
Comfortable earth moving machinery

Knowledge and experiences from the Eurocabin project

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10 Bauma 2001: information from 273 users

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10.1 Introduction

In the previous chapter we described the collection of information from users of a specific machine with the purpose to redesign this machine. It is also valuable to have information from operators in general regarding their opinion about nowadays machines. The Bauma 2001 was the right place to collect these data. During a short interview, 273 operators filled in a questionnaire (212 excavator operators and 61 wheel loader operators). The operators answered questions about overall cab comfort and specific parts of the machine related to comfort. We also asked the operators what they found to be the most important aspects to work well with the machine.

The wheel loader operators and the excavator operators who participated in this study, were experienced with a mean of 12.3 and 13.4 years of service respectively. The mean age was 36.5 ($\pm$ 9.4 years) for wheel loader operators and 36.3 ($\pm$ 9.3 years) for excavator operators. The machinery they used differed in age. In the data analysis we split up the machinery in older machines (4 years or more) and newer machines (less than 4 years old). Approximately 50% of the operators used a machine of less than 4 years old.

10.2 Operators' opinion about cabin comfort

The operators rated their opinion about overall cab comfort and comfort of specific parts of the machine on a four-point scale (poor, average, good, very good). In the data analysis these categories were merged into two categories ('poor/average' and 'good/very good'). When less than 80% of the operators rated a part of the machine as 'good/very good', we concluded that comfort could be increased by taking into account this part when redesigning the machine. In the next two sections the operator's opinion is shown separately for wheel loader and excavator operators.

Wheel loaders

Regarding the overall cabin comfort 57.4% of all wheel loader operators rated this 'good/very good'. Figure 10.1 shows that operators of newer machines (<4 years old) rated the overall cab comfort more often as 'good/very good' than operators driving older machines (≥ 4 years old); the figures are 38% and 75% respectively. These results show that during recent years wheel loader manufacturers have succeeded in improving cab comfort. To find which parts of the machine can increase cab comfort in the future we analyzed the data of newer machinery regarding the operator's opinion about specific parts of his machine.

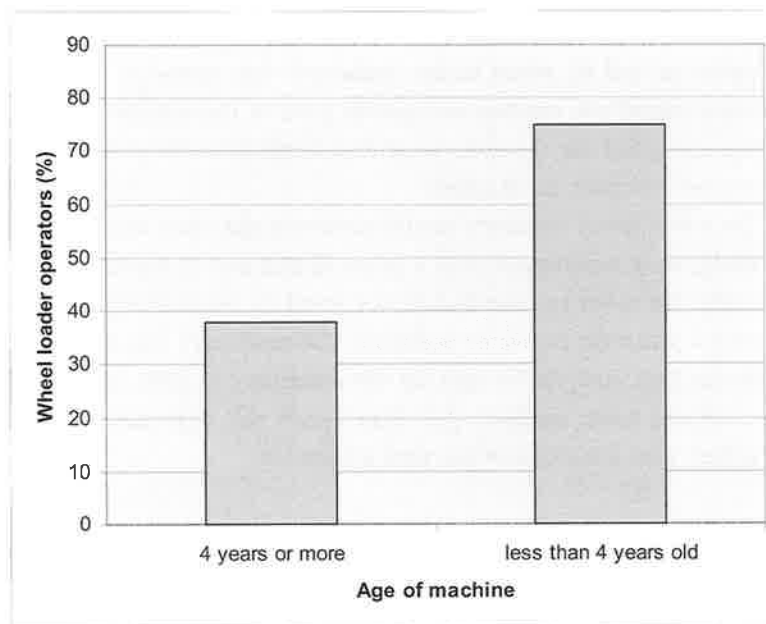


Figure 10.1 General opinion about comfort of the cab of wheel loader operators. More operators of the newer machinery (<4 years old) rate the comfort of their cab as 'good/very good' compared to operators of older machines (≥ 4 years old)

