Deliverable D.6.03
SLOPE System Fields Trials
Readiness Assessment Report

WP 6 – System Integration
Task 6.4 – Third integration – System validation

Revision: 1.0 Final

Authors: Umberto Di Staso, Daniele Magliocchetti

Author name (Partner name): GraphiTech

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<td>Veli-Matti Plosila, Seppo Huurinainen, José Ángel Rodríguez, Alex Poveda, Stefano Marrazza, Gianni Picchi, Jakub Sandak, Diego Greifenberg</td>
</tr>
<tr>
<td>Reviewer(s)</td>
<td>Daniele Magliocchetti (GraphiTech)</td>
</tr>
<tr>
<td>Editor(s)</td>
<td>Daniele Magliocchetti (GraphiTech)</td>
</tr>
<tr>
<td>Partner in charge(s)</td>
<td>GraphiTech</td>
</tr>
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<td>José Ángel Rodríguez</td>
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Statement of originality

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Acronyms

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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>DBH</td>
<td>Diameter at breast height</td>
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<tr>
<td>NS</td>
<td>Norway Spruce</td>
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<td>RFID</td>
<td>Radio-Frequency IDentification</td>
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<tr>
<td>TLS</td>
<td>Terrestrial Laser Scanner</td>
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<tr>
<td>UAV</td>
<td>Unmanned aerial vehicle</td>
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<tr>
<td>SW</td>
<td>Shock Wave</td>
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<tr>
<td>QI</td>
<td>Quality Index</td>
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<tr>
<td>CP</td>
<td>Cutting Power</td>
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<tr>
<td>HI</td>
<td>Hyperspectral Imaging</td>
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<tr>
<td>LVDT</td>
<td>Linear Variable Differential Transformer</td>
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<td>WP</td>
<td>Work Package</td>
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<tr>
<td>TRL</td>
<td>Technology Readiness Level</td>
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<tr>
<td>UX</td>
<td>User eXperience</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>FIS</td>
<td>Forest Information System</td>
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<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
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<tr>
<td>RTK</td>
<td>Real-Time Kinematic</td>
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<td>ERP</td>
<td>Enterprise Resource Planning</td>
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<td>VNC</td>
<td>Virtual Network Computing</td>
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<td>JSON</td>
<td>JavaScript Object Notation</td>
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<td>REST</td>
<td>Representational state transfer</td>
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<td>API</td>
<td>Application Programming Interface</td>
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1 Introduction

This document is placed in the context of the SLOPE task T.6.4 "Third Integration, system validation". The purpose of the aforementioned task, from the Description of Work, is the following:

“During the final integration step, the whole system will be validated and tested. In a laboratory environment the hardware components (cable-crane’s carriage, processor head) will be mounted with SLOPE graphical display and sensors and the typical workflow will be replicated. The traceability system will be stressed and the communication between different components during the whole cycle will be assessed. The data provided will be coupled with the results of forest studies during demos. Cost and productivity of the whole system and its interactions with the market stakeholders (e.g. cost saving due to reduction of sawmill yard storage) will be calculated. The sustainability of the whole system will be compared with that of current practices and potential alternatives.”

In the context of the task T.6.4, the scope of the deliverable D.6.3 is the following:

“This deliverable will include assessment of the initial user experience and recommendations for the field trials operations. It will also provide guidance and the system operation manual for the Field Trials operators.”

1.1 Structure of the document

This document is structured based on the main deliverable requirements. The document is composed by three main chapters:

1. User experience assessment: reporting feedbacks collected from involved users and operators. This chapter identifies areas for future interventions, strength and weakness of each listed component.
2. Recommendations for future field trials operations: this chapter summarizing the valuable feedbacks gathered from experts from the SLOPE advisory board during the Pilot demonstrations in Monte Sover (Italy) and Annaberg (Austria).
3. System operations manuals: including manuals, tutorials, collection of materials useful for future trials operations.

For each aforementioned chapter, main components from WP3 and WP5 are listed and described, according with the aim of each corresponding section.
2 User experience assessment

This chapter contains the assessment of the User Experience for each software and hardware component developed during the project. It is important to underline that, based on the scientific focus of the SLOPE project, the goal of the prototypes was targeted mainly on functionalities: deep refinements of the systems will be conducted before the commercialization of the products.

For the aforementioned reasons, the identified Technological Readiness\(^1\) for developed technologies is between **TRL5** and **TRL6**, corresponding to:

- **TRL 5** – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- **TRL 6** – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies).

Within the term ‘User experience’, we are referring on:

“**User experience (UX) refers to a person’s emotions and attitudes about using a particular product, system or service. It includes the practical, experiential, affective, meaningful and valuable aspects of human–computer interaction and product ownership. Additionally, it includes a person’s perceptions of system aspects such as utility, ease of use and efficiency. User experience may be considered subjective in nature to the degree that it is about individual perception and thought with respect to the system. User experience is dynamic as it is constantly modified over time due to changing usage circumstances and changes to individual systems as well as the wider usage context in which they can be found.”**\(^2\)

2.1 Intelligent tree marking and tree felling/hauling

The intelligent tree marking and felling system was developed in close collaboration with several professional foresters. The main contribution, both in term of impact and continuity, was provided by the Municipal Forest Rangers Association of the Province of Trento, a network of foresters managing municipal forest ownership.

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These provided valuable suggestions since the first steps of selection of RFID tag models and application systems, and were also involved in testing the first versions of the system.

The first impression about the system is positive in terms of practical handling and use of RFID tags. More cumbersome is the application system, which in the first stages presented bugs and imperfections (such the impossibility to zoom at sufficient level). Nevertheless, the main concern of the system was since the beginning the GPS coverage and the possibility for the app to verify the position of the operator in the digital representation of the forest and thus relate the virtual tree to the physical item.

Tree marking and hauling with the completely developed system was performed in Austria, where non-professional foresters (BOKU) performed both tasks. Impressions in this case were more critic, mostly because the intelligent tree marking system was compared entirely with the common inventory system, rather than with the possible added value services and information linked with the e-system. Again, the main issue was given by the reliability of the GPS device under forest cover.

According to the direct user experience and the feedbacks of professional and non-professional users, we can state that the general marking system is effective and reliable enough. Nevertheless, this statement is valid if the electronic marking is directly associated with common criteria of selection (visual assessment), supported by the additional information available in the database. This solution makes less essential the time-consuming task of exact identification of tree position, which cannot be skipped if a pre-marking is done on the FIS, and the field activity aims just at reporting on the physical trees a selection already finalized.

Further developments could be the deployment of a rover GPS system, which could enable more precise positioning during marking activity.

### 2.2 Processor head selection, purchase and re-engineering of the SLOPE system component

Processor head selection and reverse engineering activities performed on the purchased machine provide the necessary knowledge for the developing of the sensorized processor head. Not only technical knowledge arises from those activities, but also the perception of necessary robustness of each sub-system and
2.3 Intelligent cable crane

The intelligent cable crane has been modified in order to support extra functionalities compared to the version that is currently sold by Greifenberg. However, these new functionalities, deeply described in the corresponding deliverables, do not influence the user experience assessment compared to the original version of the Tecno, since they are completely automatic and do not required additional skills by the operator.

2.4 Intelligent processor head

The intelligent processor head has been designed and realized taking into strong account information and feedbacks provided by each involved partners. Design and implementation of each sub-system, as well as the whole machine have been done in multiple iterations. Each iteration aimed to increase robustness, reliability and ease of usage of the machine. Same considerations are valid for the development of the control software of the machine.

2.5 Intelligent transport truck

Assessments of the user experience have been done during the entire project. At the beginning, our partners in the SLOPE project gave us feedbacks in the design and usage of the iTruck system. Later, the system was tested in a real scenario integrating it with all the other elements of the Slope project.

The intelligent truck system has evolved around the feedback received. In earlier releases, different issues regarding usability and data analysis were faced. Due to the fact the application was too complex the interface was simplified, evolving from a manual interface usage to an automatic system that only interacts with the lectures of the RFID reader and the screen gives information about the state of the operations.

First live test in real scenarios took place in Monte Sover (Italy) where the RFID reader could read all the tags from the logs without too many problems. After that the route of the truck from the forest to the mill was located. During this pilot,
some problems were identified, such as the generation of unnecessary data, which was simplified on later versions to make it more readable.

Last test on a real scenario was on Annaberg (Austria) where the iTruck app was tested with the last software release to solve some of the problems encountered in the first pilot.

Although the user experience has been improved during the development period, it is known that holistic user experience is optimally studied over a longer period of time with real users in a natural environment.

2.6 Data management and back-up

Usability of the data management and back-up has been developed taking in account the experience and suggestions of all the partners involved in the project as well as the impression of specialists of the sector (data back-up systems) and operators of the forestry sectors, who were consulted for an opinion regarding the most practical and friendly system. Furthermore, practical aspects of routine practice during forest operations were taken in account, such as the type of accommodation and the related facilities (WIFI, internet connection, PC, etc.) that is generally available for the operator. As a consequence, the system conceived was designed for the maximum simplicity of use.

2.7 Database to support novel inventory data content

Database to support novel inventory data module includes central database of SLOPE FIS and REST web service API that connects directly to the database. This SLOPE FIS web service module works as gateway between SLOPE project partner’s applications and the central database. Central database data is modified via the web service API.

Basically, the end users of the inventory module are SLOPE project partners, who need to read or write inventory database data. Users has good technical knowledge to handle REST web services. For example, one user of the inventory module is GraphiTech who uses the web service API to read and write data to SLOPE FIS central database.

Some comments about tests and different use cases:

- Database and web service performance is good. Some performance issues were solved after an update of the deployment platform applications.
When the database grows bigger, performance issues can come up. It is advisable to add Redis cache server to speed up queries.

- The query engine is working well handling all the situations of the SLOPE project
- The designed data model is good and can include all the SLOPE generated data
- Inventory database is secure and backed up every night.

2.8 Platform for near real time control operations

2.8.1 SLOPE Field Application

During this project the main user using the Slope Field Application was the field operators measuring and marking the trees in the field.

