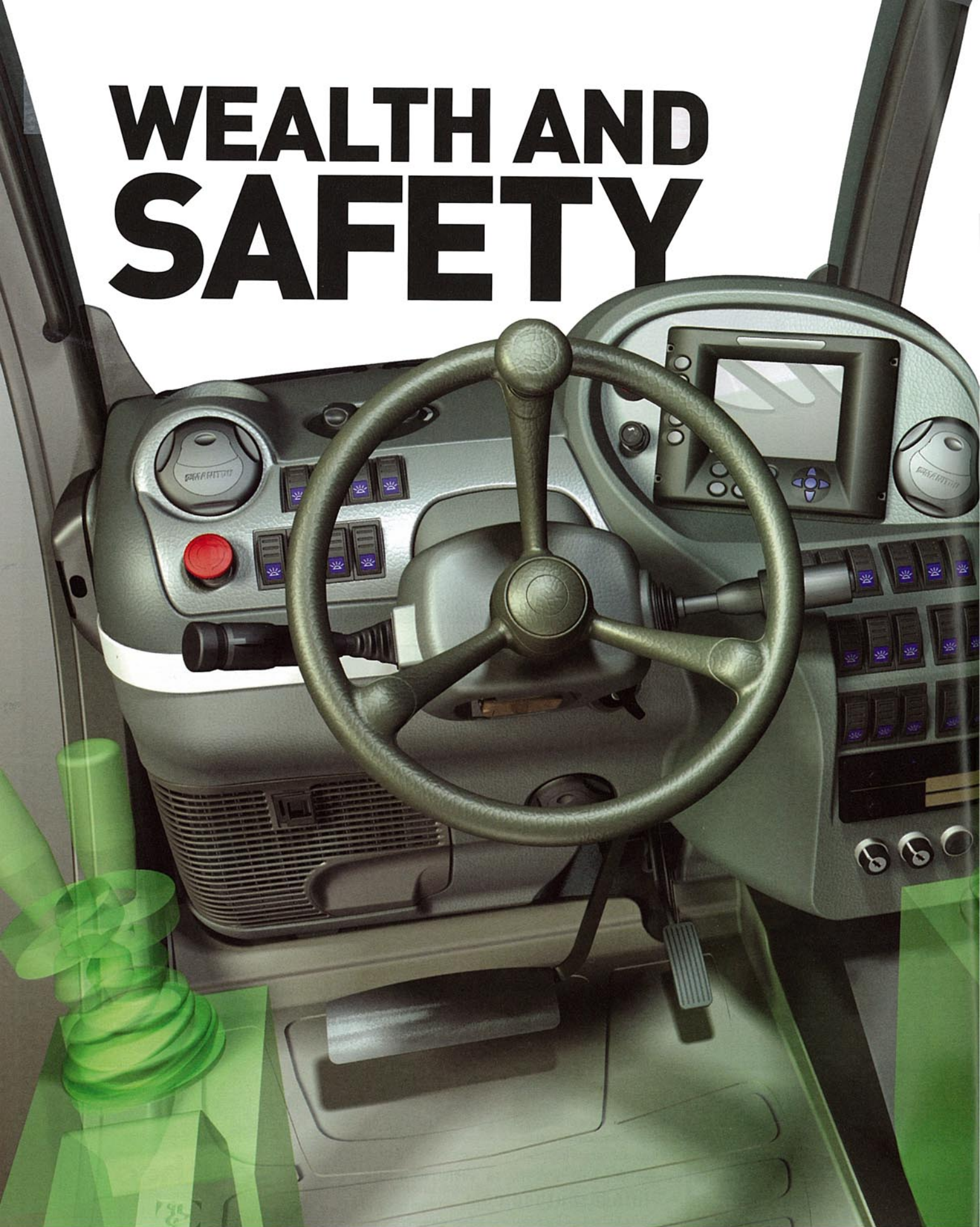


WEALTH AND SAFETY



OEMs WHO CAN OFFER THE OPERATOR A COMFORTABLE – AND EVEN MORE IMPORTANTLY, SAFE – WORKING ENVIRONMENT, ARE SET TO CLEAN UP IN THE INDUSTRIAL VEHICLE MARKET

AMA Cabins' 'comfort and safety' concept ensures optimum conditions for the operator

▶ Operator comfort seems to be the watchword in off-highway at the moment, but in these days of increasing litigation, health and safety and corporate manslaughter legislation, perhaps it is safety that should be on everyone's lips.

