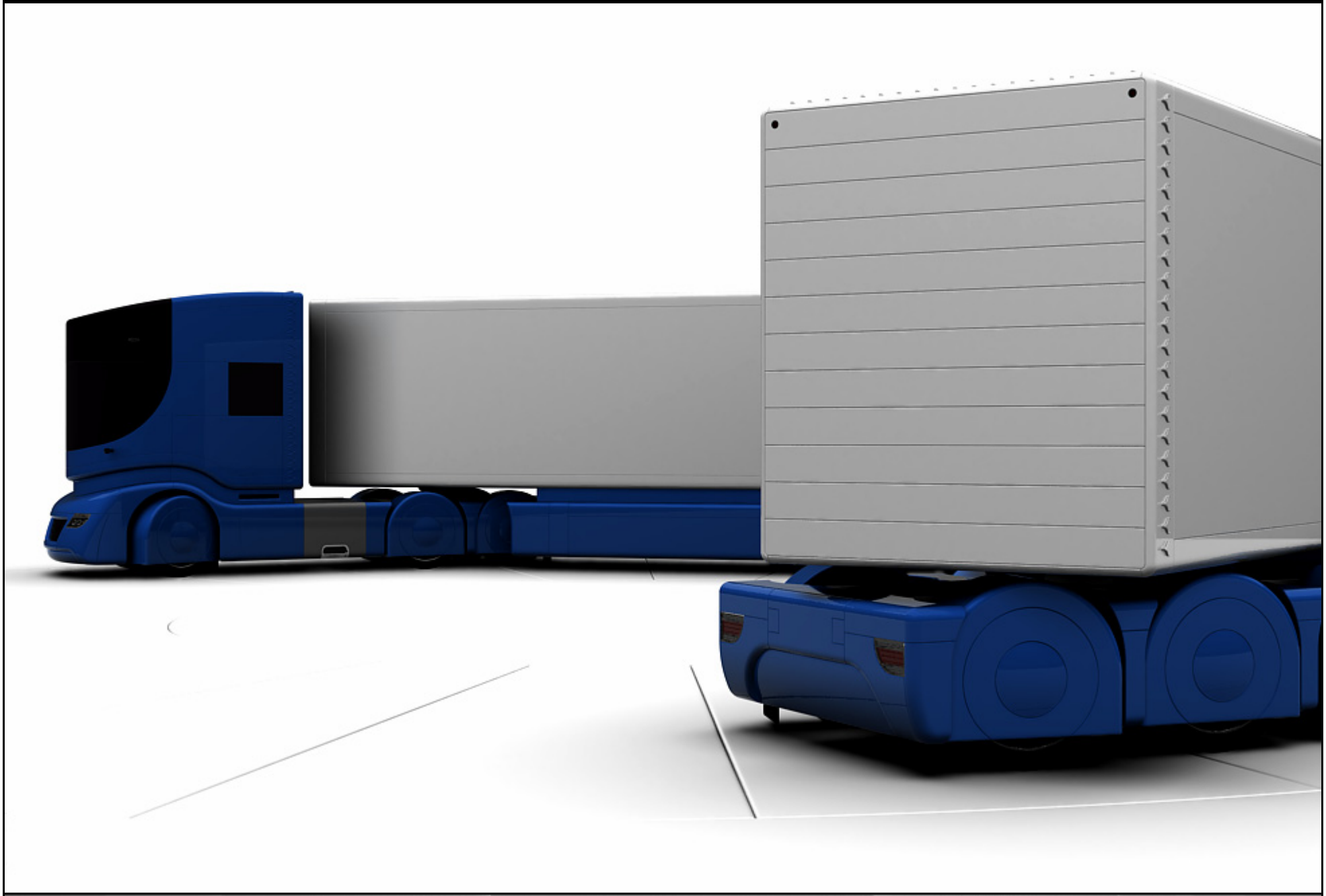
The Vayro



A.K. MUTHUI

The Vayro

Conceived as a vision for future (2020) North American long-distance road haulage, the Vayro is an endeavour to meet the demands brought about by increasing freight transport volumes. The concept intends to meet these demands with minimal environmental and infrastructural impact.

Background

Globally, long-distance road hauliers operate in a challenging environment. Freight transport volumes continue to increase and are expected to increase considerably by the year 2020. Nevertheless, contemporary trucks are ill-suited to manage these increasing freight transport volumes effectively. Thus, the demands for productive, fuel-efficient, and safe long-distance road haulage solutions are strong.

By the year 2020, the detrimental effects resulting from the continued use of fossil fuels are expected to be of even greater concern. Thus, the demands for environmentally friendly long-distance road haulage solutions will be especially strong. Moreover, in order to circumvent expensive infrastructure modifications and maintenance costs, these solutions must also be infrastructure friendly.