The Slope Field Application was used in the three Slope pilot areas (Piscine, Monte Sover and Annaberg). In each case, as the project was progressing new features were added to the Slope Field Application. During the piloting of the Slope Field Application, Treemetrics personnel have been following the users and gathering feedback through the support desk. As result, the version used in Annaberg has significant changes in comparison with the first version used in Piscine, including new utilities (e.g. RFID reader) and utility improvements from the user feedback.

- The users provided feedback regarding the utility of functions in the Slope mobile application. In early stages new utilities such as retrieve tree information using the RFID reader were included. At the end of the pilots, most users reported that the Slope app functionalities were suitable for the purpose, as they were expecting.
- The users provided feedback regarding the usability of the Slope mobile application. Based on this feedback some new improvements were made, such as improvement of filter and mapping navigation. At the end of the piloting, most users reported that the Slope app is efficient and easy to use and the usability can be considered good or very good.

2.8.2 3D Harvesting and Planning Tool

This section includes the evaluation of the usability testing surveys collected during the project lifetime. Surveys are based on the template described in the Deliverable D.6.021 “System Integration Report I”.

At the time of writing, eleven surveys related to the usability of the 3D Harvesting and Planning Tool were collected.
2.8.2.1 Gender Analysis

The following chart shows the gender distribution among the filled usability questionnaire. The total amount of interviewed stakeholders belonged to the category ‘Male’.

![Gender Analysis Chart](image1)

Figure 1: 3D Harvesting and Planning Tool - gender analysis

2.8.2.2 Professional Profile

The following chart shows the user profile distribution among the filled usability questionnaire. Due to the research background of the SLOPE project, selected users was mainly researchers. Moreover, due IT nature of the software component involved in the usability testing, the second professional profile involved belongs to the category IT service provider.

![Professional Profile Chart](image2)

Figure 2: 3D Harvesting and Planning Tool - professional profile
2.8.2.3 Age Range
The following chart shows the age range distribution among the filled usability questionnaire. The total amount of interviewed stakeholders belonged to the category between 25 and 34 years.

![Age Range Chart](image)

**Figure 3: 3D Harvesting and Planning Tool – age range**

2.8.2.4 Platform
The following chart shows the platform distribution among the filled usability questionnaire. The entire set of users involved in the usability testing performed their tests over the Desktop version of the 3D harvesting and Planning Tool.

![Platform Chart](image)

**Figure 4: 3D Harvesting and Planning Tool – platform**
2.8.2.5  Experience

The following chart shows the experience distribution among the filled usability questionnaire. The background knowledge of involved stakeholders was mainly related to IT technologies, such as Image Analysis, Simulation Software and Harvesting Planning tools.

![Experience Chart](image)

**Figure 5: 3D Harvesting and Planning Tool – experience**

2.8.2.6  Overall System & Ergonomics

The following chart shows the overall system and ergonomics distribution among the filled usability questionnaire. The aforementioned section can be considered the core of the survey, indicating the main functionalities provided by the system and the feelings perceived by the stakeholders. In general, collected feedbacks demonstrate the validity of the software solution developed during the project.
2.8.2.7 Scenario of the Test

The following chart shows the scenario of the test distribution among the filled usability questionnaire. The Scenario of the test category measures the overall system performances, considering feedback and processing time, as well as the interfaces structure. Exploiting the background knowledge in Human and Computer Interaction and Computer Graphics, Fondazione GraphiTech developed a complex IT tool able to offer both performances and simplicity during the planning operations.
2.8.2.8 Access to Data

The following chart shows the access distribution among the filled usability questionnaire. Following the conclusion from the previous section, the answers chart shows how, in general, it is very easy to display and query for data that are presented to the user in a successful way.

![Figure 8: 3D Harvesting and Planning Tool – access to data](image)

2.8.2.9 Expectations for Implementation in Final SLOPE Forest Information System

The following chart shows the expectations for implementation in the final SLOPE Forest Information System distribution among the filled usability questionnaire. The aforementioned answers were collected during the release of a Beta version of the system, and used during the software final refinements, in order to deliver a complete and consistent solution for the 3D Harvesting and Planning Tool. On this regards, the improvements on the visualization system have been performed on a better reconstruction of the forest model, a better cable line placement and a more detailed set of information visualized on the screen.

![Figure: Expectations for implementation in final SLOPE Forest Information System](image)
2.8.2.10 Suitability for the Task

The following chart shows the Suitability for the task distribution among the filled usability questionnaire. The aforementioned set of questions deals mainly with instruments needed to perform certain actions and how to find them. The 3D Harvesting and Planning Tool received high scores also for this fundamental set of feedbacks.

![Suitability for the task chart](image)

2.9 Online purchasing/invoicing of industrial timber and biomass

The sales platform in SLOPE project is based on commercial service called Wuudis a forest management and forestry marketplace platform. Wuudis has been launched on the Finnish market. The SLOPE project is running September 2016 version of the Wuudis core platform with a few specific customization.

Commercial version of Wuudis has at the time of writing 2500 users in Finnish market who have been used to collect feedbacks about the service. User groups were forest owners, forestry experts, wood buyers and contractors. They were very
satisfied about the user experience and usability. Wuudis user interface is modern and easy to use than existing forestry services in Finland.

MHG collected user feedbacks from some users by making online survey focused to usability of the service. Survey were done in Finnish language and received 69 responses. Some of the main results have been translated in English and reported below.

![Figure 11: How easy is to start using Wuudis (account and estate)](image)

In Figure 11 value 1 means “very hard” and value 5 means “very easy”. From these answers, we can conclude that starting to use the service is easy but there is something that could be improved.

![Figure 12: Overall usability](image)

In the Figure 12 value 1 means “very hard to use” and value 5 means “very easy to use”. From these answers, we can conclude that overall usability of the service is pretty good.
Figure 13: How useful the service is?

In the Figure 13 value 1 means “not useful at all” and value 5 means “very useful”. From these answers, we can conclude that users think basically that the service is useful, but something should be done (e.g. new features) to reach the “very useful” level. Finland has already a number of forestry management web services in the market and this affects these answers.
3 Recommendations for future field trials operations

This chapter contains a summary of the feedbacks collected by the Advisory Board during the First Pilot demonstration in Monte Sover and the Second Pilot demonstration in Annaberg.

For each valuable comment, issues and Adviser’s suggestions have been analysed by the SLOPE consortium and, for each of them, comments from the responsible partner are provided.

3.1 First pilot demonstration – Monte Sover, Italy

3.1.1 Recommendations from Erwin Stampfer:

Very interesting is the possibility to locate quality parameters during the harvesting process with the prototype harvesting head. It is not necessary to start with efficiency and productivity; it is better to look how the functions work. I think this would be better for the project. It will be possible to use the processor harvesting head within a few years, in an extensive way, and that is extremely interesting.

3.1.1.1 Recommendations Analysis

<table>
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<th>Partners considerations</th>
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<td>“It is not necessary to start with efficiency and productivity”</td>
<td>Purpose of the pilot trials has always been the demonstration of a proof of concept for the project. At the moment the automatic logs grading takes some minutes to be performed in its entirety but there are margins for improvements once a good quality grading model is finalized.</td>
</tr>
<tr>
<td>“It will be possible to use the processor harvesting head within a few years”</td>
<td>The feasibility of a final market production strongly relies on a good partnership and a more industrial design of the whole system by carefully choosing the sensors providing the</td>
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best compromise between precision, costs, robustness and speed.

3.1.2 Recommendations from Jarno Ylinen:

There have been extremely good progresses with this very unique project. Integration of data and information which is incoming from the six sensors, can be turned in very different indicators of quality that can be very interesting. But all must be simplified for the operator. **Some automation is necessary.** The information are useful and can be used in many different ways, but for him they have to be simpler. The processor head is a very sophisticated unit and with such very complex machine we can expect it to be **very problematic to use if we imagine the very hard conditions in which these sensors will work**, even if they are protected. This is an area of concern. The manufacturer will say which functionality they are more interested in, in order to have something more than the competitor. The focus should be having one sensor tried at the time. This is to avoid commercial difficulty. Regarding the certification system of timber, you have to be able to **track the ownership on the wood chain up to the end customer**. That is what the final consumer is asking to the seller of any object with a wooden component. That could be connected to the project, because it is a very interesting aspect. The sensor concerning echoes in the timber is very interesting and I never heard of such use in this field. Maybe the survey of the end users of the product can be useful to manage their perspective of quality assessment. Quality is not globally recognized, every country and kind of customer has very different quality standards. In this aspect there must be some flexibility in programming the software. Having this mobile app application is an extremely powerful feature. **The risk related to the use of mobile devices, could be the GPRS localization system.** In the final use of the management tool there could be some problems on how to upload different information. **In the forestry industry, contracts last generally 6 months. After that, information can change completely and it does not come automatically. It must come from somewhere else.** Chain custody requires tracking. Barcodes have the same problem of RFID, at the moment of need they can be unreadable (Liberia example).

### 3.1.2.1 Recommendations Analysis

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Partners considerations</th>
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<tbody>
<tr>
<td>“Some automation is necessary”</td>
<td>The designed system is fully automated, both in normal operations (such as automatic delimbing) and in quality assessing. In fact, sensors</td>
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should be operated with a unique button per function (e.g. stress-wave measuring, RFID marking, etc.). Due to the delays in developing the system, some of these integrated and automated operations were installed, while other were not yet active. Furthermore, once the routine of each operation is established, it would be easy to create a general routine: by pressing the crosscut button, a cycle of operations would start completing all scanning without any further action form the operator. This, of course, would make the usability much easier than in the first version of the processor head prototype.