These specific aspects the operators were asked to rate were: vibration and damping, noise reduction, what the machine looks like, cab dimensions/interior space/in and egress, climate control, view, dashboard and displays, pedals, way controls work, adjustability of seat and controls, and seat comfort. Figure 10.2 shows the percentage of operators who rate these aspects as 'good/very good'. Five aspects are rated as 'good/very good' by less than 80% of the operators: vibration and damping, noise reduction, dashboard and displays, adjustability of

seat and controls, and seat comfort. This score might be explained by the following. Whole body vibration in earth moving machinery remains a health risk and is surely detrimental to comfort, although improvements have been made by using dampened seats and load stabilizers limiting the pitching of the machine. This may also account for the seat's score as it is linked to the aspect of vibration. Noise levels are seldom damaging to the ear. However, on a comfort scale they are often still quite high, especially when compared to automobiles. The adjustability of seats and controls has two aspects: the amount of items that can be adjusted and its user friendliness. In our opinion both aspects can still be improved as was also described in chapter 7. They should be addressed together as user friendliness is very important when the adjustability is increased. Last, an explanation for the score on dashboard and displays is difficult to give. It is imaginable that operators compare the dashboard with their luxury car and thus find it less appealing. These data show on what aspects manufacturers should focus their attention when working on new machines.

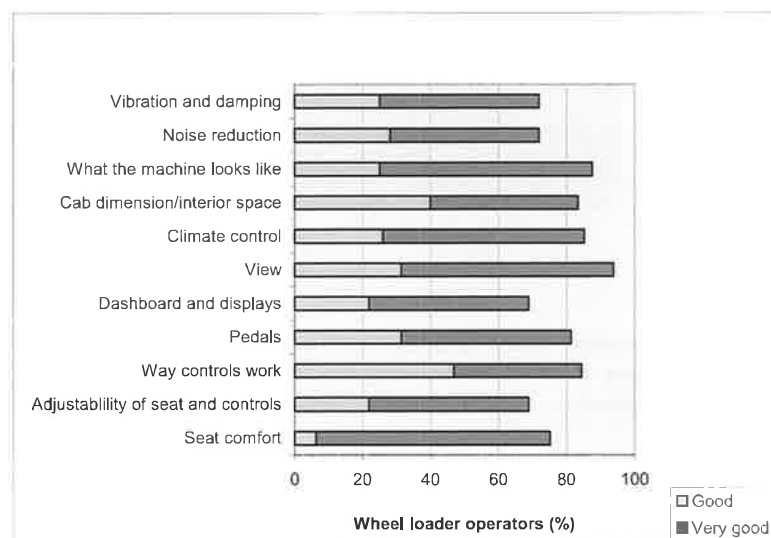


Figure 10.2 Percentage of wheel loader operators of new machines (<4 years old) who rate the comfort of specific parts of the machine as 'good/ very good'

Excavators

The excavator operators also rated the overall cab comfort on a four point scale. Of all excavator operators little more than half of them (55.9%) rated the cab comfort as 'good/very good'. Almost the same was seen among wheel loader op-

erators. However, when looking separately at the older and newer machines, we see a large difference. Figure 10.3 shows that operators of newer machinery (less than 4 years old) are far more satisfied with the overall cab comfort than those driving older machinery (73.3% versus 39.6%). Obviously manufacturers have improved their machines in recent years. To find what aspects are left to be improved in the future we analyzed the data of newer machinery as we did for wheel loaders.

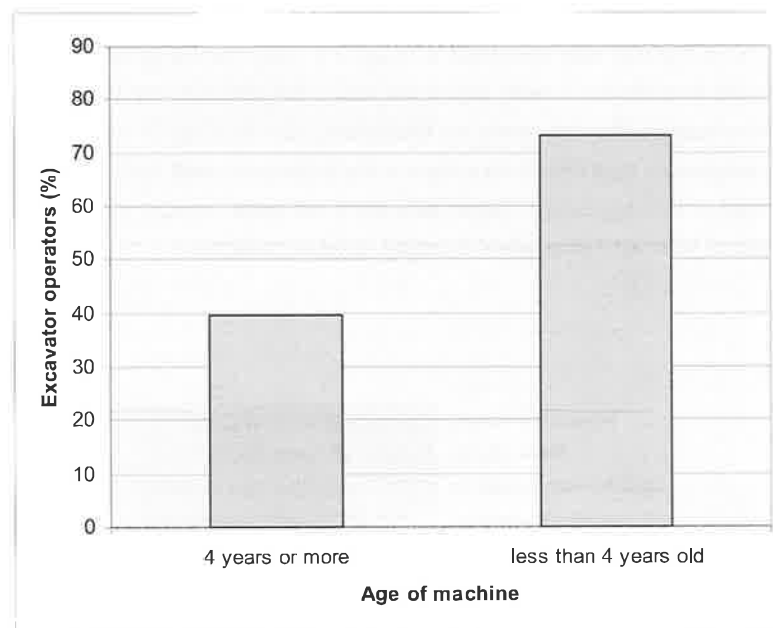


Figure 10.3 General opinion about comfort of the cab of excavator operators. More operators of the newer machinery (<4 years old) rate the comfort of their cab as 'good/very good' compared to operators of older machinery (≥ 4 years old)

