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Creating Maintenance Training Concept for Rocla End Customers and Service Partners

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This study was done for Rocla Oy AGV Solutions located in Järvenpää, Finland. They have customers all around the globe and with their extensive service network Rocla is always local. This way even when sudden failures in system happen, their service partners will be on location fast.

The purpose of this study was to create a coherent training concept for Rocla Oy to train their service partners to perform maintenance, and end users to upkeep their AGVs. The project included creating the training materials for both end customers and service partners. By creating clear concept for the trainings, Rocla Oy could guarantee stable quality of maintenance for their AGVs across the globe and decrease possible breakdowns. The training material concentrated heavily on individual maintenance tasks and tools needed to perform these tasks.

The training concept presented in this thesis will need to perform in future to prove its quality, but it is already a good guideline for the future, but will need improvements, because the information needed to create a functioning concept was too scattered, outdated or missing which caused problems in creating the material for the training.

Keywords	Training, AGV

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Tämä tutkimus tehtiin Rocla Oy AGV Solutionille, jonka pääkonttori sijaitsee Järvenpäässä. Heillä on asiakkaita ympäri maailmaa, jonka takia Rocla pyrkii ylläpitää laajaa palvelu verkostoaan, jotta voisi olla aina paikallisesti tavoitettavissa asiakkailleen. Näin myös yllättävien vikojen sattuessa heidän palvelukumppanit ovat paikalla nopeasti korjaamassa tilanteen.

Tämän tutkielman tarkoitus oli luoda johdonmukainen ja selkeä koulutus konsepti Roclalle, jotta he voisivat kouluttaa palvelukumppaneitaan huoltotöiden suorittamiseen, sekä loppuasiakkaitaan ylläpitämään heidän automaattitrukkejaan. Projektiin kuului myös koulutusmateriaalien luominen molempiin käyttötarkoituksiin. Luomalla selkeän koulutuskonseptin, Rocla pystyy takaamaan laadultaan tasaisen huollon automaatiotrukeilleen ympäri maailman, ja näin myös vähentää mahdollisten konerikkojen määrää. Koulutusmateriaali keskittyy vahvasti yksittäisiin huolto toimenpiteisiin ja työvälineisiin, joita mahdollisesti huollon suorittaja voi tarvita.

Tässä opinnäytetyössä esitettävän koulutus konspetin on tulevaisuudessa näytettävä toteen sen laadullinen arvo, mutta kaikesta huolimatta toimii hyvänä pohjana tulevaisuudelle. Tulevaisuudessa konspetia joudutaan parantamaan, sillä toimivan konspetin luomiseen tarvittava tieto oli hajanaista, vanhentunutta tai puuttui kokonaan. Tämä myös aiheutti ongelmia koulutuksen materiaalin luomisessa.

Avainsanat	Koulutus, AGV

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Contents

List of Abbreviations

AGV	Automated guided vehicle that navigates with the help of laser scanners and sensors.
AWT	Automated Warehouse Truck
I/O	Input / Output. The communication between computer and another processing system.
WMS	Warehouse Management System.
OPC	Open Platform Communications.
PLC	Programmable Logic Controller.
VR	Virtual Reality.
3D	Three-dimensional.

1 Introduction

This study was made for Rocla Oy AGV solutions department to create a training concept to train their service partners and end customers on maintenance and upkeep of automated guided vehicles, also known as AGVs. AGVs are robots that operate without drivers, instead they navigate with the help of laser scanners, wire, guide tapes, or machine vision. They are mostly used in industrial applications for moving loads, for example pallets or large paper rolls, around the facility or warehouse to improve the load handling efficiency, thus reducing costs and increasing profitability. [1.]

Rocla Oy is part of Mitsubishi Nichiyu Forklift group and is responsible of electric warehouse and counterbalance trucks within the European market together with AGVs in the global market. [2.] They develop and manufacture warehouse trucks, forklifts and AGVs. Rocla's research and development, and production are all located in Finland. The main expertise for the company is their automated solutions. Their first AGV was introduced to their clients back in 1983. Ever since Rocla has delivered over 7 000 AGVs worldwide with an emphasis on warehouse and logistic, production, paper industry, and food and beverage. Rocla offers modular automation solutions which are all tailored to the needs of each customer. [3.] The modular options can differ from regular forklift AGVs to clamps, conveyors, etc.

The objective for this project was to create a coherent and clear training concept for Rocla to train their service partners and end customers on maintenance and upkeep of their AGVs. The basis for the concept is that the training material is comprehensible and structured so that it is easily adaptable to changing training environments and modular AGV structures. The training material will be constructed of multiple presentations by using the old training materials and product manuals of the AGVs, batteries and other additional equipment as their basis. Successful training concept should result in the service partners to have the skills to do the maintenance of the AGV safely and efficiently, and the end customers to upkeep the AGV properly to increase its life cycle and decreasing the need of future maintenance and repairs.

