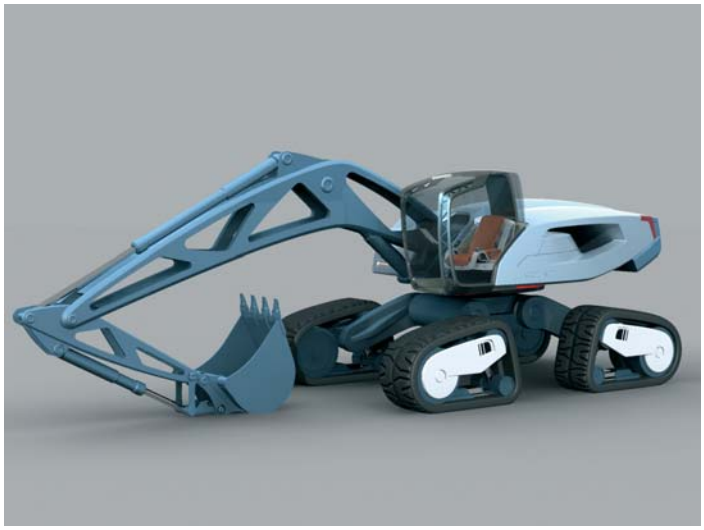
THE SHAPE OF THINGS TO COME

VOLVO

MEETING THE FUTURE'S DEMANDS WITH THE TECHNOLOGY OF TOMORROW

The philosophy of Volvo is characterized by Quality, Safety and Environmental Care. While these common values are people centered, they also create great demands on the products that Volvo CE produces. In order to lead the industry in quality, safety and care for the environment, the equipment Volvo CE designs and manufactures must be at the leading edge of technological development.

This brochure examines the work of a team of industrial designers in their quest to design the Volvo Construction Equipment excavator of the 2020s. With the corporate values at the core of the design philosophy, the end result – the SfinX excavator – is a symbol not only of Volvo's advanced technological thinking, but also of where the company wants to go in its search for product excellence and customer intimacy.



SfinX: guardian of the future

The SfinX project was the brainchild of Volvo CE's Product Portfolio and Advanced Engineering department. Working closely with Swedish industrial design house, "Prospective Design" and Volvo Group's Technology Centre, the team talked to operators about what features they would like to see on new machines. In addition, the designers also looked outside of the construction industry to search for emergent technologies that could have applications suitable to construction equipment. The automotive and aerospace sectors provided rich pickings, as did laboratories and universities.

The excavator was chosen as the subject of the research, as this is the most competitive sector of the construction equipment market, and also the most popular piece. The SfinX team was not taking the easy option.

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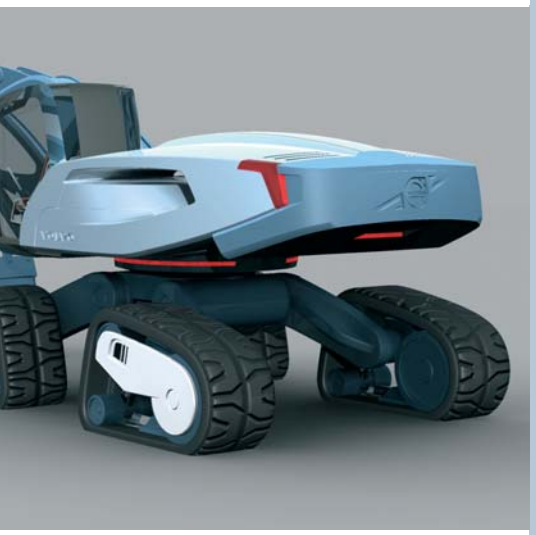
While still recognizable as an excavator, almost every component has been radically altered. The engine is no longer diesel but a small fuel cell, which produces electric energy – but emits only heat and water vapor. This frees up space in the superstructure and allows the engine to perform as an 'active counterweight', which moves in and out to compensate for the forces on the boom. Hydraulics have been largely replaced and there has been extensive use of new materials – not all of which are available today and will need 'inventing'. In fact, some of the technology may never come to fruition – while other aspects (e.g. GPS) are available today. "We had to guess sometimes," says Hans Zachau, chief designer on the SfinX project. "But that's the whole idea – to imagine possible outcomes. We learned not to be scared of new technology and radical concepts and have had the courage to include them in the SfinX."



