Caterpillar® ECO Operator training: A win-win scenario for vehicle operators and quarry managers

Following the success of European and US trials, the Caterpillar Institute (CIVT) conducted a number of pilot programmes of the ECO Operator course in Australia at Boral and Cemex sites in Victoria and Queensland. Damian Christie (of Quarry magazine) spoke with Caterpillar Institute's Richard Beard and Steve Antunovic about the outcomes and how quarry operations can benefit from learning new ways of conserving energy and fuel.

The Caterpillar Institute (CIVT) is a Registered Training Organisations that has been established as a joint venture between Caterpillar and William Adams Pty Ltd. CIVT provides Technical, Operator and Safety training and assessment services across a range of industries including Quarrying, Mining, Agriculture, Local Government, Building and Construction and Road Transport.

With Australian industry likely to be engaged in a Carbon Pollution Reduction Scheme from July 2011 onwards, the way quarry operations run their businesses now will have to change. In particular, quarries will have to demonstrate a concerted effort to reduce their carbon footprints. Diesel fuel is undeniably a major carbon-inducing component in quarrying – being emitted in all facets of the quarry operation, starting with the drilling, loading at the face, transport to the crusher and then transport of the construction materials from the quarry site. Nevertheless, it is expected there will be opportunities to make considerable savings through reducing fuel usage – thereby lowering carbon emissions and extending the working life of diesel-powered machines in the quarry environment. The ECO Operator course may provide a means, through its emphasis on fuel reduction, for quarry operations in the long term to reduce carbon emissions.

ECO OPERATOR PROGRAMME

The ECO Operator course aims to educate experienced operators of mobile equipment about best practice techniques for reducing fuel consumption, which in turn can contribute to increased fuel efficiency, an increase in engine working life, savings in service cost, improved safety, and a reduced carbon footprint. The heavy equipment covered in the course includes excavators, wheel loaders, off highway trucks, articulated dump trucks, dozers and track-type tractors.
The ECO Operator training programme was introduced in Europe and the United States in 2008. (CIVT) has in recent months introduced the course into the Australian market. It conducted three pilot courses in March, April and May this year. Two of the courses were held for Boral at its quarries in Bacchus Marsh (Victoria) and Stapylton (southeast Queensland) and the third for Cemex at Oaklands Junction, near Melbourne Airport. In May 2009, CIVT also assisted Caterpillar Australia's Equipment Training Solutions team in introducing the ECO

Operator Training programme to Caterpillar's Australian and New Zealand certified dealer instructors.
Richard Beard, an operator trainer for CIVT for the last four years, said that the ECO Operator course was directed at "plant operators who spend a lot of time in the machine" and seeks to address "some, what we call, 'bad habits'."
"The course looks at the way that the operators run the machine," Richard explained, "and identifies different techniques to improve their capabilities which results in lower fuel consumption and less emissions into the environment.
"The objective is that we don't sacrifice productivity to achieve fuel reduction. The idea of this training is to make the operators aware that we can run the machine more efficiently to achieve fuel reduction without sacrificing productivity."
"The general skills of the operator when he or she starts are always at the basic level," explained Steve Antunovic, the business development and marketing manager for CIVT. "This is no different in lay terms to how we learn to drive a car. Most drivers learn the very basics of starting and operating a car. Further skills are developed through self-practice, which is where bad habits can be developed and become ingrained. Very few drivers, once they have their licence, consider an advanced driving course in order to eliminate bad habits and improve their safety and driving technique on the road. Similarly, the ECO Operator training provides an avenue for operators to improve their skills which have broader benefits in the quarry from the very next day."
The theory session of the course covers the essentials of machine operation, including:

- Fuel consumption and conservation.
- Definition of work and performance, including variables of fuel economy, ie underfoot conditions, type of material (eg rock, soil, clay), material density, weather and climate conditions, operator experience/skill set, use of the right equipment.
- Engine performance measurements (including RPM ranges and gears).
- Ideal working ranges for the torque converter.
- The impact of tyre and track maintenance (including rolling resistance, tyre pressure, differential locks, track undercarriage designs, track tension).
- The impact of ground engaging tools (GET) on machine performance, especially in terms of lifetime, penetration and durability.
- Correct use of equipment in the working environment, eg machine selection, fill factors, truck loading, excavator/truck positioning and dozer efficiency.
- Environmental features, eg remanufacturing and rebuilding, biofuels, extended coolant life, biodegradable hydraulic oil, particle filters.
- Video examples/case studies of best and worst practices.

Richard Beard said that course topics such as engine performance, GET and suitable torque ranges encourage the operators to think about new ways of conserving energy without sacrificing productivity. "If we take wheels and tracks, for example, I explain to the participants the importance of the correct tyre

pressure to minimise rolling resistance. By maintaining the correct tyre pressure," he said, "it prevents unnecessary lagging of the engine which uses less fuel. Another topic that we discuss is GET, to ensure that they select the right tools for their application and that they maintain, monitor and replace them as required - in high impact/rock/hard-to-dig environments, GET selection can have a very big impact on productivity."