2 Rocla AGV Solutions

2.1 AGV Types

The Rocla offers multiple different modular AGVs, which can be modified to the needs of customer by choosing different navigation method, AGV model, load handling equipment, etc.

As seen in the figure 1, the range of Rocla AGVs is wide, varying from common forklift applications to more complex rotating reel clamps. On the bottom left of the image you can see two smaller model AGVs, called ATX, which are most commonly used in lifting and moving pallets, but can also come with a conveyor. Rest of the AGV models shown in the figure are called AWT, standing for automatic warehouse truck, which come in two versions: AWTm and AWT heavy. AWTm is bigger AGV than ATX and comes with more variety in applications. AWT heavy on the other hand is wider version of the AWTm and used in heavier load handling. In this thesis we will discuss only ATX and AWTm.

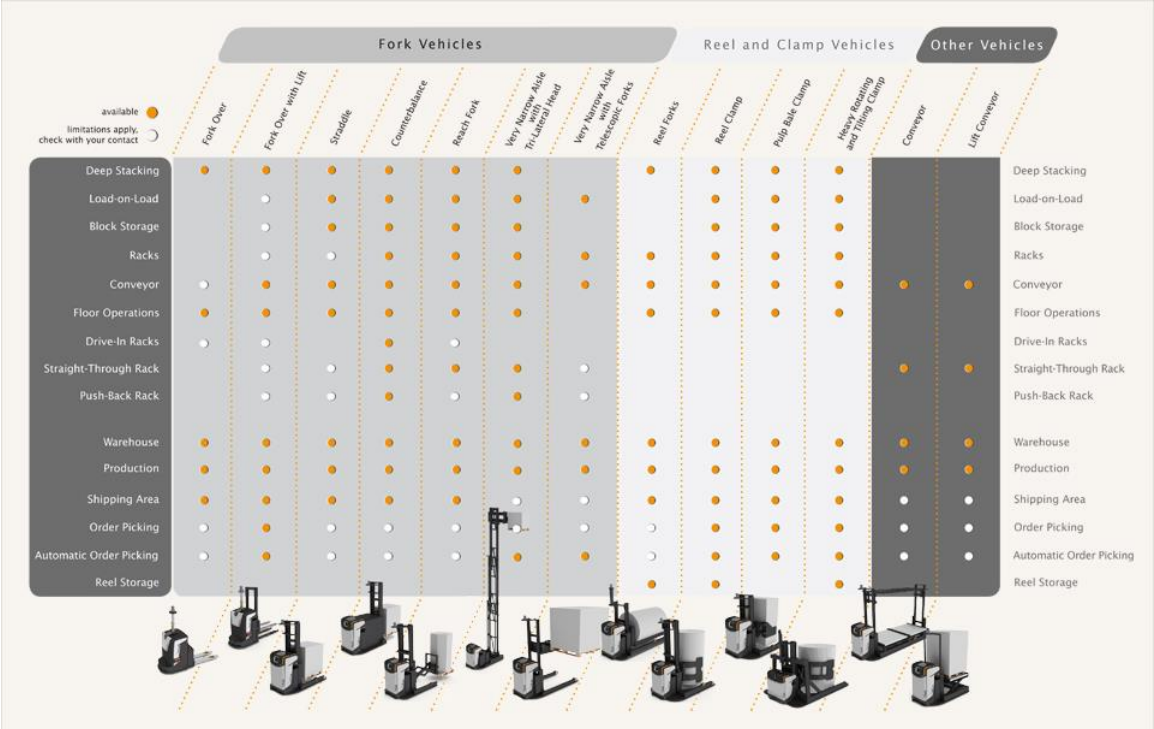

Figure 1. Range of Rocla AGVs [9.]

2.1.1 AGV Structure

The basic structure of each AGV consists out of truck, support leg, mast and load handling equipment (Figure 2). Truck is the brains of the AGV, consisting the logic controllers, control panel, motors, etc. Truck of each ATX or AWTm are always the standard models, but ATX and AWTm, differ from each other structurally, both having not only differences in set of components and design of the truck, but also differences in the locations of the components inside the truck.

Figure 2. AGV Structure, from left to right: tractor unit, support legs, mast and load handling equipment [4. p.4]

The last three parts of the AGV, support leg, mast and load handling equipment, are what makes the AGV modular and they can all be changed according to customer requirements. [4. p.4]

2.1.2 Navigation Methods

With each type of AGV, it is possible to choose from different types of navigation technologies, as seen in figure 3: laser scanner, spot navigation, wire navigation or combination of any of these.