Figure 10.4 shows the ratings of the operators of newer machinery only. Machine parts which are rated as 'good/very good' by less than 80% of the operators are: seat comfort, vibration and damping, dashboard and displays, climate control, what the machine looks like, cab dimensions/interior space/in and egress, noise reduction, view, adjustability of seat and controls, and reliability. Compared to the wheel loaders a few aspects are added. Climate control is possibly under appreciated, because less excavator cabs have air conditioning built in than wheel loader cabs. Manufacturers are reluctant to install air co as operators tend to work with either the door or the front window opened, thus making

air conditioners useless. It is no surprise that cab dimensions/interior space falls below the 80% mark. Regardless of manufacturer the available space for the cabin is limited for all dimensions. The same counts for view as the current machine layout inevitably leads to dead angles for the operator. Mirrors reduce the problem; however, it is likely that only cameras are able to substantially increase the operator's field of view.

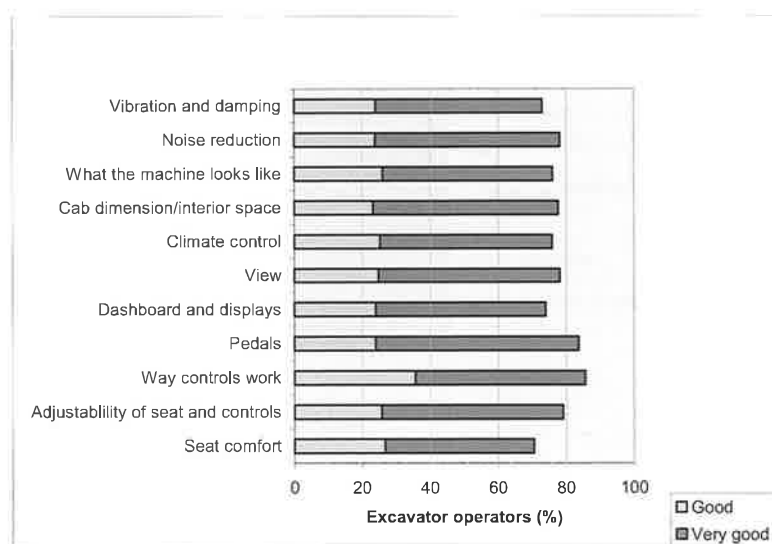


Figure 10.4 Percentage of excavator operators of new machines (<4 years old) who rate the comfort of specific parts of the machine as 'good/very good'

10.3 What has been improved in recent years?

In the previous section we saw that operators of wheel loaders and excavators of less than 4 years old are more satisfied with the overall cab comfort than operators of older machines. But which aspects of the machines have been improved? In this section we compare the ratings on specific aspects of newer machines with older machines.

Wheel loaders

Most parts of the machine are rated better by operators of newer wheel loaders compared to operators of older wheel loaders. After statistical analysis only four aspects of the machine are rated by significantly more operators of newer ma-

chinery as 'good/very good' than the same aspects of older machinery. These aspects are: view, climate control, what the machine looks like, and vibration and damping (figure 10.5).

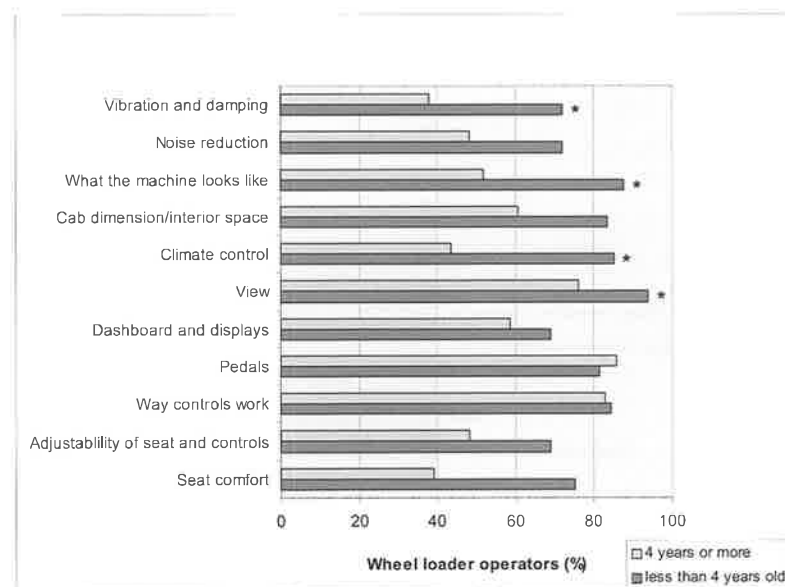


Figure 10.5 Rating of machine parts by operators of newer machines compared to operators of older machines. Machine parts marked with an * are rated by significantly more operators of newer machines as 'good/ very good' than by operators of older machines