Hungry to dig

The final design of the excavator is a mixture between space age and primordial, like a prehistoric moon buggy. The animalistic look is intentional; SfinX should be efficient, lean and hungry to dig. Purposeful and a little mean looking. But it's still a Volvo machine and therefore must reflect the core values of Quality, Safety and Environmental Care. It has the familiar outline of an excavator but the design updates current concepts of boom, cab, tracks and superstructure in an innovative way. The familiar Volvo logo and color scheme tie the design back to the current machines. The reduced use of hydraulics helps to achieve a cleaner looking, more attractive design.

Power pack

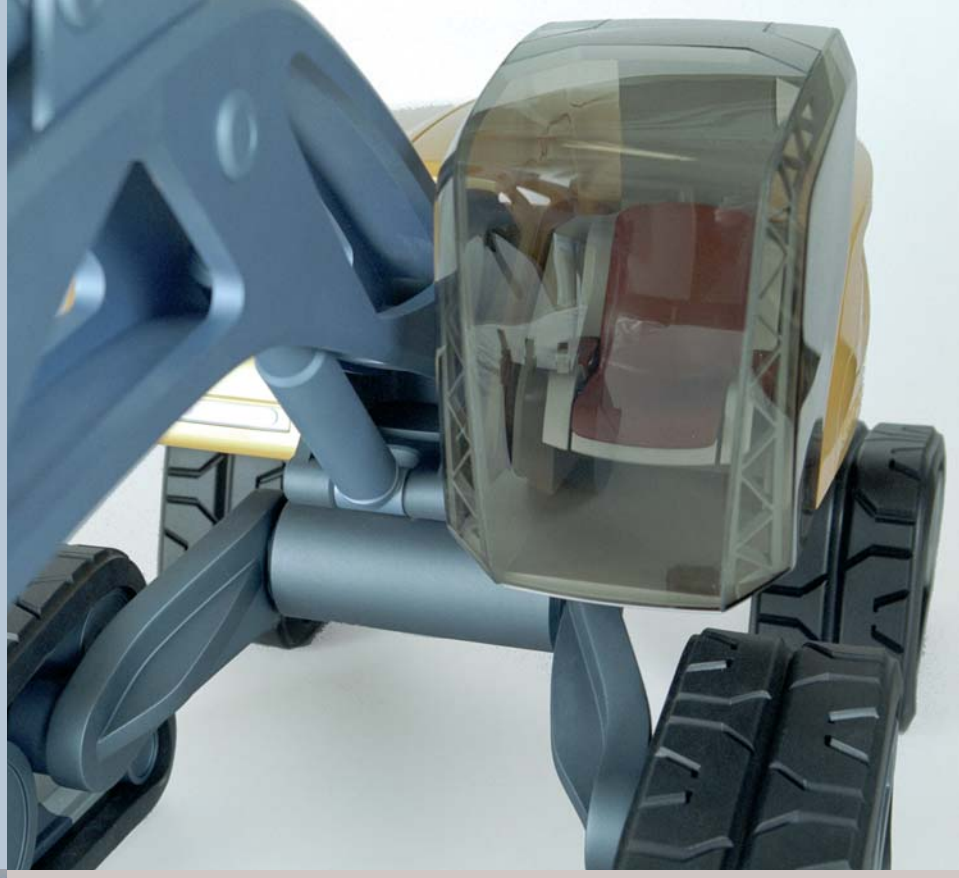
The future machines will no longer use diesel engines. The designers toyed with the idea of using gas turbines (effectively jet engines) but settled on the idea of fuel cells. Fuel cells convert a fuel's energy into usable electricity and heat – without combustion. Because hydrogen reacts with oxygen to produce electricity, it is the optimal fuel to use, as its only emissions are water vapor and heat. They are like batteries that don't run down as long as you keep feeding them hydrogen. The hydrogen is stored in liquid form at very low temperatures (circa. -45°C).