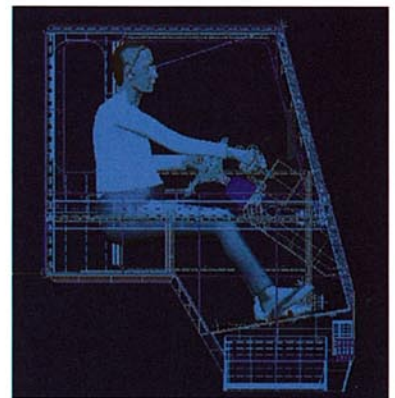
ROPS and FOPS aside, visibility is perhaps the area where a little extra attention at the design stage can result in massive improvements in safety for the operator as well as those around the vehicle. With this in mind, Mulag has opted for a new strategy in the development of its airport ground support and speciality vehicles by engaging Human Solutions' Ergonomics Consulting Services. Ergonomic research and analyses are now performed at an earlier stage in its new standard cabins, helping to avoid the increased costs that result from latter-stage corrections.

Mulag will now use Ramsis simulation software during the vehicle design phase, enabling future drivers to enjoy the best possible visibility, while operating the pedals and controls comfortably and reliably. As well as designing and selling this software, Human Solutions has offered consulting services for the ergonomic analysis of drivers' cockpits for many years, helping off-highway OEMs safeguard their competitive advantages through the use of ergonomics.

Ramsis contains numerous international anthropometric databases from Germany to Japan, via the USA, enabling the realistic reproduction of international body measurement data. Around 90 real, statistically supported physique types are saved in an anthropometric database. Typology is based on body height, proportions and corpulence.

These databases allow companies to create an individual, virtual test collective in line with their target markets, enabling initial ergonomic analyses to be carried out right from the first design phase. For the cabin

design of Mulag's Orbiter conveyor belt vehicle and Pulsar container pallet transporter, specific requirements were looked at, such as a comfortable seating position with optimal view conditions enabled through analyses of the manikin's view and mirrors, the ergonomically correct positions and angles of pedals and steering wheel, and the optimal positioning of door handles and the controls on the instrument panel. Entering the cabin and closing the door are two actions that are especially important for the driver.



Ramsis simulation software helps ensure a comfortable seating position as well as optimal view conditions

To be able to do his job properly, the Orbiter driver must have a good view of the conveyor belt through the roof opening – and be able to see the instrument panel at the same time. In automated posture simulation – one of the most important Ramsis functions – the manikin is therefore positioned in the most realistic posture possible, while taking into account individual constraints that are in place. The driver's posture has to be comfortable, and must also make sense ergonomically. Based on ergonomics study projects, the system now calculates to what degree the ergonomics are accurate – and the user then receives recommendations for optimisation.

In one case during the analysis of vehicle ingress and egress, a Ramsis-based recommendation was made

for all model ranges to have a step added to the cab, enabling operators to enter the vehicle more safely. Ramsis analysis had shown that although vehicle ingress for young drivers was possible, older drivers found it much more difficult.

"Ergonomic analyses of the new model ranges together with the Ramsis specialists from Human Solutions enabled us to easily verify the initial drafts and correct minor weaknesses," says Martin Nock, design engineer for Airport Ground Support Vehicles with Mulag. "Ergonomics will play an increasingly important role in future years, and that's why we wish to actively approach our customers and show them the advantages that the early integration of ergonomic studies in cabin construction can bring."

Seeing in the dark

Of course, there are some areas that no amount of manikin simulations will ever make visible. Many construction vehicles have extensive blind spots that can only be overcome with adequate devices for indirect vision before the driver even begins to manoeuvre the vehicle. Brigade Electronics has all the avenues covered for vehicle safety, from all-

round visibility options and movement sensors, to collision warning systems and reversing alarms – a network of which will provide the ultimate safe working environment.

Brigade's camera-monitor systems provide all-round visibility. Reversing, front and side view cameras, perhaps triggered by selecting the reverse gear or indicator, can assist safe manoeuvring through the elimination of dangerous blind spots.