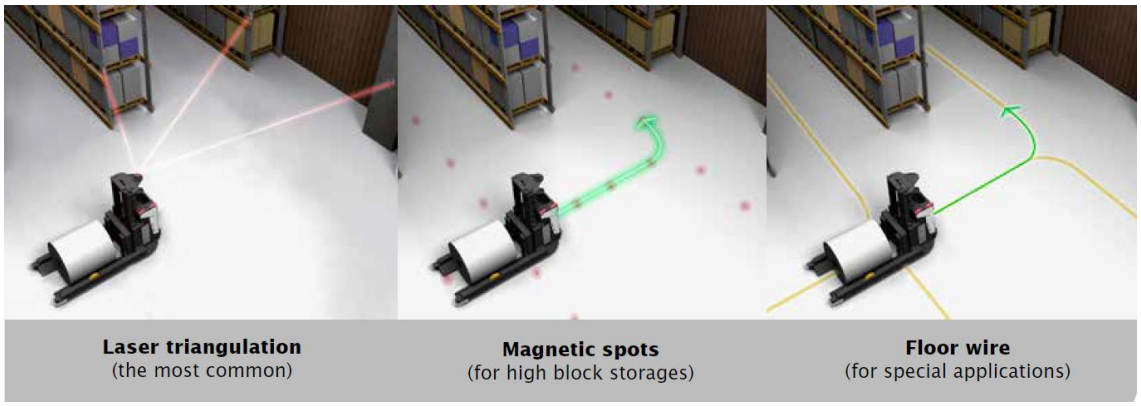

Figure 3. Navigation methods [4. p.5]

The most commonly use navigation method is laser scanner, which is based on laser scanner scanning reflectors that are placed in the navigation area and use of trigonometry. This navigation method is the most flexible and the environment where the AGVs work is easiest to change afterwards since there are no fixed installations or cutting of the floor.

Spot navigation is the most modern method of all three. The theory behind spot navigation is that the vehicle has sensors that senses the magnetic spots on the floor and thus follows the path.

The wire is most commonly used in older systems. The navigation is based on buried electrical wire in the floor that the AGV follows. [4 p.36]

2.2 AGV System

The AGV system consists out of WMS, System Manager and CWay which are installed on dedicated computer, usually at the customers' end (Figure 4). The system manager communicates through wireless network with the AGVs and through OPC (Open Platform Communication) to programmable logic controllers (PLC).

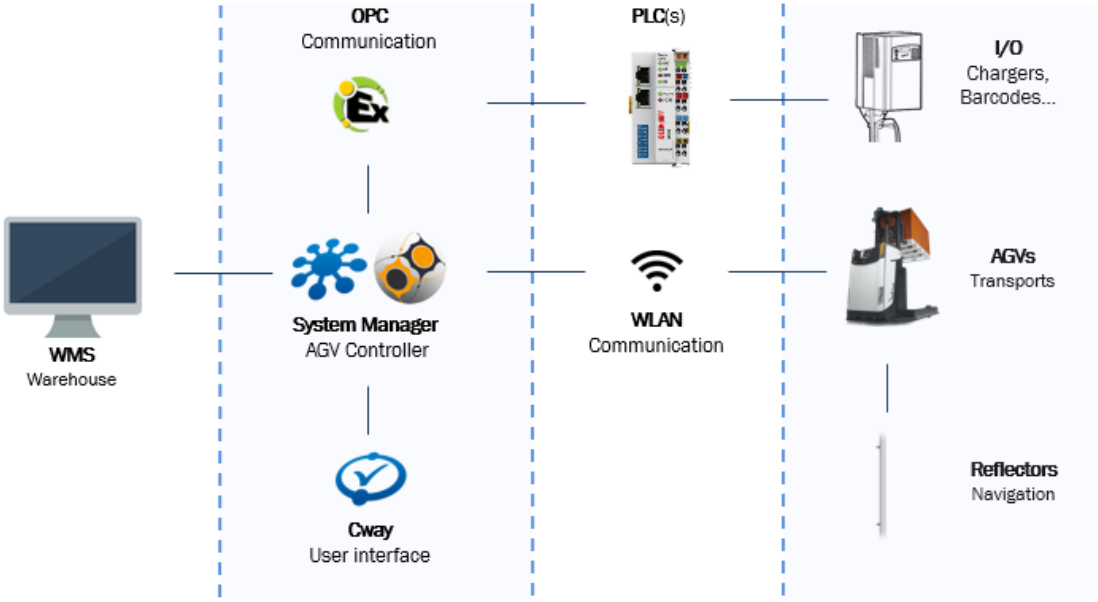

Image 1. System structure

2.2.1 Warehouse Management System

Warehouse Management System, also known as WMS, is used to manage the flow of products or materials within warehouses or manufacturing. It controls locations, product placements, transport resources and keeps track of inventories. The objective of the WMS is to increase the efficiency of logistic operations, thus creating economic savings. [5.]

2.2.2 System Manager

The system manager mostly runs as a service in the background and is very rarely accessed by the user. It has a console user interface which can be navigated with keyboard

only. The system manager handles the order reception, order execution, vehicle control and all communication with the AGVs, CWay, OPC, etc.