Vibration and damping have been reduced by introduction of the load stabilizer, which results in more comfort due to less pitching of the machine. The looks of the machine have been improved because of the use of new materials like synthetics for the cabin. These materials have given many machines a more modern rounded look. Rounded forms are also found in the design of the front windows. They too are curved. By narrowing or reducing the number of window posts a better view from the cabin is accomplished. Additionally the view has been improved by the design of a slanted hood. The increase in standard fitting of air-conditioning in wheel loaders accounts for better scores in climate control. From figure 10.5 one might conclude that seat comfort has also been improved. However, though mean scores have increased, the difference is not statistically significant due to the fact that operators show strongly divided opinions on this subject. This is not shown in the figure.

Excavators

The machine parts of excavators, which have been improved over the last years, are shown in figure 10.6. Statistical analysis shows that the comfort of seven aspects has been increased significantly: seat comfort, adjustability of seat and controls, climate control, cab dimensions/interior space/in and egress, what the machine looks like, noise reduction, and vibration and damping.

Manufacturers have reduced exterior noise. Environmental rules are likely to have played a large role on this matter. The operators appreciate the noise reduction. Cab dimensions and interior space cannot be very different compared to older machines, because they are restricted by the position of the boom and the maximum excavator width and height for transport. However, the sense of space might be changed by a different design and usage of new synthetic materials. A better climate control (by use of air co) can also positively contribute to a sense of space. Interestingly there is a significant increase in seat comfort score, though mean scores do not show the increase wheel loaders show. The increase is probably connected to a increased upgrading of standard machines as we can see in the automotive industry.

In contrast with the results of the wheel loader, the view from the excavator cabin has not been improved. As mentioned before, the excavator's design is constrained by the machine lay-out and by several transportation rules.

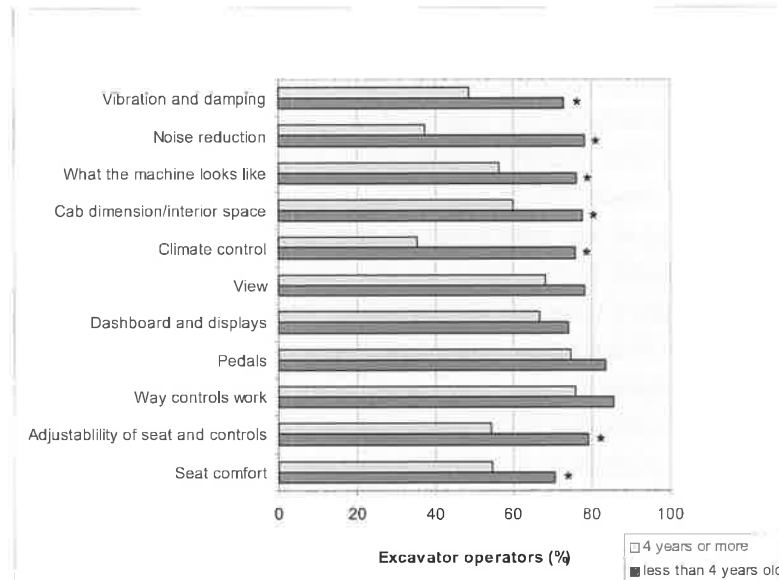


Figure 10.6 Rating of machine parts by operators of newer machines compared to operators of older machines. Machine parts marked with an * are rated by significantly more operators of newer machines as 'good/ very good' than by operators of older machines

The statistical analysis demonstrated that more aspects of the excavator have been improved than aspects of the wheel loader. This does not mean that the development of the wheel loader is backward. The number of subjects (61 wheel loader operators versus 212 excavator operators) influences the statistic results.