<p>| “The information are useful and can be used in many different ways, but for him they have to be simpler” | The planned interface is, in fact, very simple. In case the tree can be processed immediately according to the suggestions of the forest inventory (cutting instructions), the quality is pre-assessed, and is just verified and integrated by the processor with those values not detectable with the external shape (e.g. timber stiffness). In case the tree has not previous scanning, or this is not usable due to unseen defects (rotwood), the quality evaluations would be gathered and mixed for generating a final and unique quality value (as described in D 4.12). Once implemented this system, the operator would benefit of a very simple usability, where key quality parameters may be visualized if necessary, but in general visualizing just the final log value. Clearly, all quality information and the associated |
| “very problematic to use if we imagine the very hard conditions in which these sensors will work” | The developed prototype housed many different sensors, moved by multiple actuators (hydraulic and electrical) and mechanical system, as well as electronic system for sensor acquisition and machine control. Each component has been selected taking into account its reliability in harsh environment (waterproofness, vibration and shock resistance, dust, extended temperature range). After the preliminary phase, useful simplifications of the whole system can be made, increasing reliability, usability and maintenance. |
| “The focus should be having one sensor tried at the time” | Indeed, this is the same idea as originally planned. Also from the commercial point of view, each sensor is independent, and can be installed or not, depending on the demand for this specific information in the market. According to this strategy, each sensor can be a stand-alone feature of the processor head, and as such it has been tested during development. The SLOPE prototype is necessary a bench work instrument, featuring all the sensors and in some cases even redundant systems (e.g. free vibrations are measured with laser displacement and time of flight system). But this overabundance of sensors was due to the necessity to test them all on the |</p>
<table>
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<tr>
<th><strong>“track the ownership on the wood chain up to the end customer”</strong></th>
<th>unique available prototype. The final machine would be more custom made, or presented in pre-defined combinations, according to the identified markets.</th>
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<td><strong>“The risk related to the use of mobile devices, could be the GPRS localization system”</strong></td>
<td>In fact, current FIS through online purchase and sales module enables tracking the timber or biomass down to estate (owner &amp; address) and compartment level (harvested compartment with tree species, assortments and their volumes). On top of that a single tree and its assortments based on RFID ships can be traced during the whole supply chain from stump to end-user point.</td>
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<td>This is right, the GPS accuracy is a limitation of the system and it needs to be taken into account. Combine field measurements with spatial remote sensing requires an accurate position from the GNSS receiver in the ground and a good image orthorectification. The use of regular GNSS receiver used in the forestry (e.g. Garmin GLO or similar) do not allow a full automated co-registration of the data for analysis. RTK receiver can be an alternative to the traditional GNSS receivers. This type of devices provides real-time kinematic (RTK) technique for centimetre-level accuracy in surveying applications, however the need of an open view to the sky and the high cost of these devices does not justify the use of these devices in forestry in most cases. The use of systems such as GALILEO and GLONASS system available, in the near future the GNSS</td>
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measurements under forest conditions should become increasingly easy. Using the position data provided by Garmin GLO correction was required in order to combine both datasets. Figure 14 shows how the centre of a sample plot was translated to a more accurate position in order to combine this data field and remote sensing data. This requires a significant amount of work and needs to be repeated for each sample plot.

“"In the forestry industry, contracts last generally 6 months. After that, information can change completely and it does not come automatically. It must come from somewhere else”" Indeed, in European forestry business contracts between end-user and contracting company are very short comparing North American ones lasting typically 1-2 harvesting seasons. Delivery volumes and times per assortment are agreed per supplier. In case of export business measurement requirements of saw mills may change frequently, even once or twice a month. Through Wuudis platform (ERP functionalities under construction) end-users are able to give any working orders including new measurement guidelines in real time operations. Regarding the market price recording of timber, pulp wood and biomass it is not well developed in all European countries. Some countries like Italy has a statistics system for a couple of regions only not covering the whole country. Meaning local governments should invest in organizing reliable and transparent price information which could be easily linked with the Slope FIS/Wuudis. This is a case in Finland where forest management
associations collect timber and biomass sales price data on a daily basis in municipality level and report it to Natural Resource Institute of Finland, Luke, updating the price database monthly.

![Field (TLS) plot 5 correction.](image)

### 3.2 Second pilot demonstration – Annaberg, Austria

#### 3.2.1 Recommendations from Jarmo Hamalainen:

Comments about SLOPE project based on the visit on 2nd Pilot test area in Annaberg, Austria on the 11th October. At first many thanks for the excellent excursion and presentations concerning project’s activities. The research topic is very actual and important. Digitalization is a core driver when targeting, more resource and material efficient wood usage, more profitable bioeconomy and added value for the value chains of wood based products. A lot of research dealing with same type of questions are going on in EU, but SLOPE has a clear role among them and produces essential new knowledge of the theme. SLOPE has a comprehensive approach covering development of measurement technology,
information management and its utilization in practice. It is very ambitious and
deals also with extremely demanding technology challenges. Possibly the most
impressive example of them is instrumentation of processor head with different
sensors for wood quality measurement and log identification. Earlier experiments
with harvester head have showed that the conditions for sensors are very
demanding because of the very robust nature of work: tremble, strokes, pieces of
wood, sawdust, snow/water, lighting conditions etc. Processor head is obviously a
bit easier frame for quality measurements than harvester head (no felling, lower
stem speed etc.). But anyway, a realistic target would be a robust, simple and
cheap construction that brings most essential new attributes describing logs’
internal quality (log dimensions explain anyhow greatest part of timber value).
Could for example measurement of branches (amount & diameter) through oil
pressure measurements, which is tested - or with machine vision technique -
combined with camera technology measuring width of annual rings from log ends
(=> wood density), be an option? Machine vision systems for log end measurement
have been tested in some research projects earlier with good results. In the future
Big Data will offer new options in quality prediction and control of wood flow. For
example in Finland, we have compared log measurement and x-ray data of sawmills
with forest stand data (forest inventory and harvester data) to find correlations and
thereby new tools for quality prediction. That kind of method could also be used in
developing and calibration of log sorting methods in SLOPE context. But in any case,
SLOPE’s technology studies for wood properties measurement are important also
in wider context of bioeconomy. From that point of view especially testing of
hyperspectral imaging sounds very interesting. It hopefully opens new possibilities
to predict wood properties valuable for different kind of wood usage. The whole
forest information system described in SLOPE is well defined and clear. But could
the process be even more straightforward and simple (more cost effective)? Are
stand level field measurements and pre-marking of trees necessary in the future?
Just for a reference I describe a bit our Finnish "Forest Big Data" vision. Our forest
inventory system is based on aerial laser scanning and aerial photographs. That
produces basic information for wide areas on grid level (16 * 16 m) for forest
management planning and wood trade. The vision is that - in the future - nobody
visits the stand after remote sensing for additional measurements for wood trade
and harvesting operations. Right now it happens to some extend because the
quality or availability of basic information is not good enough. For example, simple
camera applications (Trestima Ltd.) are used at this stage in stand level
measurements of tree dimensions (and quality classification also tested especially
in pine stands). A lot of R&D efforts are right now in progress to improve the quality
and versatility of basic forest information (e.g. stem size distribution, quality
parameters, forest conditions). Harvester data will have very essential role in forest
information production and updating in the future. Additionally, I want to emphasize two aspects. **First of them is standardization and definition of system interfaces.** They have an essential role, when targeting more effective data utilization from different sources. For example, in Nordic countries a common StanForD standard is in use for data transfer between forest machines and wood supply companies. In Finland we have developed also other standards for forest information management. They give essential basis for application development that brings added value for the whole network of actors. **That kind of standards will be needed also when bringing SLOPE’s results widely into practice.** Another aspect I want to stress is **cost-benefit analysis concerning the whole new information system and sensor technologies.** On the basis of them a proper roadmap for implementation can be constructed. It could be useful to do that on sensor level, so it helps to prioritize the modules of new information system. Taking an example of SLOPE’s Rfid experiment, which is interesting. Cost benefit analysis would give the answer, if log level identification really gives so much added value in the chain that it is profitable. Another option could be to manage the quality information just on cutting object level through normal information systems (e.g. quality distribution of logs). With great pleasure I summarize that SLOPE project is an excellent effort and remarkable results have been achieved. The project contributes resource-efficient utilization of wood raw material and competitiveness of forest based bioeconomy in Europe.

### 3.2.1.1 Recommendations Analysis

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Partners considerations</th>
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<tr>
<td>“conditions for sensors are very demanding because of the very robust nature of work”</td>
<td>The developed prototype housed many different sensors, moved by multiple actuators (hydraulic and electrical) and mechanical system, as well as electronic system for sensor acquisition and machine control. Each component has been selected taking into account its reliability in harsh environment (waterproofness, vibration and shock resistance, dust, extended temperature range…).</td>
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<td>“a realistic target would be a robust, simple and cheap construction that”</td>
<td>Indeed, the final target is a robust and reliable processor which features some of the quality sensors studied and tested in the project. According to the</td>
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<td>“Could for example measurement of branches (amount &amp; diameter) through oil pressure measurements, which is tested - or with machine vision technique - combined with camera technology measuring width of annual rings from log ends (=&gt; wood density), be an option?”</td>
<td>The described system is one of the possible system combinations. Indeed, branches measurement, or most appropriately, branch index definition per each log is the simplest, inexpensive and robust of the tested sensors. The added value of the produced information would easily cover the low extra cost of the processor installing such system. Where requested by the market this may be easily coupled with a simple visual system for ring characterization. A similar information may be gathered from the crosscut resistance (inferred with a dulling index of the chainsaw). This second option would provide a less detailed information compared</td>
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<td>brings most essential new attributes describing logs’ internal quality”</td>
<td>final use, the local market and the type of trees handled, different set of sensors may be required. In terms of cost, the new machine cannot be cheaper than a common processor, on which is based. Nevertheless, it should be the added value of the information collected to pay back the cost difference for purchase and maintenance of the sensorized processor. SLOPE project pave the way in the field of sensorized processor head. The developed prototype houses different kind of sensors in order to better understand a sets of the most useful for log grading. After this preliminary phase, useful simplifications of the whole system can be made, increasing reliability, usability and maintenance.</td>
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| "First of them is standardization and definition of system interfaces". [...]  
"That kind of standards will be needed also when bringing SLOPE's results widely into practice." | The SLOPE consortium fully understands how a proper standardization of the acquired data is crucial for the positioning of a SLOPE outcomes on the market. For this reason a dedicated work package has been planned and a work on standardization has been foreseen in the key exploitable results analysis in deliverable D.8.05. |
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<td>&quot;Another aspect I want to stress is cost-benefit analysis concerning the whole new information system and sensor technologies&quot;</td>
<td>A detailed analysis of the SLOPE solution costs has been already performed, subject to three rounds of revisions along the last year of the project. This analysis shows that the impact of the solution is not remarkable but the real benefits will need further studies.</td>
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4 System operation manuals

In order to minimize the time required by operators and planners to learn the entire set of innovative features and instruments offered by the technologies developed during the project, a series of public manuals and tutorials has been made by the SLOPE consortium.

