

# AUCOS-Systems

## WHITE PAPER

The next steps in  
horizontal transport automation

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## Management Summary

Automation of terminal tractors and road trucks is the next phase in automating transport. Initially in constrained environments like mines and ports but soon after also on the public road.

According the IRU in Europe there is a 20% shortage of drivers. Economic growth and very typical, online shopping will exacerbate this shortage. In America the ATA predicts similar shortages at short terms. Major truck OEM create innovative solutions, but also well-known tech companies are involved.

Two innovations which contribute to automating transport are “Aucos-Coup” (Automatic Coupling) and Aucos-Lock” (Automatic Locking). Both innovations save time and allow the driver to perform his tasks from the safety of the cab. Needless to say, that after remote control comes fully automated control.

When we forget all the capex and the opex savings and efficiency improvements and only think about preventing accidents, some 95% of all the accident have a human source. Reducing man-machine interaction will considerably improve the general wellbeing of everybody in the transport branch.

*Rüdiger Metternich*

*Note: IRU – International Road-transport Union and ATA – American Trucking Association*

## History Aucos Systems

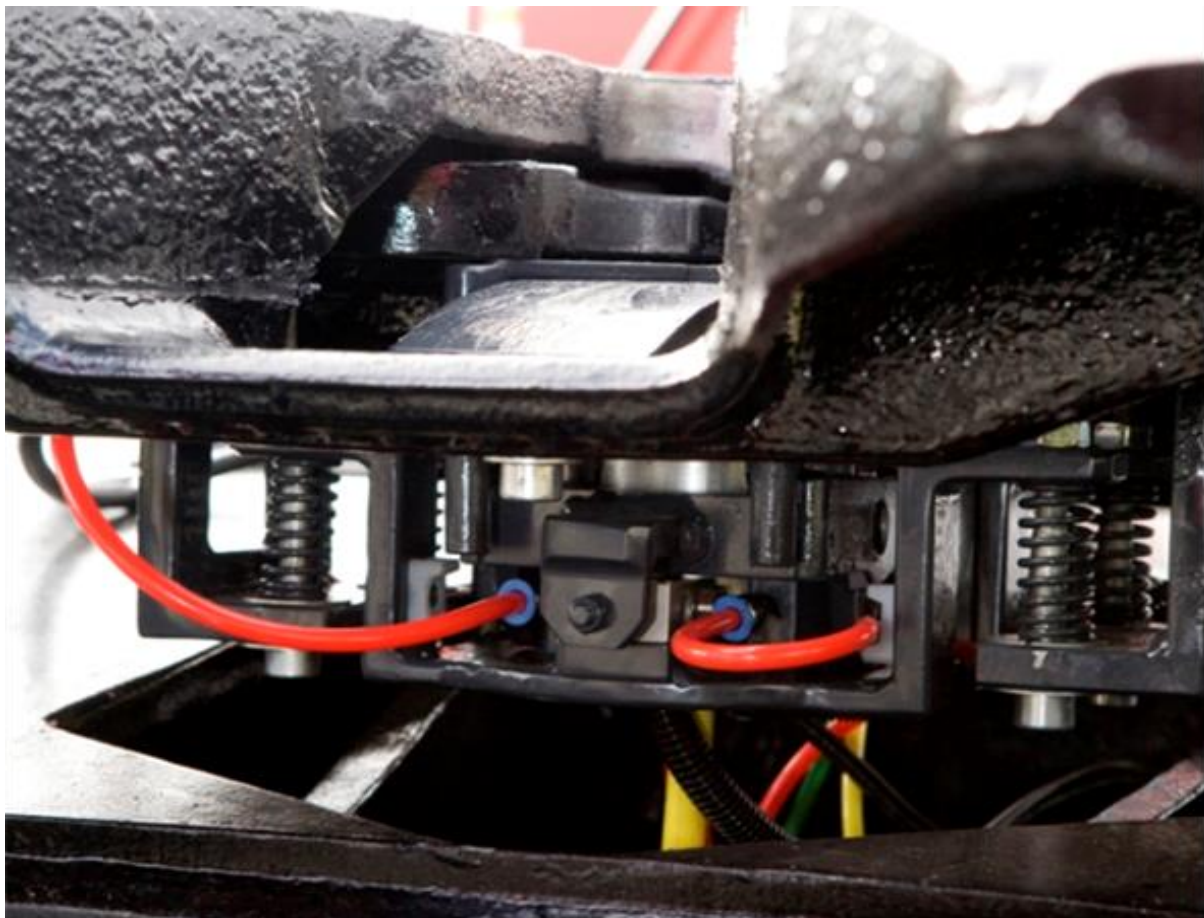
Rüdiger Metternich is a blacksmith by origin and RMM (Rüdiger Metternich Mechatronik GmbH) is an innovative, family-owned company, which has been active for more than 30 years in the construction and development of automated commercial vehicle components

