D6.9 Training Scenario and Evaluation Plan for Space

Editor: Carlo Vizzi
## Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Contributor(s)</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>12.02.2018</td>
<td>Carlo Vizzi (AL)</td>
<td>TOC</td>
</tr>
<tr>
<td>0.2</td>
<td>13.02.2018</td>
<td>Carlo Vizzi (AL)</td>
<td>Fill in of the paragraphs</td>
</tr>
<tr>
<td>0.3</td>
<td>23.02.2018</td>
<td>Carlo Vizzi (AL)</td>
<td>Sent for Peer Review</td>
</tr>
<tr>
<td>0.4</td>
<td>27.02.2018</td>
<td>Carlo Vizzi (AL)</td>
<td>Corrections implemented according to Peer Reviews</td>
</tr>
<tr>
<td>1.0</td>
<td>27.02.2018</td>
<td>Mikhail Fominykh (EP)</td>
<td>Quality review and final corrections</td>
</tr>
</tbody>
</table>

Disclaimer: All information included in this document is subject to change without notice. The Members of the WEKIT Consortium make no warranty of any kind with regard to this document, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The Members of the WEKIT Consortium shall not be held liable for errors contained herein or direct, indirect, special, incidental or consequential damages in connection with the furnishing, performance, or use of this material.
D6.9 Training Scenario and Evaluation Plan for Space

WP 6 | D6.9

Editor:
Carlo Vizzi (AL)

Authors:
Carlo Vizzi (AL)

Reviewers:
Stephan Pascall (EP)
Mikhail Fominykh (EP)
Will Guest (OBU)

<table>
<thead>
<tr>
<th>Deliverable number</th>
<th>D6.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissemination level</td>
<td>Public</td>
</tr>
<tr>
<td>Version</td>
<td>1.0</td>
</tr>
<tr>
<td>Status</td>
<td>Final</td>
</tr>
<tr>
<td>Date</td>
<td>28.02.2018</td>
</tr>
<tr>
<td>Due date</td>
<td>M27</td>
</tr>
</tbody>
</table>
Contents

REVISION HISTORY .................................................................................................................. 2
EXECUTIVE SUMMARY ........................................................................................................... 5
1. USE CASE INTRODUCTION .................................................................................................. 6
   1.1. EVOLUTION OF THE TRAINING TO SUPPORT EXPLORATION MISSIONS ...................... 6
2. USE CASE DESCRIPTION ...................................................................................................... 7
   2.1. LOCATION ...................................................................................................................... 7
   2.2. MAINTENANCE PROCEDURE ....................................................................................... 9
3. ANALYSIS OF THE EXPERIENCE ....................................................................................... 10
Executive summary

This document describes iteration 2 of the training scenario and evaluation plan for the space industrial case. It assumes access to D6.3 which described the previous "astronaut training" scenario that was tested in Iteration 1. Iteration 2 focuses on important and until-now unaddressed aspects of the space case, such as the challenge during training, or during emergencies, of how to work around the long communication delays and reaction times that occur in full-space missions to the Moon and to Mars. Planning for iteration 2 can now include more aspects of the complexity of blending the latest generations of "wearable" sensor technologies with previous generations of sensor technologies as certified for use in space suits. In those ways, iteration 2 can leverage the growing maturity of the latest iterations of WEKIT sensor technology, plus recent advances in AR as applied to Smart (AI-compatible) Internet of Things, such as "Augmented Things", which can become part of possible (beyond-the-state-of-the-art) solutions to a previously-intractable problem: how to anticipate the needs of individual users or teams of users, so that communication delays can be worked around. Iteration 1 used insufficiently-mature technologies that could not easily be combined to address such problems.

The scenario will be tested on the Mars Moon Terrain Demonstrator (MMTD) in ALTEC. A step-by-step procedure to simulate the preparation of a rover before starting an exploration mission has been created by ALTEC team. The scenario will allow to test the new versions of the WEKIT recorder and player. Moreover, in Iteration 2, a particular attention will be given to capturing the differences in performance between the WEKIT methodology and the non-WEKIT methodology.