The aim of this chapter is to collect the overall set of system operation manuals for each of the software and hardware components developed/improved during the project.

Training materials can be both paper-based and online resources e.g. video uploaded on YouTube and/or slides published on SlideShare.

The following sections contain the aforementioned set of materials for users and operators training purposes.

4.1 Intelligent tree marking and tree felling/hauling

The procedure and tools for tree marking and felling are described in D.3.01 “Portable RFID tag reader/programmer” and more in general in D.7.07 “Manuals, guidelines and learning packages for on-the-job training”. Some further information and practical suggestion are also reported in D.3.06 “RFID tag survival test along the supply chain”.

In brief it can be here reported that the operator will use always the unique RFID tag model selected in SLOPE project. This will be stapled on the standing tree and later moved to the butt end of the tree when this is felled.

4.2 Processor head selection, purchase and re-engineering of the SLOPE system component

The end user of the processor head may be aware that the base machine, ARBRO 1000 S, is a very simple processor head. This model was selected for its simplicity, ease to use and to modify, light weight and low hydraulic requirements. These characteristics are almost completely maintained in the final prototype, thus it requires a light prime mover (excavator, but even a large tractor or a forwarder could deploy this header).
The installation of the processor on the prime mover is relatively easy, but is complicated by the additional features of the prototype. Clearly, a commercial version will have a very accurate and planned cabling system, as well as the cases and protected boxes for electro valves, additional engines, sensors and control system.

### 4.3 Intelligent cable crane

As mentioned in section 2.3, the intelligent cable crane has been modified in order to support new functionalities required by the SLOPE project. Since the upgrade does not influence the operator workflow, the user manual has been not influenced by new functionalities.

![Figure 15: View of the joysticks – command of the Tecno](image)

Annex I includes the current version of the Tecno user manual.

### 4.4 Intelligent processor head

The processor head should be used and conducted as a common stroke processor for its basic functions. Most of these are maintained unchanged, while a set of new functions, linked to new commands (see figure below) are described in Deliverable D.7.07.
It should be noted that the new processor head installs a large number of sensors or tools in the bottom part, close to the additional carter beyond the chainsaw system. Due to this solution, it is not suggested to use the machine for felling trees, even if this function is not lost. In case this use is strictly necessary, one shall keep in mind that a higher cutting position should be adopted, leading to a higher stump left on the ground.

Figure 16: View of the joysticks – command of the prototype machine.

4.5 Intelligent transport truck

A system operation manual for the intelligent transport truck was developed in section 5 of the Deliverable 3.05 “Intelligent Truck”. A reviewed version is included in next paragraphs.

There are 4 main screens in the iTruck program. Although the system is designed to work without any supervision, a user interface was created to check the status, configure the solution and analyse the existing data.
4.5.1 Accessing the user interface.

There are several options to access the user interface:

- Direct connection of a monitor, keyboard and mouse with the DVI and USB port on the RPI2.
- Connection through Ethernet. The RPI2 has a VNC server running at: 192.168.0.2:0. Password: “p@ssw0rd”.
- Connection though Wi-Fi. The RPI2 has also a Wi-Fi hotspot, with net name: “slopeitruck” and password “slopeitruck”. Once it has been connected, the VNC server can be accessed with 192.168.42.1:0. Password: “p@ssw0rd”.
- Connection via TeamViewer, using credentials and the device ID provided by the TeamViewer system.

Once the RPI2 has been accessed, the python code can be started with file “itruck.py”

4.5.2 Main Screen (MS)

The main screen appears when the iTuck software is executed. It is designed with the idea to show a quick status of the current situation of the system.

- MS-1: Indicator to show if the automatic storage of the truck location and data sending to cloud is turned on or off.
- MS-2: Indicator to show if an RFID reader has been connected.
- MS-3: Indicator to show if GPS data is being received.

![Figure 17: iTuck main screen (MS).](image)
- MS-4: Indicator to show if the SLOPE database is accessible.
- MS-5: Log windows where different information is being shown.
- MS-6: Toggle button which allows to put the solution in run mode or stop mode. In run mode, the data is sent periodically to the SLOPE database.
- MS-7: Button to open the test window.
- MS-8: Button to open the configuration window.
- MS-9: Button to exit the program.

4.5.3 Test Screen (TS)

This screen is designed to test several options of the solution as a stand-alone module. The screen is shown when the MS-8 button is pressed.

**Figure 18: iTruck Test Screen (TS).**

- **TS-1: Ping Reader.** It is used to send a ping command to the RFID fixed reader. If the reader is available, the response is shown in the log window.
- **TS-2: Send command.** The RFID reader answers to BRI commands, an ITERMEC communication protocol. Here the commands can be typed, and sent to the reader when the button is pressed. The response is shown in the log window.
- **TS-3: Load Config.** The button sends the current reader configuration, stored in the configuration window, to the RFID reader. The result is shown in the configuration screen.
- **TS-4: Read tags.** A Read command is sent to the fixed RFID reader. The response is shown in the log screen.
- **TS-5: Write tags.** A Write command is sent to the fixed RFID reader. The EPC code introduced in the text field is stored inside all tags encountered by the reader. The result is shown in the log screen.
- **TS-6: Reset Reader.** This button forces the RFID reader to shut down the RFID module, and start it again.
- **TS-7: Test GPS.** The last information received from the GPS is shown in the log screen.
- **TS-8: Test GPRS.** A simple access is done to the SLOPE. The HTTP response is showed in the log screen. An HTTP response of 200 means connection successful.
- **TS-9: Store in Local.** A Read command is sent to the RFID reader, and the detected tags are stored in the local database. The log screen shows the operation result.
- **TS-10: Push to cloud.** This button is used to check the local database. Those entries that still have not been updated to the SLOPE database are sent to the cloud. To keep track of this, a specific field in the local database was created (field “isSent”, yes or no). Once the information is correctly updated in the cloud, the local database is updated.
- **TS-11: Search in cloud.** This allows to check all RFID entries introduced in the database on a specific date.
- **TS-12: Save log.** It stores all information that currently exists in the log screen in a text file.
- **TS-13: Exit.** Closes the Test Screen.
- **TS-14: Log screen.** Displays all information about the different controls.

### 4.5.4 Configuration Screen (CS)

This screen is designed to configure different options and variables in the solution. The screen is shown when the MS-8 button is pressed.
**Figure 19: iTruck Configuration Screen (CS).**

- **CS-1: Fixed RFID reader communication.** This section is used to configure the variables related to the fixed RFID reader. This includes the IP address, the communication port, and the buffer size.
- **CS-2: Reading frequency of RFID reader configuration.** Here the frequency in which the reader reads the logs along the transportation are defined in seconds.
- **CS-3: Fixed RFID reader configuration.** This section is used to configure the RFID reader. Variables like number of antennas, field strength, and tag type are used.
- **CS-4: Database related information.** In this section three values are defined: (i) frequency in which the local stored data is sent to the database; (ii) the truck ID in which the device is integrated; and (iii) comments text that will be included in the fixed RFID entry.
- **CS-5: Save button.** This button stores all information in the configuration xml file. The file is loaded when the software starts, so all the changes are kept.
- **CS-6: Exit button.** Closes the configuration screen.

### 4.5.5 Manual RFID Reader Screen (MRS)

This screen appears automatically when the RFID portable reader is detected via Bluetooth. It is used to monitor and control all activity created by the portable reader.
Figure 20: iTruck manual RFID reader screen (MRS).

- **MRS-1: Manual reader MAC address.** Used to define the MAC address of the reader.
- **MRS-2: UUID.** The Universally unique identifier is used to identify a particular service provided by a Bluetooth device, in this case the RFID reader service.
- **MRS-3: Bluetooth buffer.** The buffer used for the Bluetooth communication.
- **MRS-4: Span between measurements.** This defines the frequency in which the portable RFID reader reads tags when active.
- **MRS-5: Truck Id.** Allows to introduce the ID of the truck which will be assigned to the tags read with the portable reader.
- **MRS-6: Comments.** Allows to introduce text that will be included in the table field on the local database.
- **MRS-7: Accept test.** This is used for debug. When the logs have been read and identified, this allows to accept the batch and stores it in the local database.
- **MRS-8: Reject test.** This is used for debug. When the logs have been read and identified, this allows to reject the batch in case some logs are missing or some not-desired logs were also read.
- **MRS-9: Pause.** This is used for debug. Allows to leave the reader on pause.
- **MRS-10: Resume.** This is used for debug. Allows to exit from the pause mode and resume normal reading activity.
- **MRS-11: Write section.** This section is used to write tags. First the old and new EPC value needs to be introduced, and pressing the button allows to change the EPC information.
- **MRS-12: OK button.** The same as MRS-7, used to accept a batch.

### 4.6 Data management and back-up

Detailed description of the SLOPE software user interface, including data management and back-up functionalities, is provided within accompanying document to deliverable D.3.07 “Black-box for backup and data transmission”. The most important utilities of the data management and back-up system include:

- downloading of the information from the FIS regarding marked trees and cross-cutting simulation
- uploading progress of operations and resulting log’s quality(ies) indexes

It has to be mentioned that according to the internal agreement between SLOPE project partners, all the raw files corresponding to no-processed measurement results are stored on the internal hard disk and are available for any further/additional processing or evaluation. These are not however foreseen to be accessed by the processor operator.