The company and Rüdiger is at their best when their know how is challenged, implementing the ideas and specifications of customers at the highest possible quality level.

From the manufacture of special machines or systems to the modification of existing systems or the development of completely new technologies, RMM always offers its customers a solution for special problems with high requirements.

The core competencies are, component construction for commercial vehicles (partially or fully automated), equipment and plant construction for the transport and logistics industry, as well as in plant and fixture construction.

RMM was founded in 1989. Aucos-Systems GmbH was founded in 2018 to support the distribution of automatic couplings. At the moment, around 400 tractors and trailers worldwide are equipped with Aucos-Coup and have managed approx. 20 million coupling operations without any major faults in recent years. RMM / Aucos are currently active in Europe and America.



## The relevance of automatic couplings on container terminals

### **Whenever equipment is waiting in the transportation chain there is loss of productivity, efficiency, Capital Expenditures and Operating Expenses**

#### Productivity:

In every transport system, whether in closed or open terminals, waiting times occur as terminal tractors (TTs), or trucks with drivers wait for the drop-off/pick-up of containers or general cargo.

If these waiting times are too long, the trailers are already de-coupled manually today, parked in front of the sheds, yard area at the terminal or special parking areas, a new trailer is picked up and the next transport order is processed.

For this process, the driver has to leave the TT/truck in all weather conditions, including ice and snow, disconnect the air and power supply, turn down the legs, de-couple the trailer, get back on the TT/truck, drive to a free trailer and carry out the same process there in reverse order.

Even under optimal assumptions, this results in an unproductive time of about 3 minutes for each process, or 6 minutes for a complete cycle (couple/de-couple). With a complete round trip cycle of 30 minutes, about 20% of the complete cycle time can be saved with AUCOS-Coup, as the coupling and de-coupling of trailers is completed in a few seconds.

If, in case of container transport, it is also necessary to lock or unlock the container on the trailer, the idle time of the TT/truck is increased by another approximate 3 minutes.

The use of the AUCOS-Coup also significantly increases the safety of the driver, as he no longer has to leave the TT/truck.

#### Efficiency:

Incalculable waiting times may arise for the client during drop-off/pick-up of containers and stuffing/unstuffing at a shed. Drop-off/pick-up a container can be completed in 5 minutes but can also take up to 30 minutes, depending on unforeseen waiting times. The same picture arises when unloading or loading a container/trailer with general cargo.

By changing the trailer with automatic coupling or de-coupling (AUCOS-Coup), the control of the entire fleet can be carried out with a much higher and better accuracy and unplanned delays resulting from unpredictable handling can be avoided. The total orders of a day and utilization of the existing fleet can be optimized in a predictable manner.

#### Capex:

Even though the investment of 32,400 USD for a complete set (1 tractor and 2 trailers) seems quite high at first, with 18% additional costs, compared to the acquisition costs of one tractor and two trailers, approx. 180,000 USD, the investment turns into positive results relatively quickly.