2.2.3 CWay

CWay is a graphical user interface for the AGV system that provides the user with following information:

- Real time vehicle information, including positions and statuses, such as if the AGV is carrying a load, or battery charge level, etc.
- Active order information, including transport orders, battery charging orders, etc.
- I/O information, including graphical icons for chargers, doors, conveyors, etc.
- Events, which includes all events from the system manager and from all AGVs combined with filtering options.

Through CWay the user can also remove AGVs from the system, give and cancel orders, and use it for maintenance purposes. It also writes an event log in database while running, which consists out of status information, warnings, and errors. This database can then be used for data mining and scripting.

2.3 AGV Service

The Rocla AGV service promises service agreements that suit each customers' specific needs after the system project has been completed [4. p.38-39]. The service agreement can contain following elements, depending on the customer's needs; planned maintenance, breakdown repairs, installation audits, modification and upgrades, retrofits, spare parts and component overhaul, around the clock help desk, and training (Figure 5).

Figure 4. Body of Rocla AGV Service [4. p.39]

Important part of the AGV Service is to collect data on the condition of the AGVs through maintenance and upkeep procedures. Planned maintenances can be done from two to four times a year, and it consists out of full mechanical and operational inspection of the AGV, as well as full safety check, where all safety devices are tested so that they work as intended.

3 TruckTool

TruckTool is program used for AGV maintenance and troubleshooting. It is mostly used for hardware calibrations and to document the maintenance procedures through a check-list. Through the program it is possible to connect to the AGV through ethernet cable to access the information of the vehicle. It has multiple functions such as doing a factory reset for parameters, changing parameters, importing and exporting parameters, inspect

the values of inputs and outputs, inspect errors and events, to trigger the black box, and to start a maintenance checklist.

The maintenance checklist (Appendix 2) contains all the maintenance procedures, step-by-step, that are needed to be performed on the AGV. The checklist will be filled at the same time as the maintenance is performed and important values, measurements and parameters, are written down on the list. After the list is filled out, it will be sent to Rocla.

4 Training Methods

The aim of training in organizations is usually to increase the work performance of the employees. A successful training has beneficial impacts on both employer and employees, such as increased productivity, need of less supervision, higher job satisfactions and skill development. [6.]

On a business to business setting, such as in Rocla's case, where a company is depending on a partner to deliver tasks on their behalf, the owner of the service is responsible for the training and the one most impacted by the performance of the partner.

4.1 On-the-job Training

On-the-job training is most effective when it comes to vocational work, such as mechanics, maintenance, etc. In this type of method of training the employee is trained while they are doing the actual job, usually supported with formal class-room training, with the instructions of a professional trainer, or in some-cases an experienced senior employee. [7.]

4.2 Off-the-job Training

Off-the-job training takes place away from employees' normal work situations, just as the name implies. This means that the employees participating the training will not count directly as productive workers. This type of training may include lectures, case studies and web-based learning.

The advantage of off-the-job training is that the employees can leave their work environment and focus fully on the training, increasing concentration and effectivity of the training. This training method is more effective when wanting to improve employee competencies or improve their job-satisfaction. [7.]

4.3 Technology Assisted Training

Technology assisted training includes such methods as web-based training, computer simulations, etc. This type of approaches transfers a degree of the control to the trainee, which might seem appealing to the trainee, but beneficial effects of the train might be less than expected unless properly supervised. [8.]

Technology assisted training can be used together with both on-the-job and off-the-job training but is not necessarily included in them.

4.3.1 Web-based Training

Web-based training (sometimes called e-learning) is in general based on the delivery of training materials using digital means. The tools that can be used with the web-based learning are extensive. Depending on what type of web-based learning platform is used, it may contain digitalized books, web-seminars, videos, audio files, online quizzes and tutorials.

Because of the wide range of tools that are possible to be used within the web-based training, it is important that the training structure is well-planned and structured, so that the training will be effective and that the participants will be able to improve their skills most efficiently.

4.3.2 Simulation-based Training

Simulation-based training uses technological means to assist in trainee development. Simulations are mostly used in trainings where a high degree of practice is needed, or where the trainee might hold significant responsibilities, such as of someone’s life.

The advantage of using simulation-based training is that the trainees can improve their deficiencies in a controlled virtual environment. This also allows the trainer to study the performance of the trainee in possible real-life scenarios, such as emergency situations, thus helping improve the trainee's skills in those specific scenarios. [7.]

One of the newest technologies that is being used in the simulation-based training is the virtual reality, VR. When using VR, the training is wearing VR glasses that will then show them 3D simulation of their training subject, for example an industrial machinery which the trainee will learn to do maintenance on. Depending on the depth of the 3D-simulation, the trainee can then interact with the simulation independently or while receiving instructions and feedback to improve their knowledge on the task that they are learning.

5 Generating Maintenance Training Concept

At the start of this thesis project it was very clear that the currently used training materials were scattered and mostly generated when needed for different training sessions by several trainers. The old material did not follow any separately specified guideline nor did it support the Rocla AGV Service. The material used in these trainings did not always contain all the needed information of the specific task or it was missing completely.

