For vehicle designers, such an advance would free up an enormous amount of space and reduce the vehicle's weight, which in turn would lead to fuel savings and lower emissions.

With GPS, the Internet, online condition monitoring, engine reconfiguration and a host of other promising technologies, heavy-equipment designers are increasingly enhancing their vehicles for the needs of today. Besides performance, some other key factors leading this trend include ergonomics, developing peak power output, reducing noise and emissions, and increasing operator safety. For manufacturers and their suppliers, technology that addresses any of these issues and keeps their vehicles moving is nothing short of a competitive edge. □

COOL SYSTEM

Allowing heavy-vehicle designers greater flexibility to package subsystems independent of engine location is a driving force for Haldex. The company's Hydraulics division is capable of providing a totally integrated electrohydraulic cooling subsystem for such vehicles.
The Haldex hydraulically driven fan subsystem allows the designer freedom in selecting the location for the cooling system in the vehicle. This in turn has a significant effect on total vehicle noise output and allows today's strict emissions requirements in engines to be met.
The subsystem provides greater power to the vehicle's propulsion system by limiting the cooling power to what is actually needed in real time. This precision cooling is achieved by either the vehicle control system or by integrated controls provided by Haldex Hydraulics.
Because these cooling requirements are being managed in a way that is transparent to the operator, the vehicle designer can pay more attention to the vehicle's performance.