With a depreciation period of 8 years, the investment corresponds to an annual depreciation value of approx. 4,050 USD/year.

However, part of this cost, about 30%, is directly offset by lower investments in tractors. With a productivity increase of only 10%, the investment can be reduced from e.g. 10 TTs to only 9 TTs, reducing the additional annual depreciation cost of the complete Aucos coup set to only 2,550 USD.

In addition to the direct savings from lower investments in tractors, the costs for drivers as well as maintenance, repair and fuel costs are of course also reduced.

If the use of autonomous vehicles is planned at the terminal for the next few years, on the one hand the use of an automatic coupling system (Aucos) is indispensable, but on the other hand the acquisition costs for autonomous tractors are around 300,000 USD to 350,000 USD. The additional costs for AUCOS-Coup are only about 10% and are amortised by the lower acquisition investment for tractors alone.

#### Opex:

While the purchase prices of TTs and trailers show only a small difference worldwide, the labour costs for drivers and maintenance staff differ considerably from country to country.

In some countries the total annual cost of a driver is up to 150,000 USD, in others only about 24,000 USD. Accordingly, there are also different payback periods for each country and each terminal.

In this white paper we have used statistic data from a South America container terminal to show how to achieve a quick return of investment (ROI), even in a country with a very low wage level and fuel costs.



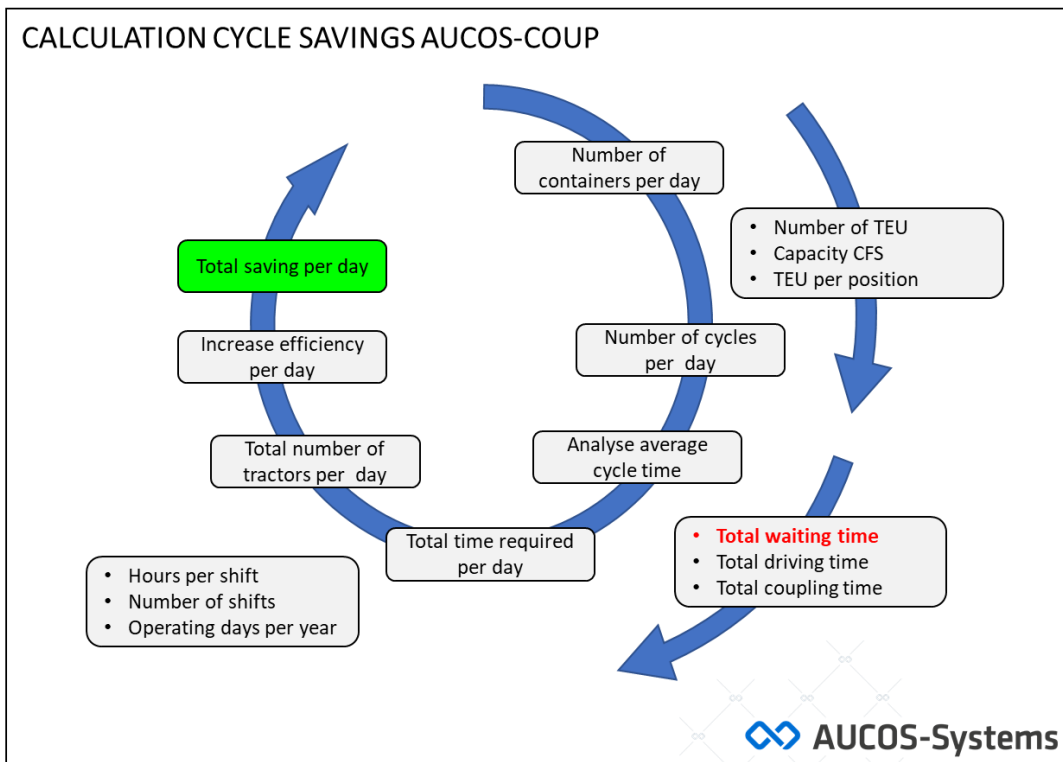
Drilled kingpin top view with Aucos connector inside.