Ideal for low-visibility conditions, the new PathFindIR thermal imaging camera can see through thick dust, smoke, rain and darkness for up to 800m. Any object with a temperature different to the ambient measurement – such as people, debris or changes in terrain – will be highlighted on the monitor to provide a crisp picture both day and night. The compact, plug-and-play camera can

also be linked to reversing and side-view camera-monitor systems for optimal, all-round vision.

A reversing alarm is an effective way to warn pedestrians, but the driver also needs to be made aware of those in his path who may be wearing ear defenders. Brigade's Backsense pulsed radar sensor system detects objects at a longer range than is typical with an ultrasonic reversing aid, making it ideal for mobile plant. Detection zones are programmable via a laptop and can be set to ignore fixed objects, attachments and bodywork in the detection zone. The system provides an audible and visual warning to the driver of anything in the path of the manoeuvring vehicle.

Now that HSE recommendations require visibility assessments to be carried out before equipment is put to use, there has been an influx of different types of convex mirrors being fitted to work equipment. Spillard Safety Systems is well aware that the three main types – oval elliptical, round and quadraspherical – all play vital roles in improving and enhancing all-round vision. However, if the incorrect type is chosen for the application, it can have an adverse effect – round convex and oval elliptical lenses in certain

RIGHT: Camera monitoring systems provide all-round visibility



GETTING A HANDLE ON AVOIDING FALLOUT

▶ Pride may usually come before a fall, but, according to Nelson & Associates – a safety engineering firm providing professional consultation, research and expert services – prevention of such accidents primarily dictates consideration of the design characteristics of the vehicle access system and related support features. Some studies estimate that as much as 25% of all driver injuries around non-moving vehicles are due to slips and falls.

'Access' refers to the handholds, footholds and similarly purposed features that are specifically designed to facilitate climbing to and from various locations on industrial vehicles, and to prevent vehicle-related falls. Although similar to ascending or descending stairs or ladders, the surfaces in question are often very irregular in location and dimension, and the descent must often be performed backwards.

Due to the smaller size of walking surfaces used for access and maintenance tasks, and the typical vertical movement of the body in such situations, it is vital to give special attention to the design of proper handholds and footholds in terms of size, location, orientation and friction (slip resistance) characteristics, in order to maintain balance and stability during vehicle access and to prevent falls.

The primary principle used in the safe design of vehicle-access systems is to allow for the continuous use of a three-point attachment system; that is, sufficient and adequate handholds and

(slip-resistant) footholds to keep at least two feet and one hand, or one foot and two hands, securely touching the vehicle at all times. This necessitates the design of a four-point attachment system throughout the access route to allow for one hand or one foot to be in movement to the next handhold or foothold during the access process. Otherwise, the body is unstable, easily unbalanced, and susceptible to 'swing' forces, meaning that an imperfectly balanced one-hand and one-foot attachment will, for example, act as a 'hinge', swinging the body away from the vehicle as the body's centre of gravity seeks equilibrium. Any mis-step or imperfect grip, which must be reasonably anticipated over time, has a high probability of resulting in a fall, as there is either no 'backup' handhold or foothold to maintain balance, or one must frantically seek some type of hand or foothold while in the process of falling.

A major standard used in this regard is SAE J-185 (1970), first published in 1972 under the title 'Access Systems for Construction and Industrial Equipment'. This offers comprehensive handhold and foothold design criteria that can be applied to a wide variety of industrial equipment and vehicles. This is also true for the handhold and foothold design criteria published in 49 CFR (DOT) Part 399, Subpart L (circa 1982) titled 'Step, Handhold, and Deck Requirements for Commercial Motor Vehicles', which presents requirements for 'cab-over-engine' trucks and truck-tractors, but



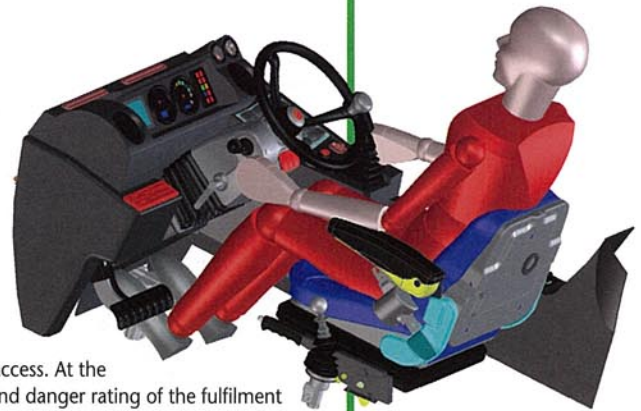
Safe and sound – in comfort

AMA's desire to become a full-service partner led the group to produce off-highway cabins, an activity that synthesises design, project and assembly. The result is a cab in which the operator benefits from a roomy environment that is insulated from noise, and is dust- and vibration-free.