Downloading of data may be performed twofold:

- by means of GPRS service or any other Internet-based method: possible only in case when the access to the network is available on the production site
- by using any digital data storage (memory card/stick, portable hard disk, among the others): possible to be implemented anytime, assuming that the operator is capable to connect to the internet after working hours to upload the generated data.

It has to be mentioned that the SLOPE processor prototype was equipped with the GPRS communication module and downloading of the data from the FIS was successfully validated in case of SLOPE project demos, both in Italy and Austria.

In any case the raw data format compatible with the SLOPE software is a native JSON file defined for the needs of data exchange between SLOPE FIS database. The downloaded file can be saved with a unique and intuitive name. It is up to operator to define the name of the downloaded file according to his preferences. In order to simplify further operations, a dedicated folder has been created on the desktop of the industrial PC, where it was possible to routinely drag-and-drop the most recent
file; the path to this file is considered as a system default. Optionally, the specific JSON file can be selected from any location within the system by using standard MS Windows explorer tools.

Figure 21 presents a tool available on the SLOPE Viewer website, to be used for collecting data from the FIS database (button **WEB-1**). The same tool can be also used for uploading the data collected during tree processing and quality sorting.

![Figure 21: Location of the WEB-1 button used for downloading/uploading data from the SLOPE FIS database.](image)

The JSON file can be opened by the SLOPE software by clicking following buttons in the “backup & reporting” tab control, as presented in Figure 22:

- **DOW-1**: downloading the production plan (JSON file generated by the FIS database) from the internet – the SLOPE Viewer is opened as a result of this action allowing operator to access the data
- **DOW-2**: downloading the production plan (JSON file generated by the FIS database) from the memory storing device – the result of the action is opening the selection window (Figure 23) where operator can choose the location of the file.
Figure 22: View of the “backup & reporting” tab control of the SLOPE software used for downloading and uploading data from/to FIS data base.

Figure 23: Selection window used for determination of the JSON file location.

The modified JSON file being a result of the tree processing can be uploaded from the SLOPE software by clicking following buttons in the “backup & reporting” tab control, as presented in Figure 22:

- **UP-1**: uploading the production results (JSON file generated by the SLOPE software) directly to the FIS database by means of the internet connection – even if technical solutions implemented in both SLOPE software the FIS database allows such direct exchange of data, it was decided to not to implement that solution at the prototype and demonstrations. It is possible however to directly upload the file by using SLOPE Viewer.

- **UP-2**: uploading the production results (JSON file generated by the SLOPE software) directly to the memory storing device – the result of the action is saving of the file in JSON file extension with the name selected by the operator.
Buttons DOW-1 and DOW-2 are replicated on the “production plan” tab control, as presented in Figure 24. It was intended to facilitate the operation of data importing as well as for improving visualization of the production plan and progress of work.

Figure 24: View of the “production plan” tab control of the SLOPE software used for downloading and uploading data from/to FIS data base a visualization of the list of trees as well as location of trees in the field.

4.7 Database to support novel inventory data content

The SLOPE FIS central database should be accesses via web service interface by different users. The manual for this web service interface is rather technical because end users of the web service are commonly developers and users that have technical knowledge to use REST web services. That is why this user manual is more like an API description for developers.

Another important resources for the SLOPE FIS web service users are WADL description and XSD description. WADL and XSD documents can be also user for generating client side code and validating data automatically with different tools.

User manual for web service interface can be found here:


Web service WADL description:
4.8 Platform for near real time control operations

4.8.1 SLOPE Field Application

4.8.1.1 Preparing the Field Inventory

Due to the fact that forestry information is not always available in order to plan a forest inventory, remote sensing data are often the only source of information before the field data is collected. The first step before performing any field visit is to divide the forest into homogeneous areas of analysis according to spatial and criteria. This includes the identification and delineation of single trees in the forest stand using UAV imagery and the tree species when there is a clear difference in canopy colour or crown size.

This information will be made available to the user after the analysis of the area of interest. This data is transferred remotely to the Slope Field Application to facilitate the field operator the identification of the trees in the forest.

The field data survey includes TLS inventory and other manual measurement including a reduced number of tree DBH and heights being recorded on the Slope Field application.

Figure 25: Treemetrics Field App map view
Slope Field application allows the user to input the data directly from Bluetooth enabled field equipment (Laser range finder / callipers). The app performs real time validation on the data and informs the user of any errors. This field application is compatible with Bober callipers, Trimble Laser Ace 100 and Tree pulse 360R in order to transfer data automatically.

![Figure 26: TLS (left), Height recording with hypsometer (centre) and DBH recording (right)](image_url)

For each single-scan plot in a stand, the following field data is collected with the Treemetrics Forest application.

1. Plot ID
2. GPS location of the plot centre
3. Scan ID
4. Tree DBH and Height
5. Tree density - the total number of trees present in a defined area (circular and square plots are supported).
6. Mark trees status, for example trees that have been identified and marked for extraction by the local foresters.
7. Distances and angles of tree from the plot centre
8. Tree quality grading
9. Tree stem visible defects

The trees tab allows the user to view each of the trees within the forest, as identified by their ID. The user can add a new tree to the block by clicking the plus icon in the bottom right corner of the tab.
After tapping on one of the tree ID’s from the Trees tab, the user is brought to a data entry page. Here the user can enter tree specific data such as; DBH, height and quality grading.

The system defined in this document can record defects features for a defined section in the stem profile. These defects will be taken in account in the harvesting simulator according to pre-defined rules for the different severity levels.

The type of defects and severity levels can be customized for each user in the current system. In this study the following defects and severity have been defined:
- Defect grade 1 (Waste quality): This includes stem sections with severe timber defects due to scar damage, conk or similar. The severity grade 1 has been defined as non-commercial timber.
- Defect grade 2 (Pulp quality): This includes stem sections with scar defects, cracks, decay, potentially hidden crooked areas or similar that prevents to create quality timber logs. The severity grade 2 will reduce the timber log quality to an inferior product.
- Dead tree: Sanding dead tree that will not be commercialized.

![Stem defects diagram](image)

Figure 29: Treemetrics field app defect definition.

4.8.1.2 Home screen

The Treemetrics app home screen presents the user with four options that allow the user to either create a new forest, load an existing forest site, download a new forest from Treemetrics’ database, or continue with the forest site presently downloaded on the app (in this case ty_glenacunna). In addition to the above four options, the home screen has two status bars indicating whether or not the app has been paired with an electronic callipers and/or a range finder device.
4.8.1.3  New forest
Clicking on the new forest option loads a pop-up window requesting the user to provide details for the forest operation they wish to create. Clicking the enter forest button will create the new site and subsequently load the site in the app. This functionality is rarely used by Treemetrics as all new forest sites are created on Treemetrics’ website and subsequently downloaded onto the app before entering the field.

4.8.1.4  Load forest
The load forest option permits the user to open a previously downloaded forest site. The user simply selects the required forest from the list presented.
4.8.1.5  Download

The download option enables the user to download a forest site from Treemetrics’ database provided the user has been given permission to this functionality and has been provided with log-in credentials.

4.8.1.6  Forest site landing page

Once the selected forest site has loaded, the landing page displays a map viewer highlighting the geographic location of the forest site. The zoom-in/zoom-out functionality allows the user to alter the level of map detail as required.
Below the map viewer, the blocks, strata and plots associated with the forest site are listed. Clicking on any of the plots will load a new page highlighting the details of the TLS scan associated with that plot (note this page will remain blank until scan data is uploaded to the app). Blocks, strata and plots can be deleted and added by the user as required. Clicking on the forest name will bring up the site details. The red warning signs indicate there are no data associated with the plots.

### 4.8.1.7 Species Tab

After selecting a plot, the species tab will allow the user to group the trees in that plot by species, and will also enable the user to set Height pairs and Tree Diameters.

After selecting a species type for your forest, you can enter your data by tapping the relevant box (for Height pairs you would click on the box with “0 pairs”). The values for the Height pairs and Tree Diameters will remain red until the user has entered enough values so as to create a valid sample size.
4.8.1.8 New Plot

The create new plot button allows the user to create a new plot using the app’s current GPS location. Alternatively, a plot can be created for a different GPS location by clicking on the desired location on the map viewer and then clicking on the create new plot button.

4.8.1.9 Default Location

After panning the map viewer, the user can jump back to the app’s current GPS location using the centre map button.
4.8.1.10 **Scan tab**
The Scan tab is used to enter metadata for the scanning device. The Scan number is the unique identifier used to identify specific scan files.

4.8.1.11 **Settings**
The **settings** option allows the user to toggle the internal GPS device on or off (used when external GPS has lost reception), to toggle on shapefiles and labels, to save the current forest (typically after uploading the TLS data for each plot), and to send the collected data to Treemetrics where it will be analysed using Autostem and the cutting simulator before being sent to the SLOPE Forest information system.

![Figure 36: Treemetrics field app – settings menu](image)

4.8.1.12 **Toggle U-Blox (GPS)**
Used to connect the app to the U-Blox GPS device (external GPS).

4.8.1.13 **Toggle RFID**
Pairs the app with the RFID reader. If an RFID tag has been assigned to a tree, the forester can scan that tag with the RFID reader and it will be presented with the information associated with that individual tree.

4.8.1.14 **Save Icon**
An alternative method of saving the current forest site.

4.8.1.15 **Toggle North**
Toggles the map to face north.
4.8.2 3D Harvesting and Planning Tool

In order to minimize the time required by operators and planners to learn the entire set of advanced and vertical functionalities offered by the 3D harvesting and planning tool, a series of public web video tutorial has been made.