10.4 Most important aspects to work well with the machine

The previous sections focussed on cab comfort, because a comfortable cab contributes to more job satisfaction. However, job satisfaction relies on more aspects. Therefore we were also interested in the operators' opinion about the most important machine characteristics. To get this information we asked them to list the three most important aspects to work well with the machine.

Operators mentioned many different aspects. We classified the answers into 15 categories. Table 10.1 shows the 15 categories followed by an explanation of the kind of answers which suits the category.

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Table 10.1 Classification of aspects mentioned by operators

Categories	Examples
TCO (total cost of ownership)	costs of machine (procurement, service costs, rest value)
machine performance	performance, hydraulics, gear
serviceability	cleaning of the machine, service of manufacturer
reliability	reliability
seat comfort	seat pan, lumbar support, arm rests, curvature of back support
adjustability of seat and controls	adjustability of seat height, adjustability of distance between seat and controls, adjustability of controls
operator's ability	joystick, steering wheel, interaction joystick and beam
view	view on work, dead angles, position of mirrors
dashboard and displays	usability of dashboard/controls, readability, absent information, position of displays
climate control	temperature, dust filters, ventilation, position blowers
design/dimensions/ingress-egress	design and dimensions of cabin and machine, position of steps, grab rails
noise and vibration	noise, vibration, damping
accessories	radio, fridge, storage space, cup holder
safety and stability	feelings of safety, stability of machine
environment	noise outside the machine, exhaust fumes

After having categorized the operator's answers we calculated the frequencies of answers for each category. Based on these frequencies a top 3 of most important aspects was composed for wheel loaders as well as excavators.

Wheel loaders

Wheel loader operators find that the most important aspects to work well with the machine are

1. machine's performance;
2. view;
3. reliability (figure 10.7).

40.3% of the answers were classified into the category 'machine's performance' (containing descriptors such as gear, performance, and hydraulics). The categories 'view' (e.g. view on work, dead angle, mirrors) and 'reliability' both count for 12.5% and 11.8% respectively.

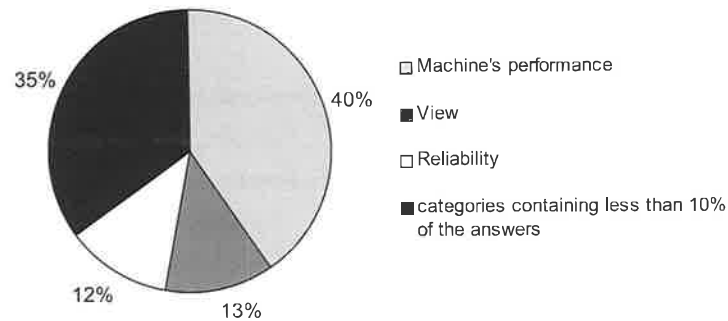


Figure 10.7 Most important aspects to work well with the machine according to wheel loader operators. Percentage answers is given for each category

Excavators

The top 4 of most important aspects to work well with the excavator contains:

1. machine's performance;
2. reliability;
3. view;
4. operas ability.

The same figure is seen for excavators as well as wheel loaders. The category machine's performance contains most of the answers (37%). This category is followed by reliability (14.6%), view (11.5%), and operas ability (11.1%) (figure 10.8).

It is not surprising to find (for wheel loaders as well as excavators) that performance is mentioned as most important, because this factor is indeed of great importance to work at a high pace. Apparently 'working well' with a machine is interpreted by operators as doing a lot of work more than working under pleasant conditions. Although not a subject of this study it would be interesting to find out more about what exactly operators mean with machine performance. Are plain figures on e.g. horse-power satisfying facts or is it the felt ease of digging? This remains to be investigated.

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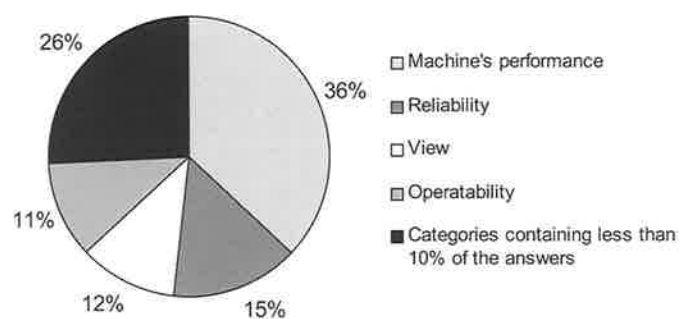


Figure 10.8. Most important aspects to work well with the machine according to excavator operators. Percentage answers is given for each category