To gather all the needed knowledge to create a functioning maintenance training concept, it was needed to gather the old training materials and all manuals related to the AGVs, then reflect that information to what Rocla expects of their maintenance trainings. After this it was necessary to consult the training experts to see what has the structure of the trainings been, and what are the pros and cons of how the training has been done up until now. Few important things were brought up in this matter, one of them was the lack of concentration from the participants during the training and the other being the language-barrier. Because these trainings are held in multiple countries where some do not speak English nor the trainer the native language of participants, it has been essential to have a local translator to help with the training.

Due to the fact that the old training material was scattered and inconsistent regarding the information needed for the trainings, new training material was generated for each training purpose as a product of this study. Doing this would ensure that the material will include all the information discussed within this thesis.

5.1 Maintenance Training Concept for Service Partners

Rocla's service partners are responsible for all the maintenance tasks on the AGVs. The service partners are always local, to reduce the call-time. Due to the fact that the service partners are spread all round the globe near Rocla's customers, it is important that their knowledge is properly maintained in a way where less supervision over the maintenance process is needed.

The training needed for the service partners had to be separated in multiple parts, because of the extent of information that is needed to be involved within the training. The training was separated in four sections as it follows:

- General Maintenance Training
- Site Specified Maintenance Training
- Troubleshooting Training
- Annual Battery Maintenance Training

The service partners are required to take each training to be able to fully understand and perform the maintenance procedures for Rocla AGVs.

5.1.1 General Maintenance Training

The general maintenance is meant to give the service partners an overview of the operation and maintenance procedures for the AGVs. The training is split in two days as it follows:

Day 1: Introduction to the AGVs

- AGV Types
- Load Handling Equipment Types
- Basic Operation of AGVs

Day 2: Use of TruckTool -Program and Basics of Maintenance Theory

- TruckTool -Program, Installation and Navigation Guide

- Maintenance Theory for ATX, AWTm and Load Handling Equipment in General

During both days there will first be a theory part, which consists of presentations. After this there is practical part to support the theory; with this the participants learn basics on how to operate the AGV (Appendix 3.) and how to connect the TruckTool program with the AGV, together with an introduction to the maintenance checklist within the program. Length of the training is estimated to be eight hours per each day.

The objective for this training is to give the service partners a basic knowledge and tools that they need when doing the maintenance procedures. This training will perform as an introduction and as a base to the site specified maintenance training.

5.1.1.1 Day 1: Introduction to the AGVs

The training starts on the first day with introducing different types of AGVs and load handling equipment types that Rocla offers, because the participants might not yet be familiar with them. After this they are taught in theory the basics of operating the AGV, which includes introducing the operating and safety devices, use of control panel, different operation modes and how to activate them, driving direction, and how to operate the AGV with a manual control device. After the theory part the participants learn how to operate the AGV in practice with both ATX and AWTm. They are physically introduced to the operating and safety devices and their locations and functions. After this, participants are taught how to set the AGV to manual control mode and then operate the AGV back and forth in controlled environment.

5.1.1.2 Day 2: TruckTool -Program and Basics of Maintenance Theory

The second day of the training focuses on the use of the TruckTool program. It is beneficial if the participants have laptop with them during the training, so that they can install and explore the program together as the training proceeds, but it is not a requirement. The training starts with a theory part where the installation and use of the TruckTool is explained, including how to connect to the AGV, what are the purposes of each window within the program, how are different functions within the program relevant to maintenance, and how to find and fill in the maintenance checklist. Followed by the theory, there

is the practical part. During the practical part, the participants are taught how to connect to the AGV with a laptop and how to use the TruckTool program and find the checklist.

5.1.2 Site Specified Maintenance Training

The main guideline in the site specified maintenance training is the maintenance checklist found in the TruckTool program, which is needed to perform the maintenance on the AGVs. The training material on ATX and AWTm maintenance are structured based on the checklist, with each maintenance procedure explained with the support of explanatory images and text.

As addition to this, the site specified maintenance training includes also load handling equipment maintenance which differs for all equipment types. Explanatory presentations were made for each load handling equipment type with the instructions from their own manuals.

Before attending to this training, each participant is required to do the general maintenance training.

5.1.2.1 ATX and AWTm Maintenance

The structure of the maintenance for ATX and AWTm is based on the maintenance checklist (Appendix 2), with theory first and practical training after. Presentations that are used in the trainings were made separately for both ATX and AWTm, because the structure of both AGVs differ from each other.

The theory part of training starts with safety instructions to ensure the participants know how to do these maintenance procedures safely. After this the structure of the AGV, ATX or AWTm, is explained together with how their covers are removed correctly. The training focuses then on the maintenance checklist. In this training the checklist is thoroughly explained: how to fill it in, what information is needed and how to send it to Rocla. After this each point within the checklist is explained in detail within their own presentation slide which includes informational text and images. Lastly in the practical part of the training, each step of the maintenance checklist is demonstrated in practice, so that the participants can then perform these maintenance procedures while supervised.