The SLOPE tutorial playlist, available on the official SLOPE Project Youtube Channel at the following link www.youtube.com/playlist?list=PLGDmdkbaisjEYuEuwJi8Kfy6VO7RrpjY are organized as follows:

1. SLOPE Project Tutorials - 01 – Camera Movements
2. SLOPE Project Tutorials - 02 – Area Selection & Terrain Options
3. SLOPE Project Tutorials - 03 – Imagery Layer Options
4. SLOPE Project Tutorials - 04 – Measurements
5. SLOPE Project Tutorials - 05 – Slope Analysis Tool
6. SLOPE Project Tutorials - 06 – Cadastral & public Data
7. SLOPE Project Tutorials - 07 – Point of Interest
8. SLOPE Project Tutorials - 08 – Building & Terminals
9. SLOPE Project Tutorials - 09 – Weather Forecast
10. SLOPE Project Tutorials - 10 – Trees Visualization and Editing
11. SLOPE Project Tutorials - 11 – Languages & Position Settings
12. SLOPE Project Tutorials - 12 – Cableway Planning
13. SLOPE Project Tutorials - 13 – Work Area
14. SLOPE Project Tutorials - 14 - Logistic
For each video, multi-language subtitles are also available: Italian or English by default; other languages can be generated by the use of the automatic on-the-fly translation service offered by YouTube.

4.9 Online purchasing/invoicing of industrial timber and biomass

User manual of online sales platform (Wuudis) covers all functionalities that are used in the SLOPE project. This user manual is for wood and biomass sellers and buyers and describes both processes.

Manual covers also some real estate management features and how to import real estate data from SLOPE FIS to Wuudis platform. SLOPE FIS optimizer (Estate
A management plan generator module is also described in this manual because it is an important step when transferring real estate data from SLOPE database to Wuudis.

User manual can be downloaded at the following link:

5 Conclusions

This deliverable reports, for each of the software and hardware components developed during the project lifetime, user manuals and reports of usability collected by final users. Moreover, it includes an analysis of the Advisor’s feedbacks where, for each issues identified, an answer has been provided by the most suitable consortium partner in charge.

Due to the prototype nature of hardware project components, usability surveys has been filled only by operators that were directly involved in the construction and customization of them. A more structured and complex approach has been followed for software components, as described in each corresponding sections.

Hardware user manuals will be deeply described in their respective deliverables, specifically D.7.06 Reports and manuals for off-the-job training and D.7.07 Manuals, guidelines and learning for on-the-job training.
Annex I – Tecno user manual
SELF-PROPELLED CARRIAGE

| SERIAL NUMBER |___________|
| TYPE AND MODEL |___________|
| YEAR OF |___________|
| CUSTOMER |___________|

| ORIGINAL INSTRUCTIONS | R 1 10/12 |
2.3.1 ENVIRONMENTAL CONDITIONS

The machine does not require special environmental conditions and is built to work outside. It must be used in a bright and ventilated area. Permissible temperatures range from -10° to 40° C, with humidity not higher than 90% at 20 °C.

![Do not use the carriage in case of rain or strong wind]

2.3.2 LIGHTING

The lighting of the environment where the mini-winch is installed must comply with the laws of the country in which the machine operates and shall always ensure good visibility at every point. We recommend 500 lux or more for maintenance and check of the mini-winch. It is forbidden to use at night.

2.3.3 VIBRATIONS AND NOISE EMISSIONS

If the machine is used according to the specifications of correct use, vibrations are not such as to endanger the stability of the machine.

As the operator's position is not on board the machine, the root mean square value of weighted acceleration to which the whole body is exposed is less than 0.5 m/s².

The machine is designed and constructed to reduce the level of noise at the source. No rule requires standard measurements for this specific type of machine. Therefore, in the noise measurement report provided (which includes important results), you will find the machine configuration and operating mode. The position, number of microphones and measurements are described in Standard UNI EN ISO 11202, concerning machines without operators on board.

Results:
- Maximum equivalent continuous A-weighted sound pressure level with a VM engine at a distance of 10 meters: 79.1 dBA.

Note

Noise values quoted refer to noise emission levels of the engine and do not necessarily represent safe operating levels.

Although there is a relationship between noise emission levels and noise exposure levels, this cannot be used reliably to determine whether or not additional precautions should be taken, especially since the actual position of the operator is not in the vicinity of the machine.

The factors that determine the level of noise exposure to which the workers are subject include the duration of the exposure, the characteristics of the working environment and other sources of noise (number of machines, adjacent processes, etc.). In addition, the allowed exposure levels may vary from country to country.

In any case, all information provided will allow the user of the machine to better assess the hazard and the risk to which he/she is exposed.
2.3.4 ELECTROMAGNETIC ENVIRONMENT

The machine is designed to work properly in an industrial electromagnetic environment, within the emission and immunity limits envisaged.

4.1 TRANSPORT AND HANDLING

The carriage is equipped with two anchor points positioned on the upper part of the chassis. Please refer to the total weight of the machine indicated in the manual to select suitable lifting measures.

| Damage to the machine caused during transport and handling are not covered by warranty. All cost of repair or replacement of damaged parts shall be borne by the Customer. |

4.2 STORAGE

If the Machine remains unused for a long period of time, it must be stored adopting due precautions with respect to the place and duration of storage:

- Store the machine in an indoor environment with the fuel tank empty (vapors are potential sources of danger)
- Grease the transmission components
- Protect the machine against impact and shocks
- Prevent the machine from coming into contact with corrosive substances
- Make sure the cable is wrapped properly, without overlapping or forcing.
### 4.4 SETTINGS AND INSTALLATION

| Create a cable line choosing the components (carrying cable, guide rails, pulleys etc.) as indicated in the technical specifications and in the cable line project. Pay close attention to all the points listed in the general instructions, especially point 3.1 concerning the positioning of limit switches. |

- In order to facilitate the installation of the carriage, it is necessary to choose a portion of the cable line that allows access below the carrying cable directly with the vehicle of transportation of the carriage, or at least to be able to position the carriage by using a crane.
- Place the carriage with the engine side facing upstream (use as a reference the radiator, which must be placed upstream).
- The anchor point of the carrying cable should be chosen so that the cable is at least 5 meters above the ground at the point where the carriage is supposed to travel. In the case this height is not respected, it is necessary to insert a guide rail on the carrying cable. It is advisable to create the cable line in such a way that at a certain point the carriage runs at eye level, in order to make refueling and maintenance operations easier.

| Insert the two limit switches on the carrying cable and position them at least 10 meters away from both ends of the cable line. Operating without them is extremely dangerous. Check that the limit switches ensure a contrast at least 20 kg before slipping on the cable. |

- Turn the unit shown in fig.5a, upright
- Insert the carrying cable as shown in SCHEME1
- Bring the unit shown in fig.5a back in the correct position and secure it by inserting the screws in fig.1-2-3-4-5-6
4.5 CONNECTING THE HOOK

- Unscrew the grub screw 1a off the hook with an Allen key
- Manually remove the dowel pin 2a
- Remove the main ring 3a
- Remove the clamping cone 4a from the hook, with the help of the extractor provided
- Insert the pulling cable into the upper hole 5a
- Pass the cable through the hook until it comes out from the bottom part for a length of about 0.5 meters
- Separate the strands forming the cable for about 15 cm
- Cut the central core
- Mount the clamping cone 4a corresponding to the cable, check the punching into the strands where the central core was, making sure they are equally distributed around the perimeter, and secure it firmly with a hammer.

4.6 INSTALLING THE HOIST CABLE

To wind the cable on the hoist drum, refer to the following instructions:

- Choose a cable with a diameter compatible with the cable guide (standard cable guide suitable for Ø 11 mm);
- Pass through the pulley fig.1c
- Operate the hoist drum until the cable guide group fig.2c is at the furthest point of the drum on the right side (where the cable is anchored)
- Pass the cable on the cable guide rollers fig.3c
- Insert the cable in the lower side of the drum and anchor
- Wind the cable and make sure it doesn’t create abnormal winding, overlapping or slow loops
- Set the maximum load lifting point (at least 10 cm before the hook touches the rollers) by pressing the "LUCE+MONTE" key combination on the radio remote control (this must be done every time the hoist cable is cut)
- If it is necessary to proceed beyond the limit set, in addition to the joystick you need to hold down the AUX2 button
4.7 PRELIMINARY CHECKS

Before setting the machine into operation, a series of checks and tests must be carried out in order to prevent errors or accidents during its operation.

- Check that the machine has not been damaged during installation;
- Use special care when checking the condition of the control panels;
- Ensure that the cable is free to move;
- Check the correct position of the carrying cable on the three pulleys.

<table>
<thead>
<tr>
<th>![Warning]</th>
<th>Check the presence of the two limit switches placed at least 10 meters away from the ends of the line. Operating without them is extremely dangerous</th>
</tr>
</thead>
</table>

- Make sure that the cable line is suitable at every point to the passage of the carriage; in particular, make sure that when it swerves to one side to retrieve the load, it does not hit against plants or obstacles along the cable line.
- Check the correct winding of the hoist cable on its roller
- Before setting it into motion, it is necessary to start the engine and let it warm up for at least ten minutes if the ambient temperature is above 10° C. If the temperature is lower or even below 0, the warming up procedure should last 20 minutes or more.
- The machine can be started with the joystick in any position, possibly in a gradual way.
- When retrieving material from the sides of the cable line, do not exceed with the distance; the carriage cannot swerve laterally with a gradient greater than 25°.
- On the carriage there is an inclinometer that reports and records every time the allowed degrees of tilt are exceeded.
- The carriage must not be used if the tensioning of the carrying cable is less than 8.5 tons, nor if it is higher than 12 tons.
- The maximum gradient is 40° with the engine facing downstream, and 40° with the engine facing upstream. Excessive gradient can cause serious damage (seizing).
- You can not use the carriage with a maximum slope and maximum gradient (either you reach a value or the other)
- It is forbidden to use guide rail covers or other devices that can obstruct the cable in any way
- Any cable joints must be formed through rope splicing, without affecting the geometric characteristics of the rope and its resistance
- During movement, the material have to be lifted from the ground
- The carriage must always travel at a minimum height of 8 meters from the ground, and in any case within a distance which ensure always the characteristics of maximum slope of the carriage.
- In order to limit the stress on the carriage, avoid frequent stop & go motions and drive it smoothly
- Do not tamper with any components
- When the carriage is not in use, remove the key from the transmitters

The preparation of the machine for the first start-up can be performed by a Groffenberg's engineer or by the dealer, possibly in collaboration with the customer's technician, who will then have the opportunity to acquire the information needed to carry out further maintenance activities.
5.1 SLOPING FUNCTIONS

Sloping functions are the following:
- Negative brake activates due to pipe breakage;
- Stopping for lack of commands on the joystick;
- Stopping when reaching the end of the line limits;
- Machine self-holding by pressing the start button;
- Emergency stopping when reaching mechanical limit switches;
- Emergency stopping due to loss of radio signal when the self-holding mode does not work;
- Emergency stopping due to manual activation of the emergency stop button on the radio remote control;
- Emergency stopping due to manual activation of the emergency stop button on the control panel.