### Calculation cycle example

De-coupling of the tractor from the trailer achieves that the tractor and driver, being the most expensive part, are separated from the trailer and the load.

This means you can use the tractor and driver more efficient. So, wherever a tractor is idling at the terminal, waiting for loading or unloading, it may be worth it evaluating the transportation process with a calculation cycle evaluation.

An example is given below. Basically its observing the operation, or a part of it, and mapping all the driving-, waiting-, transfer- and coupling time.



## Container Freight Station CFS

### Definition

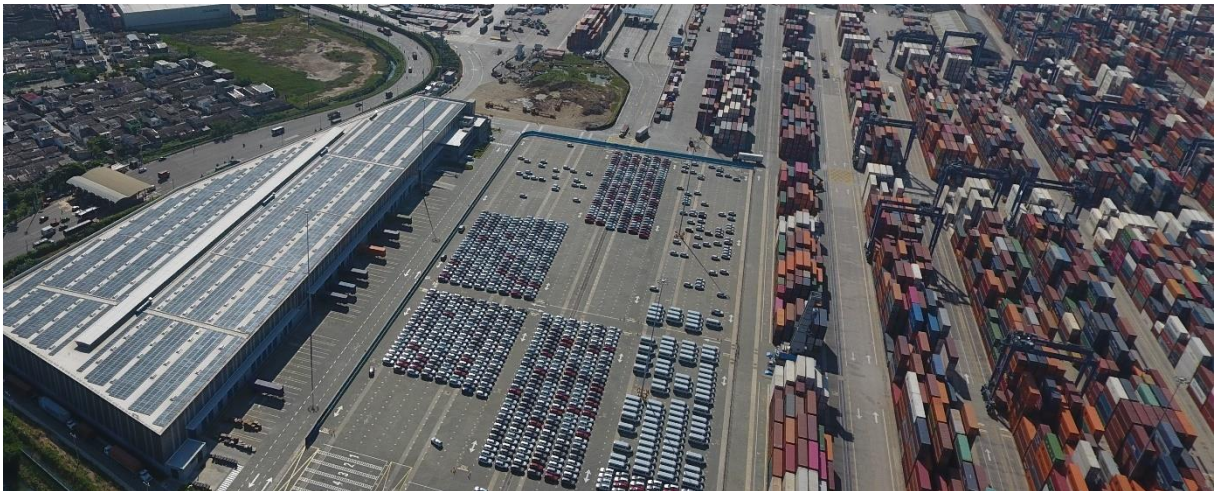
CFS stands for 'Container Freight Station'; a station, shed or warehouse where goods are serviced to be shipped or unshipped in containers.

At a CFS, the goods normally belong to a number of different customers. CFS Receiving Services include:

- Moving empty containers from a Container Yard to a CFS
- Drayage of loaded containers from the CFS to the Container Yard
- Tallying
- Issuing dock receipt or shipping order
- The physical movement of cargo in or out of a Container Freight Station
- Stuffing, sealing and marking of containers for labelling and identification
- Storage of containers
- Ordinary sorting and stacking of containers pre or post shipment
- Preparing containers internal load plan

CFS operation is typically for container ports & terminals with a lower transshipment figure. Where there is lots of import export activities there is lots of CFS services.

Operations like this consist of a container fetch, empty or full, from a depot or stack and transportation to a shed, warehouse or other facility where the above-described services are executed.