With this training Rocla ensures that their service partners understand each step of the maintenance procedures and can perform it independently and efficiently.

5.1.3 Troubleshooting Training

The training for troubleshooting contains how to do troubleshooting on AGV System, ATX and AWTm. The training material created for ATX and AWTm troubleshooting training uses the same structure, with only specific details being different for both AGV models. The training will be structured mostly out of theory, with short practical part at the end, to show how to find the event logs and black box trigger. The objective for this training is that the service partners will know where to find and how to use the information needed when troubleshooting. The estimated length for this training is 8 hours.

5.1.3.1 Troubleshooting ATX and AWTm

The theory for ATX and AWTm troubleshooting starts off with safety instruction, so that the troubleshooting can be done safely. After this the methods and tools needed for troubleshooting are discussed, starting with the event log. Event log gathers information regarding the status of the AGVn thus being important source for information when troubleshooting. The training will explain various ways of being able to access this log and how to use it. There after the theory will focus on black box, which is most essential log file, which can be used to analyse the problems of the AGV and system failures by Rocla support team. It includes data of the AGV's internal message traffic and other runtime data. The theory will then continue to explain the use of CAN-bus within the AGV, communication architecture, safety scanner error messages, I/O module structure, parameter edit on touchscreen and which parts of the AGV are changeable. Lastly there will be circuit diagram overview and troubleshooting examples (Appendix 4).

5.1.3.2 Troubleshooting AGV System

The theory for AGV system troubleshooting training starts with the explanation on the system structure and how it functions. After this each part of the system (see p.5 Figure 4) is discussed separately to further explain their meanings and function within the system. Then the theory continues to explain how the system can be restarted and when this should be done, where the AGV system files can be found, and how to use the CWay

for system troubleshooting. Lastly it contains troubleshooting examples for troubleshooting the AGV System.

5.1.4 Annual Battery Maintenance

The annual battery maintenance focuses on all the maintenance procedures needed to be done for the battery of AGVs. The new training material was created based on the AGV manuals and the old training material. The training starts with the theory part executed with a presentation, which consists of safety instructions and the actual maintenance procedures with explanatory images. After this there will be a practical part where the participants are taught how to do these maintenance procedures in practice.

Safety is important when handling the AGV battery, especially due to its size and weigh when taking it off and placing it back into AGV (Figure 6). When pushing the battery back into its place in the AGV, it is possible for the maintenance worker to have their fingers hurt. Other factors that are important is making sure that the maintenance area is clean, and that the battery is fully disconnected before any maintenance procedures are done.

Figure 5. AGV Battery

During the battery maintenance, it is required to mark down certain measurements, such as gravity, temperature, insulation resistance and voltages of cells. Due to this, it was

important to create a clear battery inspection report document where these measurements can be written down to. During the practical part the participants will also learn how to fill in the battery inspection report. (Appendix 1)

The objective of this training is to give the service partners full knowledge of the maintenance procedures for the AGV's batteries, together with necessary skills and tools to be able to perform these maintenance tasks. The estimated length for the training is four to six hours.

5.2 Maintenance Training Concept for End Customers

The subjects covered in the maintenance training for the end customers consists of the basic upkeep procedures for their AGVs, which includes the daily and weekly maintenance procedures as they are specified within the product manuals, but with explanatory images supporting the text. The training starts with theory, which is executed with the training material, generated for this thesis project, in form of a presentation. After this there is the practical training, where the participants learn how to do the upkeep procedures in practice. The length of this training is estimated to be four hours.

The structure of the material generated for this training is as it follows:

- Safety Instructions
- Daily Maintenance
- Weekly Maintenance
- Cleaning the AGV

Safety instructions includes checking the correct operation of the safety sensors, horns and warning lights, scanners and bumpers located in the AGV in such situation as object being in front of the AGV or pushing the side of the AGV.

Daily and weekly maintenance includes examination of the AGV for any visual damages or leaks and making sure of the correct operation of the AGV by using the manual controller (Figure 7). This includes movement forwards, backwards, steering and acceleration, and lifting and lowering the load handling equipment.

Figure 6. Manual Controller of the AGV

The objective for this training is that the end customers will be able to properly upkeep their AGVs, which will then decrease the number of possible defects, thus decreasing the number of needed repairs and maintenance.

6 Discussion and Conclusions

When working on the study it slowly became clear how difficult it is to make a clear guideline for all trainings Rocla holds for their service partners and end customers. This is due to the fact that there are so many variants of the AGVs and the information is scattered, not available, outdated or collides with other information. For this study it meant that some of the information regarding the trainings was hard to achieve or was not available at all.