5.2 CABLE LINE OPERATING FUNCTIONS

The operating steps are the following:
- Turn the general key fig. 12 in the position for the first click
- Select a radio remote control according to the position on the cable line:
  - Radio remote control 1 in loading position
  - Radio remote control 2 in off-loading position
- Insert the radio remote control key and turn it fig. 9
- Disconnect the emergency stop from the radio remote control fig. 3a
- Press the start engine ignition side button for 1 second fig. 9c
- In order to get familiar with the carriage, ride it several times without any load at a low speed, trying to memorise the function of each command, in particular, joystick 1 has four functions:
  - Uphill movement
  - Downhill movement
  - Load lifting
  - Load lowering
Other buttons on the radio remote control are:
- Activation of the travel holding mode Fig. 6c
- Deactivation of the travel holding mode 6c
- Emergency Stopping Fig. 2a
- Diesel engine activation fig. 8d

The central display 2b indicates several functions and in particular eight steady LED lights that indicate:
1. Winch maximum cable winding is set
2. Winch maximum cable unwinding is set
3. Loading point is set
4. Off-loading point is set
5. Guide rail 1 is set
6. Guide rail 2 is set
7. Guide rail 3 is set
8. Guide rail 4 is set

In case of emergency, all LED lights will turn off and only the indicator light corresponding to the current emergency will flash, with the following meaning:
1. Lifting encoder error warning
2. Fuel level warning
3. Insufficient engine oil pressure warning
4. Coolant temperature too high warning
5. Excessive carriage's gradient warning
6. Transition encoder error warning

Central display showing:
- Position from the load point in meters
- Diesel engine current speed
- Unwinding percentage of the hoist cable
- Travel speed in m/s
- Carriage gradient percentage along the cable line

⚠️ It is possible to use the recovery drum and perform the transition only up to 1 m/s travel speed at the same time by pressing the joystick 1a.

Please note that the functions "fast downhill travel" and "fast uphill travel" are re-elaborated by the management software: the speed is constantly being updated and changed according to the load carried and the slope of the cable line.

⚠️ It is preferable not to carry out lifting operations when the carriage is on a guide rail or close to it (minimum distance 15 m) and to travel at low speed on the guide rails.

⚠️ It is strictly prohibited to climb into the cart or be carried by it.
5.3 SELF-HOLDING FUNCTION

If the cable line happens to be so long to get out of the reach of the radio remote control (greater than 150 m) or if you cannot control your carriage with a single operator, you can use the self-holding function.

In this case, there must be two operators with a radio remote control: the first one in the vicinity of the off-loading area and the second one in the vicinity of the loading area.

It's not possible to use the two transmitters at the same time, in order to avoid dangerous situations.

| The self-holding function works only with set upstream and downstream thresholds |

To activate the self-holding functions, proceed as follows:

- Perform the travelling maneuver with the joystick to the desired speed (make sure to slow down in the vicinity of guide rails) and press D6 (to activate it)
- Turn off the radio remote control within 5 seconds, otherwise the carriage will stop, in which case this operation must be repeated

| At this point, the carriage will travel independently, no radio remote control is connected to it. To stop the carriage, turn on a remote control, turn the key on "ON" and press the start button. |

- To connect the radio remote control, hold down the "start" button for 2 seconds
- The connection of the radio remote control will stop the movement of the carriage; to prevent this to happen, in addition to holding the "start" button, set the joystick in the desired direction of travel.
- If you want to stop the carriage, just hold down the start button.
- It's possible to reset the load limit switch with the load radio remote control
- If no radio remote control is connected to the carriage, this will stop anyway once it reaches the set limit of the beginning/end of the cable line.

| If you don’t disable the self-holding function, the carriage will stop at the limit switches without any deceleration ramp. |
5.4 CABLE LINE SETTING

TO SWITCH FROM A RADIO REMOTE CONTROL TO ANOTHER, TURN OFF THE REMOTE CONTROL IN USE AND CONNECT THE OTHER REMOTE CONTROL WITHIN 3 SECONDS.

- Select the upstream (MONTE) or downstream (VALLE) off-loading mode with the switch fig. 3a.
- Position the carriage (using slow uphill and downhill travel mode) over the off-loading point.
- Save the off-loading point by pressing AUX1+VALLE on the OFF-LOADING radio remote control (1) (fig. 5a+7a).
- Proceed with the carriage to the loading point with any radio remote control.
- If there are guide rails, save their position by pressing AUX1+BLOCCA on the OFF-LOADING radio remote control (2) (fig. 5c+4a).
- Once you got to the loading point, save it by pressing AUX1+MONTE on the LOADING radio remote control (1) (fig. 5a+7a).
- Regulate the winch maximum winding SET POINT by pressing load uphill until the load reaches the maximum height by pressing LUCE+MONTE (fig. 10a+7a).
- At this point, the load can be lowered only in the holding mode.
- To force the SET POINT, press AUX2+ LIFTING JOYSTICK (fig. 5a+3a).
- Unwind the hoist cable until there are at least five wraps of cable left on the winch, in order not to stress the hooking pawl.
- Select the winch maximum unwinding SET POINT by pressing load uphill until the load reaches the maximum height by pressing LUCE + VALLE (fig. 10a+7a).

Pay attention to the position of the upstream/downstream selection switch 3a.
If you change it after setting the cable line, it will automatically reset the cable line completely.

Command combinations

- OFF-LOADING POINT: AUX1+ VALLE
- POSITION OF THE GUIDE RAIL: AUX1+BLOCCA
- LOADING POINT: AUX1+ MONTE
- LOADING POINT BYPASS: SIBLOCCA+JOYSTICK
- HOLDING MODE ACTIVATION: JOYSTICK+ATTIVA (turn the radio remote control off within 3 seconds)
- WINCH MAXIMUM WINDING: LUCE + MONTE
- WINCH MAXIMUM UNWINDING: LUCE+VALLE
- WINCH SETPOINT BYPASS: AUX2+JOYSTICK
- CABLE LINE RESET: AUX1+DISATTIVA
- UPDATING ON THE POSITION OF THE WINCH: AUX2+MONTE
## 4 MAINTENANCE

### 6.1 SCHEDULED MAINTENANCE AND CHECKS SUMMARY TABLE

<table>
<thead>
<tr>
<th>MAINTENANCE</th>
<th>Every 8 hours</th>
<th>Every 50 hours</th>
<th>Every 150 hours</th>
<th>Every 250 hours</th>
<th>Every 1000 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging radio remote control batteries</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel oil refueling</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checking main pulleys</td>
<td>X</td>
<td></td>
<td></td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td>Replacing hydraulic pumps filter</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checking gear reducer and negative traction brake oil</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacing gear reducer and negative traction brake oil</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Checking gear reducer and negative lifting brake oil</td>
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<tr>
<td>Replacing hydraulic oil</td>
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<td>Checking chain tension</td>
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<td>Checking guide rail wheels</td>
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<tr>
<td>Checking carrying cable tensioning</td>
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<td>Checking hoist cable</td>
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<td>Checking connection to the lifting hoist</td>
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<td>Diesel engine maintenance</td>
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<td>See diesel oil table</td>
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<tr>
<td>General cleaning</td>
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<td>X</td>
</tr>
<tr>
<td>Replacing hydraulic oil</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Checking chain tension</td>
<td>X</td>
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<tr>
<td>Greasing</td>
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<td>X</td>
</tr>
<tr>
<td>Cleaning heat exchanger</td>
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<td>X</td>
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</tr>
<tr>
<td>Checking guide rail wheels</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Checking carrying cable tensioning</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checking hoist cable</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Checking connection to the lifting hook</td>
<td></td>
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<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Diesel engine maintenance</td>
<td></td>
<td></td>
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<td></td>
<td>See diesel oil table</td>
</tr>
<tr>
<td>General cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
To replace the oil in the negative traction brake:
- use a large container to collect the used oil
- loosen the drain plug fig 4
- collect all the used oil in the large container
- tighten the drain plug fig 4
- loosen the filler and level plug fig 3
- top up to the optimal level
- tighten the filler plug fig 3
- make sure you have put all plugs back properly

⚠️ Dispose the used oil according to applicable regulations

Checking lifting gear reducer oil

To check the oil level in the lifting gear reducer fig F
- rotate the hoist drum until you can see the plug through the opening fig 4
- loosen the plug
- rotate the hoist drum until the plug will result on the horizontal axis of the drum, in the position shown in fig 4
- check that the oil appears at the level hole
- if you need to add oil, rotate the drum until you can see the plug through the opening fig 4, and top up with oil
- tighten the plug
- make sure you have put back all the removed parts properly

Replacing lifting gear reducer oil

To replace the oil in the lifting gear reducer:
- take a large container
- rotate the hoist drum until you can see the plug through the opening fig 5
- loosen the plug and collect the used oil in the large container
- rotate the hoist drum until the plug will result on the horizontal axis of the drum
- top up the oil
- rotate the hoist drum until the plug will result on the horizontal axis of the drum as shown in fig 4
- check that the oil appears at the level hole
- tighten the plug
- make sure you have put back all the removed parts properly