Partnership with a manufacturer of soundproofing systems has led to the use of self-extinguishing and sound-absorbing materials – features that have resulted in its 'comfort and safety' concept. ISO 3471 and 3449 (ROPS and FOPS) are kept to the forefront, along with the deflection limit volume (DLV), which is regulated by the ISO 3164 norm. As for glass, only homologated varieties that meet EU standards are used, hardened or stratified as per customer request.

ISO norms in terms of ergonomic size, minimum mass space of the operator, comfort areas and access to command devices are painstakingly followed, and simulations on the distribution areas of the command devices are regularly

carried out. More precisely, the regularity of every single command is indexed, and on that basis, the corresponding button or handle is located in the area of the dashboard where it is easier to access. At the same time, the risk and danger rating of the fulfilment of commands is evaluated, leading them to be located in positions that prevent unintentional use. In this way, every control will be simple to use, efficient, safe and up to the operator's requirements, responding to any demand on the machine.



applications can introduce too much light and inevitable glare from the sun, even when rotated all the way down. A quadraspherical (BB052 and SC010) lens, however, resists glare by way of its unique geometric shape.

Ergonomics and safety were in focus when Motometer developed the MotoCANDis display unit. Able to analyse and show the digital data of a modern engine management system, it also allows up to two cameras to be directly connected to



its high-definition display.

These can be positioned and configured to accurately see to within a centimetre behind the vehicle, providing high-quality extensive panoramic vision, although the user can zoom into certain areas or objects to see them more clearly. Using these high-definition camera pictures means that tasks can be filled precisely, and possible damage to individuals and

LEFT: MotoCANDis provides a variety of visual information to enhance safety

indirectly supplies authoritative technology for any other similar vehicle where such technology can be applied to prevent falls.

Handholds and footholds

The landmark SAE J-185 (1970) publication set forth basic requirements for the design of adequate handholds and footholds for climbing irregular vertical surfaces such as those encountered when climbing to the operator's cab on various construction and industrial vehicles, and was revised in 1981, 1985 and 1988.

Select requirements of J-185 (1970) include:

- Steps, ladders, and grab rails to, on, and from platforms and walkways, should be designed to invite the person using them to have three limbs on the system at all times;
- The maximum height of the first step from the ground to the machine should not exceed 30in when the machine is in the normal parked position. The preferred height of this step is 16in;
- The maximum distance between steps of vertical ladders on machines is 16in. The preferred distance between steps is 12in;
- Where lateral movement is necessary from the top step of a vertical ladder to a walkway or a platform, the vertical distance should be no more than 12in;
- The minimum toe clearance from the outside edge of the step should be 5in. The preferred distance is 7in;

- The design of steps should minimise the accumulation of debris. The tread surface should have high slip-resistance and should aid in the cleaning of mud and debris from the shoe sole;
- Grab rails, appropriately spaced to provide continuous support to a moving man, should be placed within convenient reach;
- The preferred cross-section of a grab rail and grab iron is circular. A square or rectangular cross-section with rounded corners is permissible;
- For circular cross-section grab rails and grab irons, the maximum diameter should be 1-1.5in, and the minimum diameter should be 0.75in. The preferred dimension is 1in. For square or rectangular cross section, these dimensions apply across flats;
- Grab rails and successive grab irons should be placed parallel to the path of motion of the vehicle user. Grab irons may be oriented vertically or horizontally, but should be consistent within a given system;
- On incline ladders, where hip clearance is a factor, the preferred spacing between parallel grab rails is 24in;
- The preferred grab rail height vertically above any step or incline ladder is 36in.

Select requirements of J-185 (1988) – which conforms in all important detail with ISO 2867-1980 – include:



objects can be prevented. Typical tasks for the camera system are reversal and workspace observation.