Fuel cells are currently in the development stage (although the automotive industry has working prototypes under evaluation) but it has been calculated that to power an excavator, a fuel cell the size of two normal suitcases would be needed. This frees up a lot of space on the superstructure where the diesel engine would normally sit – hence the machine's ability to have such a large cutaway section. The engine acts as the machine counter weight, which moves all the time to compensate for the forces on the boom. By moving it towards the centre of the excavator, it could be made small for transport, moving it right out would give maximum stability. (Zero swing or large swing.)

Increasingly onerous emission legislations are also likely to speed up the move to hydrogen cells – a most environmentally friendly power system.

Fluid thinking or electric ideas?

The introduction of electricity could also do away with hydraulics. All systems that are currently hydraulic could be converted to electric motors. Notice how hydraulic cylinders have been removed as much as possible and hydraulic piping abandoned. This would obviate the need to circulate oil all over the machine. Hydraulics is an old technology but it still has some life yet. Volvo believes that gradually hydraulic cylinders may be phased out and replaced by electric motors sited at the pivot points of the stick & boom.



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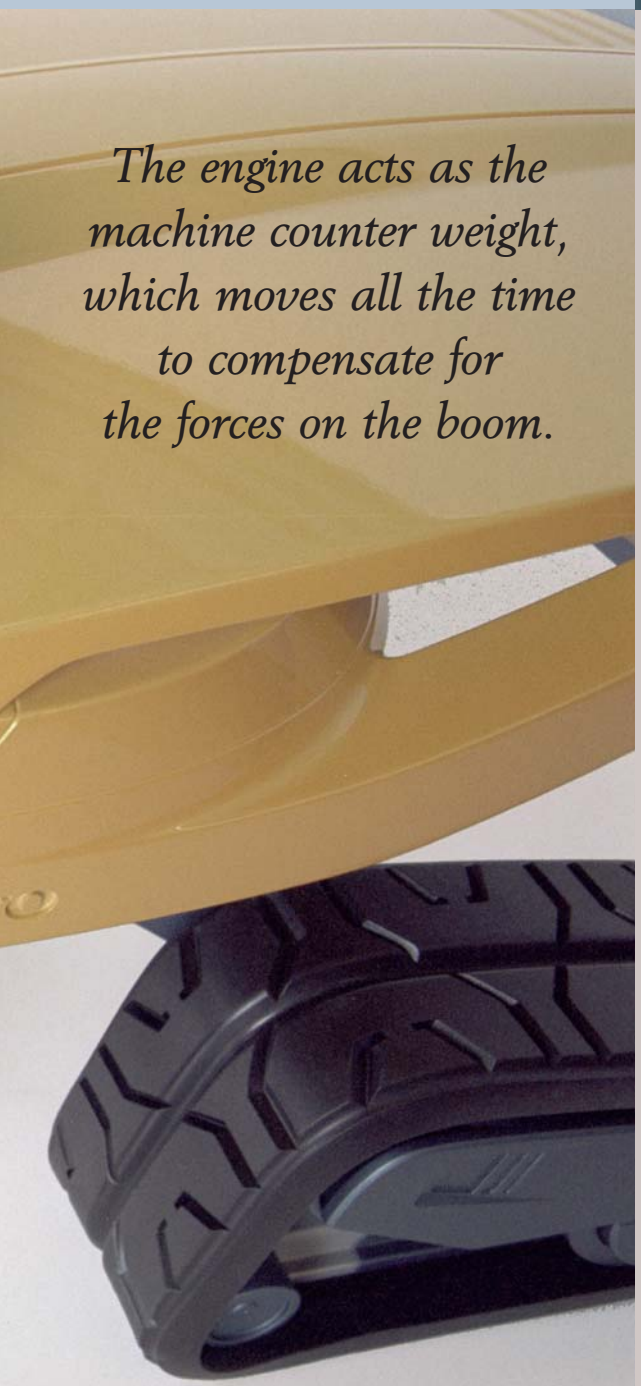


Boom boon

The central concept was to make a light boom – because everything in weight on the boom is lost in capacity for lifting or digging. The see-through lattice allows visibility through the boom, aiding safety by reducing the operator's blind spot caused by solid metal booms. While current steels would struggle to cope with the large forces imposed on the boom, the designer are expecting a new generation of high strength steels to be available that could make this a design possibility.