⚠️ Dispose the used oil according to applicable regulations

Replacing hydraulic oil

To replace hydraulic oil in the tank:
- use a large container with a capacity of about 50 LITERS
- loosen the drain plug of the tank and collect the used oil in the container
- tighten the drain plug
- loosen the filler plug and fill the tank up to the optimal level using Paralux synth HPL 46 oil
- tighten the tank filler plug
- turn on the diesel engine for 5 minutes
- check the level fig 2, and top up if necessary
- make sure you have put back all the removed parts properly

Fig. 1.
Recommended diesel oil table

<table>
<thead>
<tr>
<th>Description</th>
<th>Features</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE OIL</td>
<td>AGIP SIUERDIESEL 15/40</td>
<td>7</td>
</tr>
<tr>
<td>TRANSITION REDUCER OIL</td>
<td>AGIP ROTRA MP SAE 80/90</td>
<td>2.4</td>
</tr>
<tr>
<td>LIFTING WINCH OIL</td>
<td>AGIP ROTRA MP SAE 80/90</td>
<td>1</td>
</tr>
<tr>
<td>GREASE POINTS</td>
<td>AGIP GRASE 30</td>
<td>q.b.</td>
</tr>
<tr>
<td>NEGATIVE TRACTION BRAKE OIL</td>
<td>OSO 46</td>
<td>0.9</td>
</tr>
<tr>
<td>NEGATIVE LIFTING BRAKE OIL</td>
<td>OSO 46</td>
<td>0.6</td>
</tr>
<tr>
<td>HYDRAULIC OIL</td>
<td>PANOLIN SYNT HPL 46</td>
<td>45</td>
</tr>
</tbody>
</table>

Checking chain tension

To check the chain tension:
- Apply a force of about 5 kg at the center of the chain \( l_0 \) and observe a bending of about 1.5 cm
- If you observe an excessive bending, adjust the chain tensioner by loosening the two locking screws
- Adjust the chain tensioner to tension the chain
- Securely fasten the locking screws of the chain tensioner
- Check again and adjust until you reach the optimal tension
Greasing

Every 50 hours of work, the following grease points must be greased using Agip GREASE30

- Cable guide cross-head screw fig 2a
- Sliding guide fig 1a
- Sliding fork on cross-head screw 3a
- Cable guide bearings fig 2a
- Cable guide chain fig 1a
- Idler pulley: pump 2-3 doses of grease Fig 1 – 2a
- Driving pulley 1a

An external tube for greasing has been provided to avoid having to remove the protective casings.

In idle and driving pulleys, pump 2-3 doses of grease: too much grease can cause the expulsion of the oil seal, with the consequent possibility of introduction of foreign bodies which may cause bearing breakage.

Radiator cleaning

The heat exchanger should be always kept free from obstacles that do not allow the free flow of air. Every 50 hours, it is necessary to clean the heat exchanger with water (maximum pressure of 2 bar) and soap.

Checking guide rail wheels

To ensure the smooth passage of the carriage on the guide rails, you need to check that the guide wheels fig 6a are always able to rotate freely.

Checking carrying cable tensioning

The state of tension of the carrying cable must be checked every day and sometimes it is necessary to tension it to the optimal level, as stated in the cable line manual.

Checking hoist cable

To check the status of the hoist cable, it is necessary to unwind the entire cable and check its status for its entire length, by referring to the following table:
### SLOPE - Integrated processing and control systems for sustainable forest production in mountain areas – FP7-NMP-2013-SME-7 – 604129

WP 6 – System Integration
Deliverable 6.03 – SLOPE System Fields Trials Readiness Assessment Report

<table>
<thead>
<tr>
<th>MAINTENANCE</th>
<th>DESCRIPTION</th>
<th>MACHINE STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABLES</td>
<td>Visual inspection every 50 hours of operation or every 6 months.</td>
<td>Low-speed operation and stop</td>
</tr>
<tr>
<td></td>
<td>Such inspection may be replaced by a magneto-inductive inspection.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visual or magneto-inductive inspections after special events (storms, overlaps, derailment, etc.).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magneto-inductive inspection after 2000 hours, or 6 years after the installation. According to the results obtained, shorter term inspections will be established.</td>
<td></td>
</tr>
<tr>
<td>CABLE ANCHORAGE</td>
<td>Renew the loops placed at the ends of the cable every year. In the case of damage to the point where the clamp is installed, the cables must be cut at that point. If present, the swivel head joint must be replaced every 4 years.</td>
<td>Insulation for maintenance</td>
</tr>
<tr>
<td>PLANT</td>
<td>Check on a daily basis that the cables slide on the pulley and wind on the drum correctly.</td>
<td>Insulation for maintenance</td>
</tr>
</tbody>
</table>

**Check the last 10 meters of cable 4 times a day** because if not used correctly, they might cause premature damage due to their dragging.

The status of wear of the hoist cable must be checked on a daily basis, making sure that there are no distortions, reduction in sections, broken wires or signs of partial shearing. In case you find any of these signs, cut the cable on the upstream side of the imperfection or replace the cable.

**Checking connection to the lifting hook**

The status of wear of the connection to the lifting hook must be checked on a daily basis, making sure that the hook has not generated any type of premature wear on the cable. However, it is essential that you remove and reconnect the hook every 16 - 20 hours.

**Diesel engine maintenance**

As for diesel engine maintenance, refer to the instructions contained in the manual, following the timing and type of maintenance. The engine oil can be checked using the dipstick without having to remove the case.

**Cleaning**

You must consider from time to time (depending on frequency of use) carrying out a complete cleaning of the machine, even using compressed air and paying special attention to the crevices.
6.5 CHECK REGISTERS

The register performs as required by paragraphs 8 and 9 of Art. 71 Decree 81/08 (as well as by the manufacturer), and shall contain:

- All checks (including visual inspection) and maintenance schedule provided for in this chapter, or as may be necessary to ensure the good state of preservation and efficiency for security, either they are performed by the user (if able to do it) or an external technician.
- Interventions and extraordinary maintenance (including repairs and modifications performed by the manufacturer), in order to ensure the maintenance of good conditions whenever exceptional events occur.

|^ The faithful filling of the register assures, for the validity of the warranty, that the maintenance and inspections imposed have been carried out. |
General instructions for working safely

- The carriage must be used for lifting and transportation of materials on a temporary cableway (i.e., installed in the same place for no more than 24 months), built and maintained in a safe condition. It is strictly prohibited, in any case, the transport of persons or animals or dangerous goods!!
- Before use, it is mandatory to have available in the yard obligation, prohibition and warning tables provided by applicable law. In particular, signs prohibiting to get on the carriage. The main safety signs are already indicated on the machine. The working area, i.e., the entire operating line, must be signaled and divided into sections, to prevent any access or crossings.
- Make sure that the cable line is suitable in every point to the passage of the carriage; in particular, make sure that when it swerves to one side to retrieve the load, it does not hit against plants or obstacles along the cable line.
- During movement, the load have to be lifted at least 2.5 meters above the ground
- The carriage must always travel with a minimum height of 8 meters from the ground, and in any case within a distance which ensure always the characteristics of maximum slope of the carriage. Working with the load and the carriage near the ground can cause bumps to all internal components of the carriage (engine, radiator, pumps, etc.) and this may result in their malfunctioning and breakage.
- No operator must stay less than 20 m from the cables on the move. You should always check that the points of work or rest of the operators are not under the cables and/or carriage
- During loading and off-loading operations, the operator must move away, to avoid being hit by the cable in case of breakage. "No parking" stickers must be placed within the range of the machine.
- Always make sure there is perfect compatibility and communicability between the operators of the carriage and any workers dealing with the hooking and releasing of the material, who must agree in advance upon an easy and clear language with unique signals (any signal which is not understandable is equal to a stop). The workers shall be equipped with intercoms.
- Do not try to make the machine overcome the maximum values stated on the plate and on the technical data table (40 ° maximum gradient, 25 ° maximum slope, the two values cannot be achieved simultaneously)
- The limit switches must be installed, it is extremely dangerous to use the carriage without them.
- The limit switches must provide a contrast of about 20kg before slipping on the cable
- The limit switches must be placed on the carrying cable at least 10 m before the carriage touches at any point
- The carrying cable must have a diameter of 24 mm. The diameter of the individual wires must not be greater than 1.5 mm. The breaking load of the cable must be greater than 39 ton
- Do not carry out lifting maneuvers when the carriage is on a guide rail or when it is close to it (minimum distance is 15 meters)
- Transfix on the guide rails at a low speed
- Maximum gradient of deviation is 20 ° for each guide rail
- The minimum carrying cable tensioning is 8.5 ton. 12 ton is the maximum tensioning.
- When lowering the hook, be careful to keep the hoist cable tensioned all the time: it must go out smoothly from the guide rollers.
- Check the operation of the limit switches before every installation
## Command combinations

<table>
<thead>
<tr>
<th>Action</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF-LOADING POINT</td>
<td>AUX1+VALLE</td>
</tr>
<tr>
<td>POSITION OF THE GUIDE RAIL</td>
<td>AUX1+BLOCCA</td>
</tr>
<tr>
<td>LOADING POINT</td>
<td>AUX1+MONTE</td>
</tr>
<tr>
<td>BYPASS LOADING POINT</td>
<td>SBLOCCA+JOYSTICK</td>
</tr>
<tr>
<td>HOLDING MODE ACTIVATION</td>
<td>JOYSTICK+ATTIVA (turn the radio remote control off within 3 seconds)</td>
</tr>
<tr>
<td>WINCH MAXIMUM WINDING</td>
<td>LUCE+MONTE</td>
</tr>
<tr>
<td>WINCH MAXIMUM UNWINDING</td>
<td>LUCE+VALLE</td>
</tr>
<tr>
<td>BYPASS WINCH SETPOINT</td>
<td>AUX2+JOYSTICK</td>
</tr>
<tr>
<td>CABLEWAY RESET</td>
<td>AUX1+DISATTIVA</td>
</tr>
<tr>
<td>UPDATING THE LOCATION OF THE WINCH</td>
<td>AUX2+MONTE</td>
</tr>
</tbody>
</table>