TRANSFORMERS

DELIVERABLE REPORT

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AUTHOR(S):	**THORSTEN KOCH (FHG)**
REVIEWED BY:	**BJÖRN MARDBERG (VOLVO)**
APPROVED BY:	**COORDINATOR – MARCUS ELMER (VOLVO)**

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Executive summary

To increase the efficiency of road transport by tractor-semitrailer trucks one approach of the Transformers project is fuel saving by reducing the aerodynamic drag. Therefore a research is started to get an overview about current and possible new aerodynamic measures at the tractor and the trailer. As the subject of aerodynamics is quiet complex a basic background of aerodynamics for trucks was prepared to get a common understanding of the relevant parameters and the different influences on trucks aerodynamics. The main findings for aerodynamics were discussed with several aerodynamic experts from DAF, Daimler and Volvo within an aerodynamic workshop.

During the inquiry it was realized that almost all shown or mentioned aerodynamic measures for tractors are already implemented by most of all OEM. The improvability of up to date tractor design is nearly exhausted and only an overall redesign of the tractor is able to give little improvement possibilities within current legislation. Here the parallel optimization of several parameters is needed, as the aerodynamic effects are very sensitive. Changing a single measure will not lead to a drag reduction for sure, without considering the overall aerodynamics of the tractor. Therefore the research is focusing on the trailer aerodynamics giving several improvement possibilities. The trailer design improvement is also challenging because of different design parameters beyond aerodynamics like load volume, cargo/trailer weight, handling at loading/unloading and robustness. An improvement in aerodynamics that leads to a reduced fuel consumption is not necessary a cost improvement. A teardrop designed truck for example has less fuel consumption, but also less cargo space. It has to be considered, if the cost advantage from fuel saving will compensate the lost revenue of less cargo space.

The Transformers project assigns therefore a configurable trailer, which adapts the height of the trailer to the height of the cargo inside. Additional to this measure other measures and combinations of measures are collected and compared. The assessment of the collected results is challenging, because the results are gathered by different methods like computational fluid dynamics (CFD) simulations, wind tunnel tests and track tests. Regarding to CFD simulations and wind tunnel tests it has to be mentioned that small differences in the models can cause big effects which can also lead to a under- or overestimation of the results. Nevertheless several calculations with different assumptions are made to compare the different result parameters like drag reduction coefficient, drag reduction or fuel consumption reduction. Outliers are neglected and "similar" results are averaged. However the quality of the results can only be ranked by an aerodynamic expert with experience regarding to the specific measure or measure combination.

As there are three areas at the trailer (front, the underbody and the back), where aerodynamic measures can be integrated, the most promising measures are selected. These are the leading edge fairing (front), which supports the airflow in the transition between the tractor and the trailer, and also improves the robustness of slightly misaligned cab roof deflectors at different truck velocities. Here a drag reduction of 1.3% is assumed at a yaw angle of 0° and 3.6% at a yaw angle of 5°. The next one are the side wings (underbody), which supports a smooth airflow along the trailer side especially at crosswind condition. Here an averaged drag reduction of 5.0% is assumed at a yaw angle of 0° and 9% at a yaw angle of 5°. The last one is the rear flaps (back), which supports the airflow merging behind the back of the trailer and therefore reducing the wake area and the drag. Here a drag reduction of 5.7% is assumed at a yaw angle of 0° and 8.1% at a yaw angle of 5°. The special Transformer trailer roof lowering and tapering in combination with an adjustable cab roof deflector will give an additional benefit. Here different configurations are averaged to a drag reduction of 9.1% at a yaw angle of 0°. At a yaw angle of 5° there are no results available for lowering and tapering the roof. However it is expected that there will be an appreciable drag reduction.

At a yaw angle of 0° a drag reduction of approximately 21.1% can be expected with the combination of the measures leading edge fairing, side wings, averaged Transformers roof lowering and tapering, and rear flaps. As the Transformers roof lowering and tapering results are averaged over the different configurations, a much higher drag reduction is possible, if the best configuration (-21.7% drag with (3.57 m/3.1 m)-configuration) is taken into account. In this case a drag reduction of up to 33.7% seems to be achievable.

At a yaw angle of 5° a drag reduction of 20.7% can be expected with the combination of the measures leading edge fairing, side wings and rear flaps. The benefit of the Transformers roof lowering and tapering is neglected because of the lack of results at a yaw angle of 5°, but it can be assumed, that there will be an appreciable additional drag reduction.

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PROJECT PARTICIPANTS:

VOLVO	VOLVO TECHNOLOGY AB(SE)
BOSCH	ROBERT BOSCH GMBH
DAF	DAF TRUCKS NV
DAI	DAIMLER AG
FEHRL	FORUM DES LABORATOIRES NATIONAUX EUROPEENS DE RECHERCHE ROUTIERE
FHG	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V
IFSTTAR	INSTITUT FRANCAIS DES SCIENCES ET TECHNOLOGIES DES TRANSPORTS, DE L'AMENAGEMENT ET DES RESEAUX
IRU	IRU PROJECTS ASBL
P&G	PROCTER & GAMBLE SERVICES COMPANY NV
SCB	SCHMITZ CARGOBULL AG
TNO	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK (NL)
UNR	UNIRESEARCH BV (NL)
VEG	VAN ECK BEESD BV
VIF	KOMPETENZZENTRUM - DAS VIRTUELLE FAHRZEUG, FORSCHUNGSGESELLSCHAFT MBH

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