Independent thinking

The adoption of four tracks is to make them more wheel-like. When driving on rough ground traditional tracks 'tiptoe' and the contact area is quite small. Four tracks have a much higher contact area with the ground, aided by independent suspension to each track, suspended via a swing arm from a central pivot. **Each track has a separate wheel motor, which can brake, accelerate and allow the track to steer the excavator**. On traditional tracks you either brake or accelerate, left or right. Tracks will also use a non-metal rubber-like material that can cope with high abrasion surfaces. The four tracks can be moved to form a traditional two track appearance to distribute the weight better when on soft ground. This system (also powered by electric motors) can be used to extend the tracks outwards for increased stability while working – or inwards under the superstructure for transportation.

Drive-By-Wire

Another area where aerospace is developing new technologies of interest to the SfinX team is 'fly-by-wire'. This is where there is no physical link (solid cables, mechanical links or hydraulic piping) between the driver controls and the components they operate. Instead commands are sent 'wirelessly' to sensors on the components or via electric wires. In construction machinery this would enable the eradication of hydraulic or mechanical controls and the replacement with electronic and electrical controls. These systems, like on aircraft, would have multiple 'redundancy' on critical systems, such as brakes and steering, whereby a secondary back-up system would not only ensure constant performance, but also enhance safety. **The coming generation of excavators, graders and wheel loaders is likely to feature some form of drive-by-wire.** It has potential applications in braking, steering and moving the boom. Legislation will also play a part in determining when drive-by-wire becomes a reality.

Are customers demanding drive-by-wire? Customers are demanding soft levers and easy to use controls – and drive-by-wire allows this to happen. Drive-by-wire also eliminates the need for hydraulic oil to be piped into the cab – which can get very hot (thereby heating up the cab).

The SfinX excavator hovers on an electro-magnetic field.

Houston: we have a solution

Satellite technology is already available and will become much more popular in the future. Volvo CE is working on GPS (Global Positioning System) based telematic capabilities for its future product range. 'Geo-fencing' can make sure that a machine doesn't leave a predetermined area – sounding an alarm and incapacitating the machine if necessary. Also data such as hours worked, temperature, fuel consumption and productivity information can all be captured. This not only helps prepare service programs, but also highlights machine misuse/abuse and enables equipment owners to calculate lifetime ownership costs. Real time fleet management is now a reality. GPS also has operational advantages. For example, in excavators or graders, GPS information can help to notify the operator how the bucket or blade should be placed so that only the precise amount of material is removed. Therefore there is no wasted effort and productivity is correspondingly improved.

GPS information can help to notify the operator how the blade should be placed.