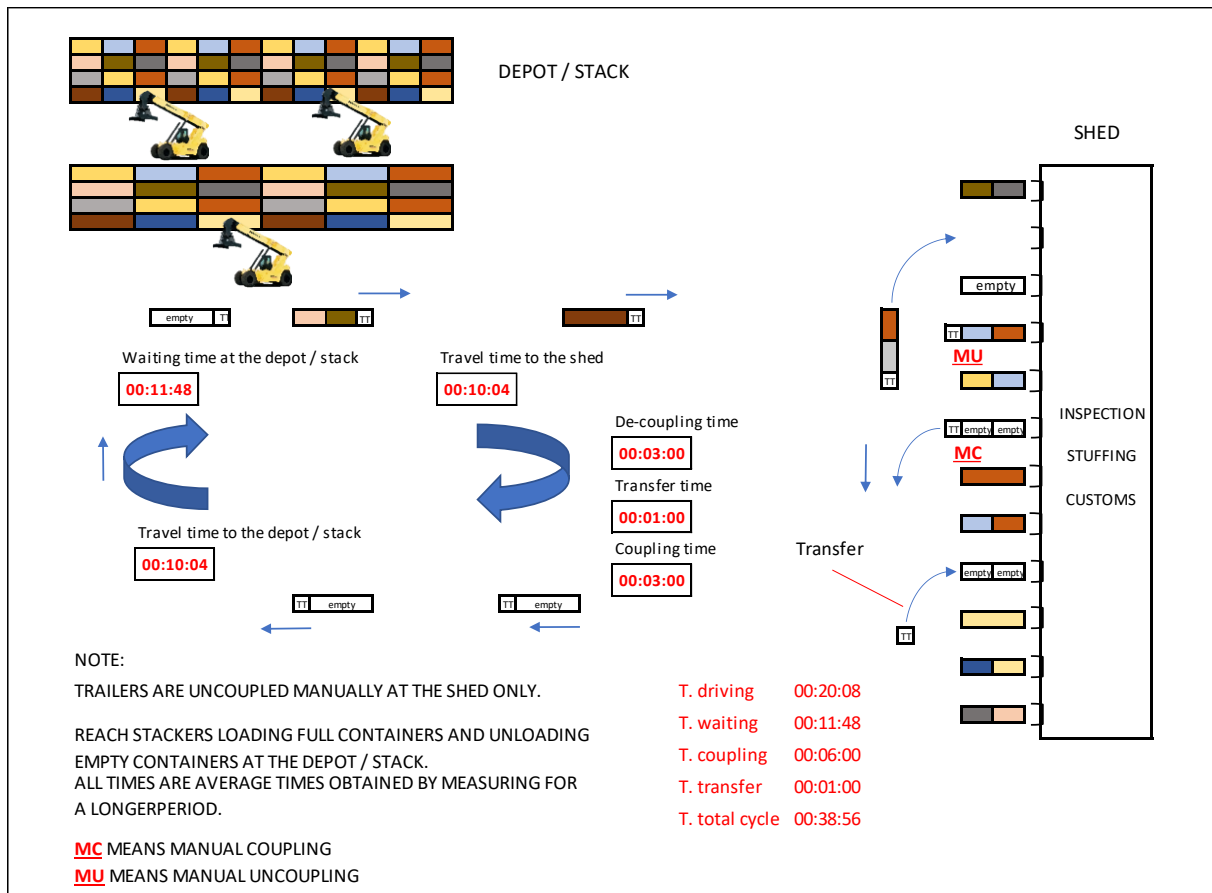
This type of operation is often characterized by considerable waiting times. At the depot or stack, due to container finding/digging or the number of equipment to service the terminal tractors. At the other end of the logistic chain there is a similar waiting time.

All this waiting- or idling time has a cost. Personnel- and fuel cost and de-coupling the tractor from the trailer will result in a more efficient use of equipment and personnel.

To get an insight in the efficiency improvement it is recommended to draw up a simple simulation path. A simple diagram with the various parameters to measure during a certain time.

A simulation path will also help when you present your proposal to the DMU in your terminal.

## Simulation path “manual coupled / de-coupled”



A simulation path is made to describe the terminal operation. Goal of the simulation path is to determine the various times.