Productivity

In order to haul a large quantity of freight, the Vayro would make use of high capacity semi-trailers. The semi-trailers would be 53 feet (16.15 metres) in length and feature 51,000 pound (23 tonne) tridem axles. For even greater productivity, the tractor unit would tow these semi-trailers in tandem (à la "turnpike double"). Overall, the combination would be 123 feet (37.4 metres) in length.

With a proposed 182,000 pound (82.5 tonne) maximum gross combination weight (GCW) and an anticipated 55,000 pound (25 tonne) tare weight, the Vayro could haul a 127,000 pound (57.5 tonne) payload.

Fuel Efficiency

Aerodynamics

For minimal air resistance, the Vayro would feature a sleek profile. This would be achieved through a conical windscreen, curved tractor cab, raked low-profile "nose", comprehensive panelling (e.g. underbody, side, and wheels), rounded corners, "slippery" surfaces, and flush bodywork (e.g. devoid of mirrors, handles, windscreen wipers, horns, etc).

At speeds above 55 mile/hr (90 km/hr), the suspension would automatically lower the entire combination by…

…4 inches (100 millimetres) from the drive height. This feature would drastically reduce underbody drag and lower the overall height of the combination from 13.5 feet (4.12 metres) to 13.2 feet (4.02 metres).

In order to eliminate the turbulence between the tractor cab and lead semi-trailer, between the lead semi-trailer and secondary semi-trailer, and behind the secondary semi-trailer, vortex generators would be incorporated into the trailing edges of the tractor cab and the semi-trailers.

Powertrain

The Vayro would be powered by a hydrogen-fuelled internal combustion engine (HICE). With a displacement of 16 litres, the HICE would feature a maximum output of 550 kW (805 hp). This power would be transmitted through a power-split transmission (PST). The PST would also act as a regenerative brake.

The PST would transmit the power mechanically through a typical driveline (i.e. driveshafts, differentials, and halfshafts) or electrically through an integrated electric generator, which would charge a high capacity lithium-ion battery pack. An electric motor, which would draw power from the battery pack, would be integrated into the driveline. Given that a mechanical path is efficient at consistent speeds while an electrical path is efficient at inconsistent speeds, the appropriate path would be chosen to suit the driving situation.

The six-cylinder HICE would feature a variable displacement system (VDS). When power requirements are…

…low (e.g. when travelling at a consistent speed on a flat road), the VDS would disable two cylinders to match lower power requirements efficiently. Therefore, the HICE would effectively displace 10.7 litres and consume less fuel as a result.

When the Vayro is at rest, power would be drawn from the battery pack. The HICE would recharge the battery pack when necessary. Solar cells would be located on the roof of the tractor cab and the energy captured would be used to power the cab's HVAC system.

Safety

Active

Via forward radars, strategically located proximity sensors, and sophisticated lane sensors, the Vayro would be conscious of the immediate environment. Through this consciousness, the system would automatically initiate appropriate countermeasures when need arises. For instance, the system would apply the brake force required to avoid an imminent collision and prevent a lane change manoeuvre if a collision would occur as a result.

The entire combination would incorporate a unique independent suspension with variable damping, low-profile wide-base tyres, and active steering (except for the forward drive axle). In concert with aerodynamic stability, this would allow the Vayro to travel at speeds of up to 65 mile/hr (105 km/hr) safely.

Hub-mounted wheel covers would virtually eliminate the spray that occurs during wet conditions. This feature would drastically enhance the safety of other road users.

Passive

With axle weights maintained at the current limits, each of the Vayro's 11 axles would brake their own share of the 182,000 pound (82.5 tonne) GCW. In concert with an advanced brake system, the combination would come to a stop well within the current limits.

Should a collision occur, however, the Vayro would incorporate measures to protect the driver and other road users. For instance, a central driving position would ensure that the driver has more survival space on each side and comprehensive underrun protection would prevent passenger cars from serious damage and the occupants from serious injury.

"Friendliness"

Environment

Fuelled by hydrogen through internal combustion (i.e. the HICE), the Vayro would only emit nitrogen oxides (NO_x). Furthermore, the quantities produced would be minimal owing to the high cargo capacity and high fuel efficiency of the concept.

Infrastructure

Although the Vayro is 123 feet (37.4 metres) in length, the combination would have no difficulty manoeuvring the current road network. In effect, the combination could “turn within a swept circle having an outer radius of 12.5 metres (41 feet) and an inner radius of 5.3 metres (17.4 feet)” as specified by EU regulations. This would be as a result of ten actively steered axles and four points of articulation.

With a 12,000 pound (5.5 tonne) front axle, 34,000 pound (15.5 tonne) drive and dolly axles, and 51,000 pound (23 tonne) semi-trailer axles, the Vayro would cause no additional damage to road surfaces.

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