The problems within the current training is that it is heavily based on having a presentation where a person talks at the front and explains the theory and then these things are

learnt in practice. This causes that either these trainings need to be performed at the location of service partner or end-customer, which currently causes Rocla heavy financial costs, or the service partners and end customers should be ready to travel to Rocla's office, which will also increase in financial costs for them. To counter this problem, it would be worth considering training an expert within each service partner and end customer company, who will then be responsible for the knowledge sharing within their company. This way it will be cheaper for them to travel to Rocla's office for the trainings, but also this would help with language barriers. Training an expert to the service partner or end customer company will enable them to fully teach others within the company that do not necessarily speak English or other language common with the Rocla training experts. This will improve the quality compared to having translator, because the translator does not necessarily understand the content and meaning of the training, thus the translation might not be perfect.

The current training material which was created as a product to this study brings clarity compared to the old training, and the information is more structured and coherent. Even so, the current structure of the training is still in need of improvements to fully support Rocla's service. It would be required that all the information, documentation and manuals needed for the trainings would be properly gathered so that they are easily accessible for the trainers, but also updated so that all the information is correct and up to date. Also, to improve the quality of the trainings, the feedback of the participants is important. This could be gathered in form of questionnaires given during the training, where each participant can write down their wishes and opinions regarding the training.

To maintain the knowledge of the service partners, it would be important for Rocla to hold re-trainings every two years. Meaning, it would be recommended to create a separate training where each part is shortly explained again, and possible new information highlighted and thoroughly explained to the participants. Another way would be testing their knowledge by online test. If the score is too low, they would have to come and renew their training from the beginning.

In future it would be possible to try different ways to carry out the trainings, such as interactive videos, where for example problem with the AGV is explained and the trainee needs to choose correct way to troubleshoot the AGV. This could be also used as a supportive material together with the presentations. Another possible innovative way of carrying out the trainings is using virtual reality, but the downside is that it is costly. If the

VR would be wanted to be implemented in the training, it would be recommended to only apply the base model of each AGV truck, because of the modularity and high number of variations within the load handling equipment.

References

1 Automated Guided Vehicles, Webpage, Wikipedia. https://en.wikipedia.org/wiki/Automated_guided_vehicle Read 5.6.2018

2 Rocla celebrates its 75th anniversary, Online article, Rocla. http://rocla.com/en/press/news/rocla-celebrates-its-75th-anniversary-see-photo-personnel Read 4.6.2018

3 About company, Webpage, Rocla. http://www.rocla.com/en/rocla/company Read 4.6.2018

4 Maximise your logistic performance – AGV range brochure, PDF document, Rocla. https://www.rocla-agv.com/sites/default/files/sample-files/rocla-agv-brochure.pdf

5 Rocla's Warehouse Management System, Webpage, Rocla. https://www.rocla-agv.com/en/agv-technology/roclas-warehouse-management-system

6 Training and Development, Webpage, Wikipedia. https://en.wikipedia.org/wiki/Training_and_development Read 16.9.2018

7 Training, Webpage, Wikipedia. https://en.wikipedia.org/wiki/Training Read 16.09.2018

8 Brewster, C., Houldsworth, E., Sparrow, P., and Vernor, G., (2016) International Human Resource Management, 4th Edition, London, CIPD pp.292-293

9 Automated Guided Vehicles, Webpage, Rocla. https://www.rocla-agv.com/en/automated-guided-vehicles Read 1.10.2018

Battery Inspection Report

Rocla

Battery Inspection Report

Date	Location

Service Partner Information	Company name	Employee name
AGV Information	AGV type	AGV ID
	Battery type	Battery no.

Pilot cells	No.	No.	No.	No.
Specific gravity of electrolyte [kg/l]				
Temperature of electrolyte [°C]				

Cell or bloc no. beginning at the positive terminal of the battery. For bloc batteries the specific gravity of the electrolyte of the cell next to the positive pole must be measured in each case.

Insulation Resistance	Positive Connector	Negative Connector	Ideal Result
			48V Battery: > 2 400 Ω 24V Battery: > 1 200 Ω

No.	Voltage [V]	S. G [kg/l]	Temperature [°C]
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

No.	Voltage [V]	S. G [kg/l]	Temperature [°C]
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

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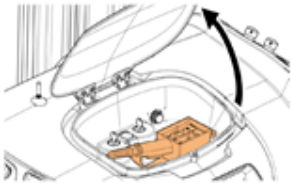
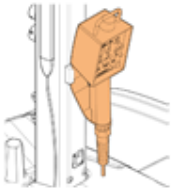
Maintenance Checklist Contents

Sample of Training Material: Basic Operations of the AGVs

BASICS OF THE AGVS
MANUAL CONTROL DEVICE

- MCD8 (Manual Control Device, System 8) is needed to control the vechile in manual mode.
- In AWTm it can be found on top, inside the compartment
- In ATX it can be found behind the key switches