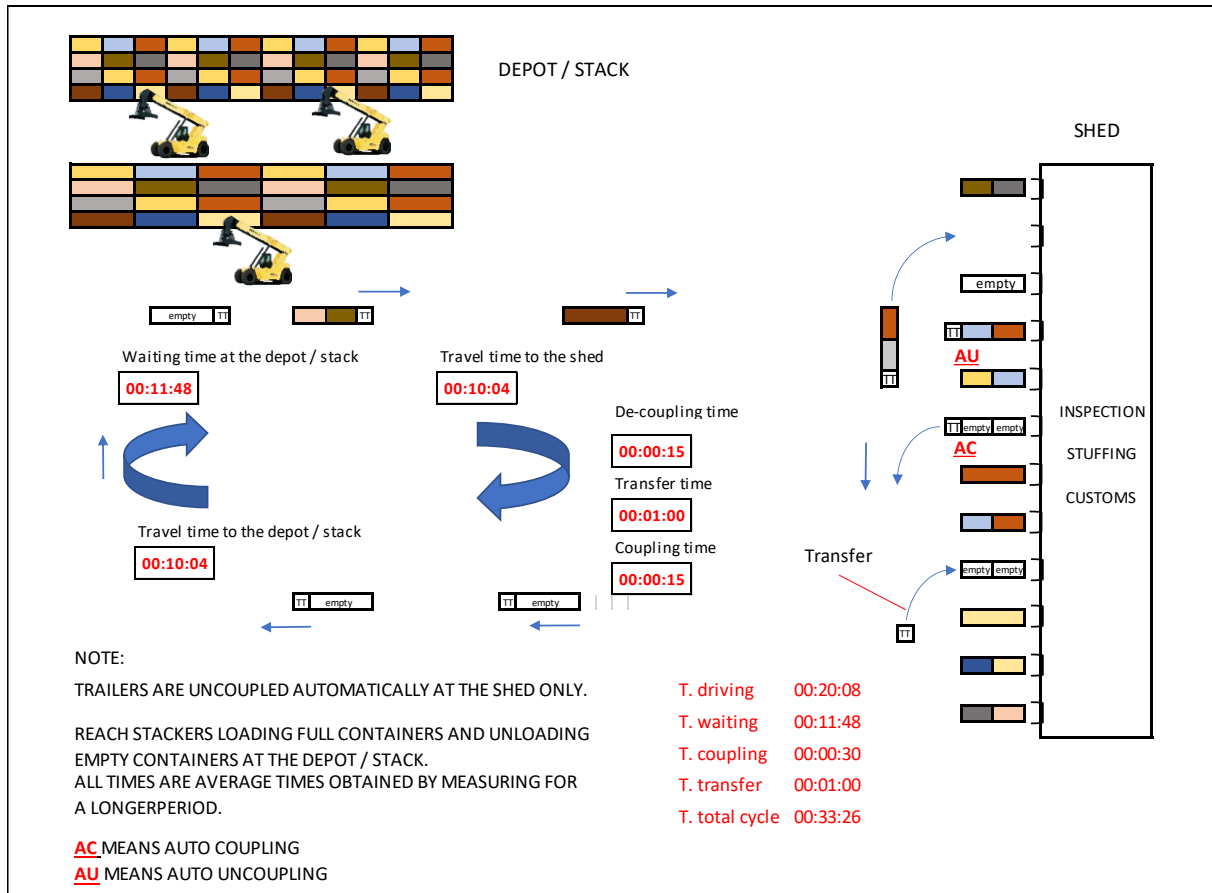
- Driving time - net time driving the tractor
- Waiting time – time waiting at the depot, stack or other area for other equipment to load or unload the container.
- De-coupling time: time to uncouple a trailer and unplug the air- and electric connection.
- Transfer time – time to transfer to another slot to pick up a trailer.
- Coupling time - time to couple a trailer and plug-in the air- and electric connection.

Every day a number of containers are transported to an area where the containers are serviced. Reach stacker (RS) are used to load containers at the depot. A tractor transports the containers to a shed for CFS services.