Material evidence

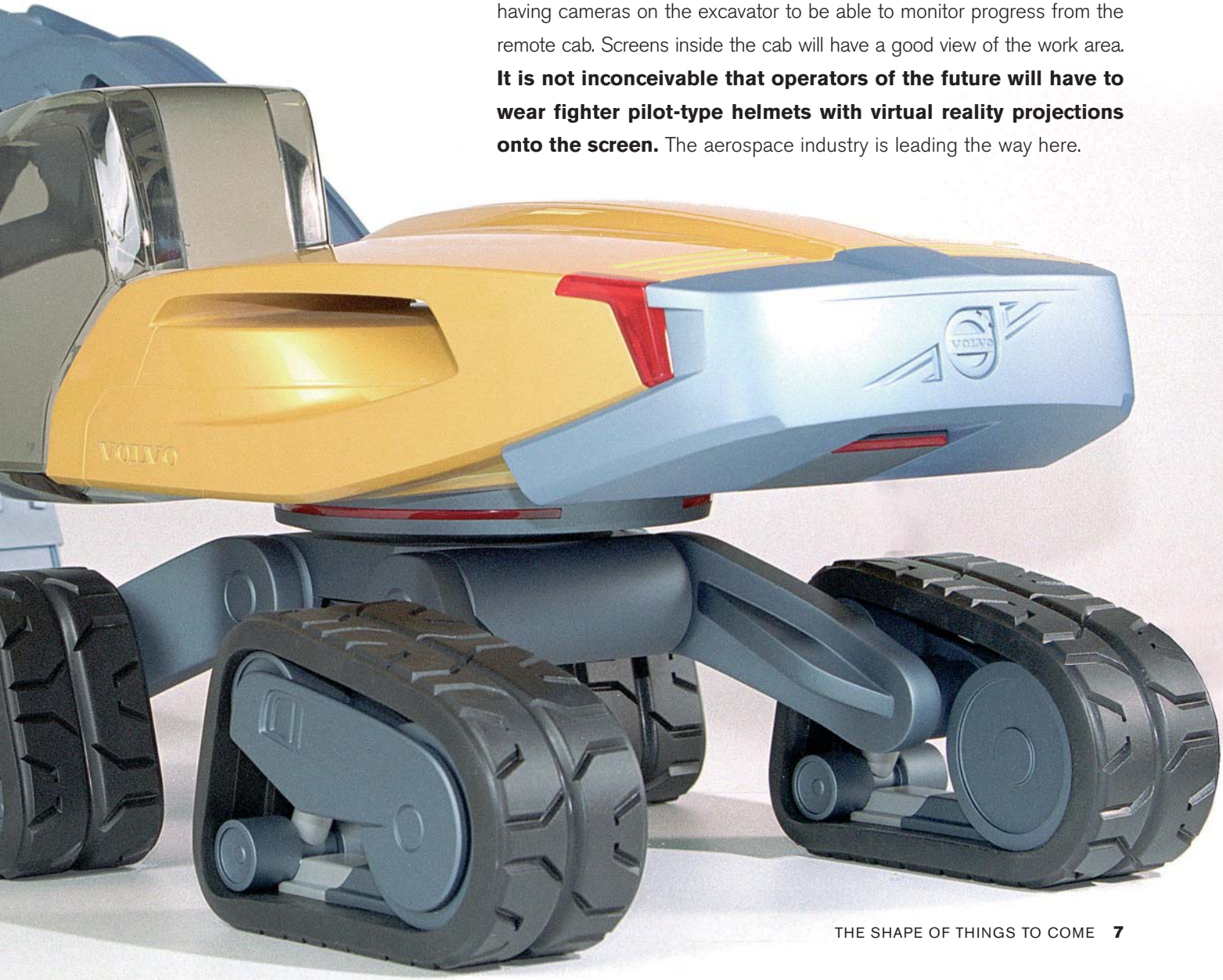
As shown in SfinX, metal will increasingly be replaced as a component material by composites. This is because they are resistant to the environment and can be relatively easily repaired (they are also generally lighter; can be molded into more interesting shapes). Plastics, meanwhile, are lower cost, can be painted to a higher specification and – in line with Volvo's core values – environmentally friendly plastics are becoming available, helping manufacturers meet their targets for recyclability.

Force field

The juncture between the undercarriage and superstructure would eschew the current arrangement of a large roller bearing. Instead the SfinX excavator hovers on an electro-magnetic field. The advantages of this are that there would be zero friction and better control of the speed and torque turning of the superstructure.