MotoCANdis provides other functions to increase safety – for example, an incident-controlled display can be programmed. When, for example, a defined temperature-, speed-, or pressure range is exceeded, the unit brings this incident to the driver's attention.

Visionary products

With a reputation as an innovator, Webasto's Special Products & Markets business unit dedicates its activities to create ergonomic solutions for industrial vehicles. Some of these products focus on making the most of the visibility created by others – such as a kinematic monitor-retaining fixture in the cabin roof, where the monitor can be restored after use. The same kinematic system can be applied to touch-screen displays and similar devices in front of the operator.

Sophisticated sunshades with remote operation make it easy for the operator to reduce the impact of sunlight and manage the visibility right from his seat. High-tech glazing solutions can filter solar

effects, reducing heat load on the cabin and eliminating glare from sunlight, while opening roof solutions ensure thorough ventilation and emergency escape facilities.

A Webasto air-conditioning system or heater also ensures efficient and concentrated work in any environment. Silent outlets efficiently deliver cold air into the cabin and create a comfortable climate, while the heating system can maintain optimum operator conditions, as well as keeping critical vehicle systems at the correct temperature for efficient operation.

Southco's position- and motion-control devices also provide great solutions for creating a safe working environment. Headrests, for example, are an important factor in both driver comfort and safety. The integration of Southco's constant-torque position-control mechanisms into these components not only enable the side wings to be fully adjustable to suit the operator's desired position and reduce neck strain, but their precise factory pre-set torque values offer lifetime performance without any need for adjustment or routine maintenance. From a design perspective, their

compact size increases flexibility by helping to optimise the space available within the headrest for the integration of additional crash restraint systems.

With the increase of in-cab LCD screens, effective positioning control is essential for optimum viewing. Here, tilt and swivel mechanisms are commonly used to provide multi-axis control for raising, rotating and positioning the display screens for optimum user convenience. The excellent consistency of torque throughout the life of the product also ensures the touch-screen display is easy to position, but firm enough once positioned so that it does not move when touched or when encountering forces such as shock and vibration loads, thereby saving the operator from having to over-stretch to change the settings or viewing angle.

Bauser instrument clusters are trendsetters not just because of their attractive and ergonomically adaptable 'outfits' – the combination of several single indication instruments provides improved vehicle supervision and control.

The standard instrument clusters are available in fixed or custom

- Access systems shall be obvious as to proper usage without special training;
- Access systems shall permit and, by proper placement of components, promote achievement of three-point support while ascending or descending the access system when more than 1m above the ground;
- Step, walkway, and platform surfaces (including any machine or tool structural component used as part of an access system) as a minimum shall be slip resistant at the foot contact areas;
- Steps shall conform with the recommended dimensions in Table 1. All steps should be wide enough to accommodate both feet,

with minimum dimensions for step width (one foot) of 160mm (6.3in), 200mm (7.87in); (both feet) 320mm (12.6in), 400mm (15.75in), and toe clearance of 150mm (5.9in), 190mm (7.87in);

- Steps shall be co-ordinated with properly positioned handrails and handholds;
- Step design shall minimise foot slipping laterally off the step;
- Step design shall provide natural foot placement while descending, or the step shall be clearly visible while descending;
- Handrails and handholds shall conform with the recommended dimensions in Table 2, with a minimum distance above standing surface of 900mm (35.43in), and a maximum width between parallel handrails of 600mm (23.62in);
- Handrails shall be appropriately spaced to provide continuous support to a moving person and within convenient reach.



Wide steps with good grip and a rounded handle – as seen on Caterpillar's 730 articulated truck

In association with the 49 CFR (DOT) sister standard for cab over engine highway trucks (see www.hazardcontrol.com for more details), proper adoption of these requirements should not only provide operators with a more ergonomic path to their daily duties, but continue to reduce accidents. It should be borne in mind that the technical content of design standards, typically promulgated for the purpose of solving one particular problem, is usually capable of being applied to a raft of similar problems. Engineering design work requires creative adaptation and combining the prudent application of basic concepts and principles with the practical use or adaptation of resources that address similar subject matter.

On a roll in cab manufacturing

Bending is an important process in the manufacture of cabs for earthmoving equipment, forklift trucks and agricultural machines, and Welser Profile is one of the leading European producers of high-tech components made from roll-formed and longitudinal welded sections.