It's important to have a clear picture about the number and type of equipment needed and the staff to operate the vehicles. This information will be needed in a later stage to calculate overall efficiency and savings.

A good reference for starting an operation with automatic coupling is of course a high number of coupling/de-coupling, little driving time and/or long waiting time.

## Simulation path “automatically coupled / de-coupled”



In the simulation path above the coupling times at the shed are minimised by introducing automatic coupling / de-coupling. After de-coupling a loaded trailer the tractor drives to another pay to pick up an empty container. Total coupling / de-coupling time is around 15 seconds.

## Economic calculation

<b>Comparative costs with and without an automated coupling system</b>	
Container to be unstuffed per day	120 container
Factor TEU	1.6
Total TEU to be unstuffed per day	192 TEU
Total slots available at sheds	40 position
Average utilisation	75%
<b>Required number of trailer parked at the shed</b>	<b>30</b>
Cycles required to serve the shed with full container	120
Cycles required to remove empty container	120
<b>Total cycles required per day</b>	<b>240</b>

The example describes a calculation based on two sheds with different kinds of operation. One shed is just for unstuffing of import container, the other shed is used for unstuffing and stuffing. (consolidation and tallying)

<b>Average cycle time with manual coupling / de-coupling</b>	
Waiting time at the yard	0:11:48
Travel time yard to shed	0:10:04
<b>Manual uncoupling trailer with full container</b>	<b>0:03:00</b>
Transfer time to other slot	0:01:00
<b>Manual coupling trailer with empty container</b>	<b>0:03:00</b>
Travel time from shed to yard	0:10:04
<b>Average cycle time manual coupling</b>	<b>0:38:56 hours</b>
Total time required per day	155:44:00 hours
2 shift per day	16:00:00 hours
<b>Required tractors per day</b>	<b>9.7</b>

Note: in red manual coupling, in green automatic coupling.

<b>Average cycle time with automated coupling / de-coupling</b>	
Waiting time at the yard	0:11:48
Travel time yard to shed	0:10:04
<b>Automated uncoupling trailer with full container</b>	<b>0:00:15</b>
Transfer time to other slot	0:01:00
<b>Automated coupling trailer with empty container</b>	<b>0:00:15</b>
Travel time from shed to yard	0:10:04
<b>Average cycle time automated coupling (AUCOS)</b>	<b>0:33:26 hours</b>
Total time required per day	133:44:00 hours
2 shifts per day	16:00:00 hours
<b>Required tractors per day</b>	<b>8.4 tractors / day</b>
<b>Less tractors required</b>	<b>-1.375 tractors</b>
Less operating hours required	22:00:00 hours/day
Operating days per year	300 days
<b>Less operating hours per year</b>	<b>6600:00:00 hours</b>

All cycle times are based on actual average figures during one year of operation.

By taking out the waiting time at the depot / stack more savings can be achieved. Typical operations to accomplish this are depots with a transfer area or stacks with perpendicular loading / unloading. (ASC, RMG or ARMG)

Manually coupling / de-coupling the extra saving is 5 minutes (12%). With automatic coupling / de-coupling the extra saving is 10 minutes (25%).

<b>Possible cost reduction with an automatic coupling system</b>	
Investment costs per tractor	120,000 USD
<b>Total cost savings in investments</b>	<b>-USD 165,000.00</b>
Operating costs per tractor per hour (incl. combustibles)	8.25 USD
Reduction of tractors operating costs per year	54,450 USD
Costs per driver per hour	12.50 USD
Reduction driver costs per year	82,500 USD
<b>Operational costs reduction per year</b>	<b>136,950 USD</b>

Note: Annual wage tractor driver \$ 15.000; Ancillary wage costs 60% \$ 9.000; Total annual driver costs \$ 24.000; Working hours per week 40; Working weeks per year 48; Working hours per year 1.920; Tractor driver cost per hour \$ 12,50

<b>Automatic coupling investments</b>		
Cost per tractor (8.4)	15,600.00 USD	130,390.00 USD
Cost per trailer (38,4 - 30 at the shed and 8.4 driving)	8,400.00 USD	322,210.00 USD
<b>Total investment automated coupling system</b>		<b>452,600.00 USD</b>
<b>Simple payback in years (investment/cost savings)</b>		<b>2.10 years</b>

The calculation is based on actual figures in South America. The tractor driver costs are at the absolute minimum in a global comparison.