The operators are encouraged at the start of the training programme to operate a specific vehicle in controlled conditions (eg operating a wheel loader to make passes from the stockpile to load a dump truck). They then spend an intensive morning session on the essentials of machine operation theory before returning to the cabin to operate the machine again, where they have the opportunity to practice the theory they have learned in the morning session. During the hands-on component, each operator's performance is monitored in real time, with engine data - including the cycle time, engine speed and fuel burn rates - being captured by a wireless radio link from the engine to a computer. This live data, collected and monitored by Caterpillar's Electronic Technician software, is used to compare the effects of the training on fuel consumption and efficiency.

"One of the objectives in the outdoor practical session is to time the operators, to see if they are within the production envelope of the cycle time, to give them advice as required and also to identify different techniques," Richard Beard explained. "I feel that by seeing it all first hand, seeing the machine run and seeing the graph and the numbers on the screen, the candidates comprehend the difference.

"It's very beneficial that they can see the monitor and the fuel consumption being burnt at the same time and can appreciate the comparison between the two techniques. They can then relate the practical results back to their learning in the theory component about cycle times and what they can expect to load into a dump truck in may be three or four passes."

AUSTRALIAN CASE STUDIES

While there has been some data gathered for the ECO Operator training conducted abroad, mainly in Europe and the United States, CIVT preferred to conduct its own Australian case studies, based on the courses it has run so far this year, to demonstrate the potential cost savings for quarry operations. Steve Antunovic explained that CIVT's intention was to simulate the working environment for the operators so that the data captured on site was as accurate as possible and reflected the actual work environment.

"We do not ask the operators to overextend the machine or do anything which is different from what they would normally do," he explained. "They are directed to operate the machine to the best of their ability, as they would in their own workplace. Initial fuel, RPM and cycle data is captured at this time. After they have sat through the theory, the operators are then expected to have grasped enough of the concepts to apply them in the second simulation session, at which time the second lot of data is captured."

The data gathered from CIVT's pilot courses suggested significant cost savings in fuel burn, the extension of engine working life and a reduction in carbon emissions.
Table 1 shows combined mean data that was captured in the morning session of the course – before the theory component - and then in the afternoon session. This includes the results of the most improved operator and the least improved operator from all three pilot courses. The most improved operator showed a reduction in fuel burn by 9.79 litres per hour, while the least improved showed a reduction in fuel burn by less than one litre per hour. The average saving in fuel burned of all operators in these trials was 3.56 litres per hour or just under nine per cent.

	AM Session			PM Session			
Operator	Load time Secs	Engine RPM	Litres / Hr	Load time Secs	Engine RPM	Litres / Hr	Fuel Burn Reduction
Most	58	1597	45.36	73	1338	35.57	-9.79
Least	88	1322	38.16	86	1279	37.49	-0.67
Average	78	1374	39.9	79	1272	36.3	-3.56

Table 1. Data captured prior to training and at the end of the training day.

To support the course day findings, CIVT also charted the progress of at least one operator from each of the pilot courses before and after the training. This involved gathering data on one of the operators conducting their regular tasks in their working environment prior to each course and then assessing the fuel burn rate of that operator after they had completed the course to show that there was a significant level of performance improvement as a result of their learning.
After analysing the data based on all the participants, CIVT has concluded that on average it is possible for operators to reduce fuel consumption between six and nine per cent. If one accounts for idle time with earthmoving vehicles, the fuel saving marginally drops by approximately one per cent, but is by no means lost. In terms of carbon emissions, this equates to a reduction of 2.7kg per litre saved.
Based on its case data, using a typical Caterpillar 980G or 980H wheel loader (the vehicle used during the training), CIVT has estimated the cost savings that could be achieved in a year, assuming 10 hour operating days, a five day working week and a 52 week working year. The results are outlined in Table 2.

ECO operator test results were carried out under conditions that were set up to replicate the actual working operation. Time and data captured was during the loading process of a haul truck and it was taken from the first bucket load to the last bucket, three bucket passes were recorded for each operator. This process conducted before training started and at the end of training to capture the difference. Important to note here that each operator was asked to perform the task as they would normally do. The table below shows the likely savings that could be achieved on the job at three different percentages.

Possible fuel savings and Carbon reductions	Based on one operator using 9500 Litres per/month	Litres saved from one operator over one year	Estimated fuel cost saving over one year @ $1.20 p/l	Fuel cost saving from Ten operators	Carbon reduction from ten operators.
Fuel savings at 8.92 per cent	803	10,169	$ 11,560	$ 115,603	26,011 Kg
Fuel savings at 6 per cent	540	6,840	$ 7,776	$ 77,760	17,496 Kg
Fuel savings at 5 per cent	477	5,724	$ 6,869	$ 68,688	15,455 Kg

Table 2. The projected fuel and carbon savings that could be achieved in a year from advanced training from one and from ten operators.