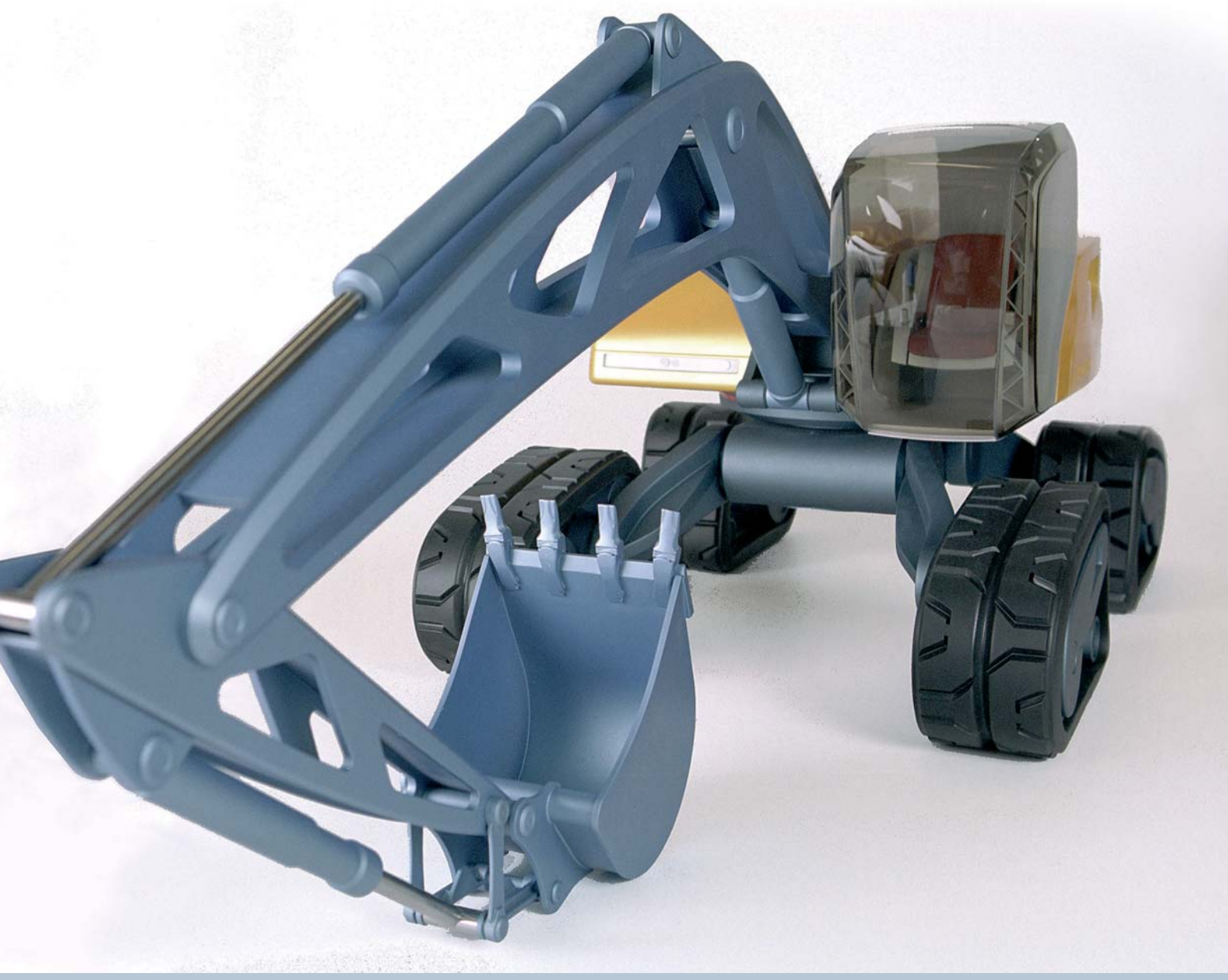
Operator environment

The cab on the SfinX excavator is cantilevered to improve all round visibility. But it can also tilt the cab, move it away from the machine to improve visibility (as some waste handling machines already do) – or be left on the ground entirely. This latter attribute is for the remote control of the machine, such as where the operator cannot safely work on the machine (such as close to high radioactivity or if the machine is working underwater). In the morning the cab comes down to meet the operator, it then opens the door and says 'hello, how are you today?'! Having a detachable cab necessitates having cameras on the excavator to be able to monitor progress from the remote cab. Screens inside the cab will have a good view of the work area. **It is not inconceivable that operators of the future will have to wear fighter pilot-type helmets with virtual reality projections onto the screen.** The aerospace industry is leading the way here.



The road to reality?
Is this how the future will look?

Of course, not all glances into the future have proven correct. Even if SfinX is not **exactly** how Volvo's excavators look in the 2020s, if only a small number of its ideas come to fruition, then the project will have proven to be a success. The SfinX concept is a statement of Volvo CE's intention to be at the forefront of technological development – producing machines that are not only highly productive but also people and environment friendly.



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