This applies not only to the driver costs, but also to the labour costs of maintenance and the other operating costs of the terminal tractor. In the example, the price per litre of diesel is approximately 0.57 USD

With own statistic data and detailed personal and equipment costs, individual payback time can easily be calculated.

## Environmental impact:

Worldwide, the requirements for a wide variety of environmental regulations are increasing. What is uniform, however, is the discussion about CO<sub>2</sub> reductions.

While the use of Aucos-Coup does not reduce the distances travelled on the terminal, it does reduce waiting times to a very considerable extent.

Hot temperatures in summer or cold temperatures in winter lead to drivers using either the heating or the air conditioning and the engine also running during waiting times. Although this consumes significantly less fuel, it still emits CO<sub>2</sub>, which can be reduced by automatic coupling and uncoupling.

With a consumption of approx. 8 litres/hour in full operation, the consumption in idling mode is reduced to approx. 1 litre/hour, corresponding to an emission of 2.665 kg CO<sub>2</sub>/hour.

At 16 hours per day and with 9 tractors, this results in approx. 385 kg CO<sub>2</sub> savings per day or 115 to CO<sub>2</sub> per year.

## Medium term market development 2025 – 2030

Automatic coupling is the logical next step in terminal automation. There are multiple ways of decoupling the horizontal transport chain but using automatic coupling of the trailer is the most economic, efficient and safe way of doing so.

Automatic coupling and de-coupling of the load has proven itself on so called closed terminals in Europe and North America. This principle will be rolled out from closed terminals to the public road within 5 years.

At the moment driverless driving is being tested in multiple European countries due to the expected increasing lack of drivers in the medium term. Experts estimate a shortage of around 60,000 drivers in Germany alone.

Driverless trucks are flexible and they can utilize the roads at 24/7. Think of bulk cargo postal services or supermarket supply, transported at night when general traffic is low.

De-coupling the truck from the trailer/load means increasing the efficient use of the automated truck and improving ROI. The first cases of deployment will be the highly frequented hub-to-hub routes. For example: Bulk transports from factory to intermodal hubs and vice versa.

## Near future developments RMM

The following developments are foreseen for the near future.

### Street version Europe

The street version or public road version basically is the existing technology with improved specification to withstand the public road environment.

For example, this will include a dirt cover to prevent contamination of the connectors while driving on the public road. The technical specification has to be such that dust and mud mixed with water and grease including: Dirt cover, mechanical or pneumatic, Transponder for trailer recognition,

### Automatic locks

Especially in road transport, but not only there, automatic twistlocks for securing the containers on the trailer are an essential part of any automation in container transport. RMM Aucos-Systems has developed and patented various solutions for this (Aucos-Lock).

The first trailers with automatic twistlocks were installed in the port of Hamburg more than 5 years ago and have worked without any major failures for a long period. RMM Aucos is currently in the process of introducing the various solutions in different versions on a large scale in Europe.



### Automatic support legs (Aucos-Leg)

In addition to the manual coupling/uncoupling of trailers and the manual unlocking, many terminals also require the support legs to be manually adjusted to different heights. The various manufacturers offer individual solutions, some of which are very user-unfriendly and require a considerable amount of time.

With Aucos-Leg, RMM-Aucos offers an automatic solution which, like the other components, can also be controlled directly from the cabin. This means that leaving the driver's cab can also be avoided, which leads to further time savings, optimisation and accident prevention in the entire process.