Based on the estimates outlined in Table 2, Steve Antunovic explained that if "one machine in your quarry fleet consumes say 100,000 litres of fuel in a year, it would mean a saving of between 6000 and 9000 litres in the first year from just one operator. If multiplied by ten or even a hundred operators, the savings become more significant".

He added that the flow-on effects from achieving this saving can result in other net gains for the quarry plant, particularly with regards to maintenance, servicing and productivity. "It is possible that the engine life could be extended by an equivalent amount of fuel reduction litres or percentage.

Based on actual fuel data collected since the May 2009 training, indication is that the table 2 projections of 6% in fuel savings is being achieved.

"There is the potential for an operator to save up to 12,000 litres on just one machine, and that is going to contribute enormously to an extended engine life. It also means that if reduced fuel consumption is applied across a fleet of machines, then a quarry operation can potentially re-evaluate the need and timing for servicing and maintenance of its vehicles and reconsider its purchases of new machinery until the following financial year, in turn generating more savings."

Richard Beard added that while a reduction in fuel consumption and increased engine life can be valuable for a quarry operation, it is partially dependent on several factors. "There are many contributing factors that can affect fuel

consumption. For example, rolling resistance can have a big influence, including just after rain, and obviously if you have wet haul roads, there will be some resistance there. Maintenance and the initial design of the haul roads will have a big influence on fuel consumption, and generally the application and the material itself. What we are loading in our practical sessions is dense graded sand, so it is heavy material and that also contributes to fuel consumption."
Steve Antunovic added that the positioning of vehicles within the loading area is also conducive to fuel consumption. "The placement of the dump truck or on-highway truck to the wheel loader is important. If a truck is too far away, it could determine the number of wheel turns the loader has to make when it's making its pass. Three or four wheel turns, as opposed to two 1.5 wheel turns, uses up more fuel. You'll save fuel with better truck positioning."

IMPROVING PRODUCTIVITY AND ENGAGEMENT

As reflected in Tables 1 and 2, both Steve Antunovic and Richard Beard said it was not unexpected that there was a slight increase in cycle times and reduced power between the pre-training and post-training sessions. Steve Antunovic forecast that the savings in fuel and extended engine life will over the long term outweigh a small potential decline in productivity. "As the operator becomes more attuned to the new techniques, the gap between the fuel savings and productivity will narrow. Again, it is also dependent on loading techniques and vehicle positioning."
Richard Beard was asked to nominate what he would consider to be good economical figures for engine speed. He said it was dependent on the application. "There are times when operators will need to use full acceleration and full RPM - there may be trucks lined up and they need to utilise the full potential of the machine. However, each operator who has undertaken the course is now mindful that when that heavy load of trucks is gone, they can reduce the RPM and not be as aggressive on the machine – they can dial down to get the fuel consumption results that we're chasing."
Richard suggested it would be realistic to achieve a decrease in fuel consumption of five or six per cent. In a large environment such as Boral or Cemex, where they have such a large fleet of equipment, that percentage will have a massive impact on resources, particularly financially. We'd love to get into double figures with the reduction of fuel consumption, but that will be something that time will tell us as a result of the training".
Steve Antunovic said that whether operators will achieve significant fuel savings and prolonged engine life in their work environment after completing the course is not only dependent on how they adopt best practice, but also to a great degree on the support of their quarry managers and supervisors.
"I believe that it is critical quarry managers and supervisors undertake the ECO Operator training in addition to their operators," he said. "That way, they will better understand what the operator is learning and they can start to think about their work environment and what may be changed in the quarry to provide immediate gains. Do they need to improve their haul roads? What can they do to

make the conditions easier for the operators to achieve fuel reductions and raise productivity?
“Managers can create an environment that gives support to the operators and helps them put into practice what they have learned on our course. This involves engaging the operators in outcomes and recognition of achievements. The operators and managers alike should also be encouraged to attend a refresher training session where they can both discuss and consider the improvements that have occurred on site and how they can continue to promote that scale of change and improvement.”
As Steve Antunovic concluded, the ECO Operator training programme offers a potential win-win scenario for both equipment operators and quarry managers alike. Equipment operators and their managers have the opportunity to collaborate in minimising fuel consumption. This in turn will then mark the first steps to reducing carbon emissions which – whether quarry managers like it or not – have to be demonstrated from July 2011 onwards under a new emissions trading scheme.

Caterpillar Institute has scheduled seven more ECO Operator courses between October and December 2009, places are still available. For further information about the ECO Operator Training programme and course dates, contact Caterpillar Institute (Vic-Tas) Pty Ltd, tel 03 9953 9544 or visit www.caterpillarinstitute.com.au

Damian Christie observed the first ECO Operator Training course at the invitation of CIVT at Boral Bacchus Marsh on 26 March, 2009.