Welser Profile set up a new bending machine especially designed for the manufacture of cab components such as A-, B- and C-posts, roof frames and other associated profiles. This process enables it to combine mandrel bending and push bending within one process, allowing three-dimensional bending operations as well as a combination of tight and large radii to be offered that are widely used in modern cab design.



In addition, the company offers typical roll- and stretch-bending facilities, as well as various finishing processes such as double-head mitre cutting saws and drilling/milling stations.

To guarantee perfectly fitting sections and components, tight tolerances have always been a main focus throughout Welser's 45 years' experience in cold-roll forming using the most modern machinery and state-of-the-art quality tooling.

More and more high yield and ultra-high yield material is used for cab components. On some special parts for the automotive industry, the company already produces sections with a tensile strength of up to 1,400N/mm².

dimensions, with large, backlit displays (in a choice of colours), enabling easy and comfortable reading of the different operational parameters. The LED warning indications are also perfectly readable even in direct sunlight, so the operator will always be informed and warned in a timely manner about any problem with the vehicle.

A range of ergonomically designable varieties of bar graph through needle animation to digital indication are offered for the display – available in a variety of LCD and other technologies. The errors or fault indications can be indicated as text, with additional flashing warning lamps and symbol of the function in danger, or by an audible sign accompanied by a text on the display.

Even rough application conditions are not dangerous for these units, due to their high shock- and vibration-resistance, with IP67 protection providing resistance to salt spray or high-pressure cleaning.

The safe positioning of all frequently used control elements follows one principle, according to W. Gessman: they should be in easy and ergonomic reach, without any bending or changing of the working position of the seated operator. Displays may have the additional requirements of visibility and illumination, but again – the closer to the operator's eye the better.

The compact arrangement of all the defined operating elements

including joysticks or finger-pilots and displays also reduce the cost of installation when they are packaged together in an ergonomically designed console. A clear interface definition with optimised one-screw fixing and plug-and-play (CANopen) of the complete console helps to reach this goal.

Modifications of the console itself provide additional flexibility to the OEM, by compensating for all the variations of different machines in its range. Optimised adjustment features, with easy operation through the pressing of one button, enable the quick setting of the right position of the console. Sealing is provided for outdoor use on machines without a cabin.

Electronic joystick controllers offer several benefits over all-manual hydraulics. They are easier to operate, quieter and cleaner, because high-pressure hydraulics are no longer in the cab. And because the effort required by the operator is reduced, it is a more comfortable working environment, helps to reduce the likelihood of mistakes and can help make great improvements in productivity.

Strength, reliability and functionality are key in maximising efficiency and safety, and the design of the latest joysticks reflects this. For example, Penny + Giles' JC6000 rugged joystick controller is



Gessman's consoles provide flexibility for the OEM



Bauser displays are easily readable even in direct sunlight

available in single-axis or dual-axis configurations and can be supplied with non-contact Hall-effect sensors or long-life potentiometer tracks to provide the analogue signals proportional to lever movement. These outputs can be combined with contacting directional and centre-switch functions to provide signals for higher levels of system safety checks and output verification.

The JC6000's compact size, high lever strength and superb proportional control are ideal for a range of operator control applications. It can be specified with a choice of handles and grips to increase the functionality of the operator controls, and the options for push buttons, trigger grips, proportional and switched rockers in a variety of different configurations mean that users can match their handle selection to suit their specific application.

Last but not least, few things will influence safety quite like the operator's seat, which is why flexible and robust ergonomic designs are the guidelines for Sittab seat accessories.

Using the experience gained from tackling the complexity and rough conditions of forestry machinery, the company has developed a range of products well received by all sectors of the off-road industry.

The philosophy behind its products is a combination of being user friendly while conforming to complex requirements. Working with all major seat manufacturers gives Sittab the opportunity to participate in many exciting cab developments where high-spec options are the norm.

A combination of strength and flexibility makes its products very easy to use, such as when connecting a high-tech joystick arrangement to the seat, or when rotating the seat between two operator positions.

One of the latest concerns is vibrations, where seat manufacturers are focusing on z-axis damping – the company has therefore successfully developed an adjustable lateral isolator to eliminate x- and y-axis vibrations. **IVT**