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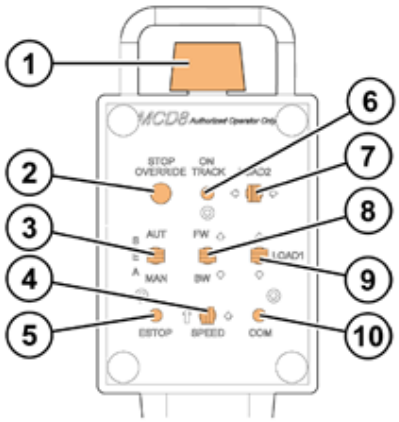
BASICS OF THE AGVS
MANUAL CONTROL DEVICE



1. Steering potentio meter
2. Safety stop override button
3. Steering mode selection switch
   - AUT: Steering wheel straight
   - SEA: AGV follows programmed routes when operator gives command
   - MAN: Fully manual mode
4. Speed switch
5. Emergency stop indicator light
6. On track indicator light
7. Load handling switch
8. Driving direction selection switch
   - FW: Forwards
   - BW: Backwards
9. Switch for lifting and lowering
10. Communication indicator light

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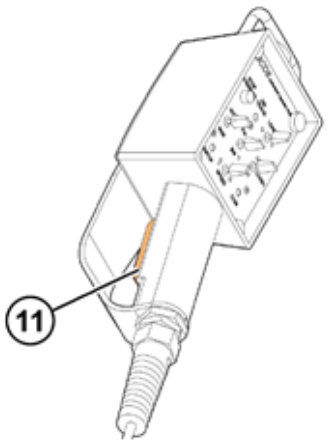
BASICS OF THE AGVS

MANUAL CONTROL DEVICE



11. Enabling switch

- To operate the AGV push the enabling switch to the center position.
- If you do not push the enabling switch enough or if you push it too much, the manual operation mode is disabled and the red emergency stop indicator light turns on.
- When operating the AGV in manual mode, walk beside the AGV.

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Sample of Training Material: Troubleshooting Examples

Fault	Possible Reason	Action
The AGV does not move.	The manual control device is not correctly connected.	Connect the manual control device.
	The AGV is not in the manual mode	Set the AGV to the manual mode.
	The AGV is in the emergency stop state.	Clear the emergency stop state.
	There is a traction motor or sensor bearing failure.	Examine the motor connections and electrical connections.
	The traction motor is too hot.	Measure the temperature of the traction motor.
	There is a failure in the traction motor controller.	Examine the traction motor controller and the connection to the logic board.
	The laser scanner does not rotate.	Examine laser scanner.
	CAN bus non operational message shows on display at start up.	Wait until the message disappears. If it doesn't, search the cause from the Event log and remove it. Set the power of the AGV OFF and ON

Fault	Possible Reason	Action
The AGV cannot be steered.	The manual control device is not correctly connected.	Connect the manual control device.
	The AGV is the emergency stop state	Clear the emergency stop state.
	The manual control device is not in the manual operation mode.	Set the manual control device in the manual operation mode.
	There is a traction motor or sensor bearing failure.	Examine the motor connections and electrical connections.
	The steering potentiometer of the manual control device is damaged.	Examine and repair the steering potentiometer.
	The steering motor is too hot.	Measure the temperature of the steering motor.
	There is a failure in the steering motor controller.	Examine laser scanner.
	CAN bus non operational message shows on display at start up.	Wait until the message disappears. If it doesn't, search the cause from the Event log and remove it. Set the power of the AGV OFF and ON

Fault	Possible Reason	Action
The AGV cannot be steered.	The manual control device is not correctly connected.	Connect the manual control device.
	The AGV is the emergency stop state	Clear the emergency stop state.
	The manual control device is not in the manual operation mode.	Set the manual control device in the manual operation mode.
	There is a traction motor or sensor bearing failure.	Examine the motor connections and electrical connections.
	The steering potentiometer of the manual control device is damaged.	Examine and repair the steering potentiometer.
	The steering motor is too hot.	Measure the temperature of the steering motor.
	There is a failure in the steering motor controller.	Examine laser scanner.
	CAN bus non operational message shows on display at start up.	Wait until the message disappears. If it doesn't, search the cause from the Event log and remove it. Set the power of the AGV OFF and ON

Fault	Possible Reason	Action
The AGV cannot be steered.	The manual control device is not correctly connected.	Connect the manual control device.
	The AGV is the emergency stop state	Clear the emergency stop state.
	The manual control device is not in the manual operation mode.	Set the manual control device in the manual operation mode.
	There is a traction motor or sensor bearing failure.	Examine the motor connections and electrical connections.
	The steering potentiometer of the manual control device is damaged.	Examine and repair the steering potentiometer.
	The steering motor is too hot.	Measure the temperature of the steering motor.
	There is a failure in the steering motor controller.	Examine laser scanner.
	CAN bus non operational message shows on display at start up.	Wait until the message disappears. If it doesn't, search the cause from the Event log and remove it. Set the power of the AGV OFF and ON