Iteration 2 looks at the anticipation-of-need scenario in the context of space versions of "Field Service Maintenance", FSM, specifically maintenance activities for coming exploratory missions on Mars or Moon surface. This document is composed of three chapters. Chapter 1 describes the scenario and the context of the maintenance activities that will be taken into account. Chapter 2 describes the use case in more details with a particular focus on the location and procedures. Chapter 3 describes how the scenario will be analysed.

The technical details of how the scenario will be tested using the WEKIT prototype and the description of the trial and evaluation phase will be reported in D6.12 – Implementation of Evaluation Trials in Space. This deliverable is very important for the organization, execution and evaluation of the trials that will be carried out in the following months with the supervision of WP6, but it is also important for the development of the WEKIT prototype, since it will take input from the Road Map and Exploitation tasks, and it will provide input to the technical WPs (WP2, WP3 and WP4).
1. **Use case introduction**

In the early stages of the WEKIT project and more specifically in D6.3, ALTEC identified two possible scenarios for the space use case, namely:

- Astronauts training
- Maintenance/assembly activities

During Iteration 1, ALTEC focused on the development and testing of the astronauts training scenario, collecting feedback and results from the trial and evaluation phase. For the second iteration of the project, ALTEC will focus on the development of the maintenance/assembly activities scenario.

The scenario described in the following paragraphs can be considered as a futuristic scenario (Fig. 1). The crew training concepts and tools supporting the exploration missions will be taken into account. In this scenario, an astronaut will prepare a rover to be used on the Mars or the Moon surface for exploration tasks.

1.1. **Evolution of the training to support exploration missions**

The astronaut training process needs to evolve taking into account the need to adapt to the different conditions of exploration missions. Currently, the training period for an astronaut is 18-24 months. During this period, the crew is prepared for the activities that will be conducted during the six-month mission on the International Space Station (ISS). A large portion of the crew training aims to instruct them on procedures regarding the removal/replacement of items although the chances that such procedures are implemented on-orbit are quite small. If this estimation is projected on a Mars/Moon mission of probably 2 years (i.e. including the long distance journey to/from Mars), a training period of about 6 years seems to be necessary, but at the same time not feasible.

In addition, crewmembers are constantly supported by the Ground Teams (Ground) while performing the on-orbit activities. Therefore, Ground is always able to guide and support them. This will not be possible during a mission to Mars since the communication between Ground and Mars is affected by a delay that can range from 8 to 20 minutes, depending on how Mars and Earth are aligned in that specific moment.

![Figure 1. Examples of futuristic activities carried out on Mars/Moon surface](image)

The duration of the training period and the communication delays for this type of activities, highlight the necessity to make astronauts more independent and autonomous in executing their tasks and also in reacting to contingency and even emergency events.
The WEKIT prototype is expected to fill these gaps by reducing the hours of training dedicated to maintenance activities and providing support to the crew when communication with Ground is not available.

2. Use case description

The use case identified for the maintenance activities scenario will simulate a situation where an astronaut on the Mars or Moon surface, has to prepare a rover for an exploration mission. Before starting the mission, the astronaut will have to check the status of the rover (damages, functionalities, etc.) and charge the battery. The steps of this activity are described in a procedure that has been defined by the ALTEC team.

2.1. Location

The scenario will be tested on the Mars Moon Terrain Demonstrator (MMTD) facility in ALTEC (Fig. 2 and 3).

The MMTD is an experimental area that simulates some characteristics of the Mars/Moon terrain. One of the main aspects of this terrain is its chemical composition, which is very similar to the Martian Soil. The terrain is essentially composed of volcanic tuff that represents a good mechanical model of the Martian terrain. From a visual point of view, the colour is very similar to the pictures received directly from Mars via the two NASA MERs (Mars Exploration Rovers), Spirit and Opportunity. The Mars Moon Terrain Demonstrator dimensions allow the simulation of some of the activities that could be carried out on the Lunar/Martian surface (using a suitable crane for gravity compensation). Such activities include the rover mobility, the rover egress and the probe landing. The MMTD can be utilized to test rovers with different dimensions and landers requiring specific engineering support during the operations (Fig. 3).

The facility can be utilized for both long- and short-duration missions. It allows the verification of operational parameters by performing functional tests (simulating the rover egress phases from the landing vehicle) and the study of the mechanical iteration between the wheels and the terrain. In addition, it allows to support the development and verification of the locomotion elements in terms of performances, manoeuvres, obstacles avoidance and autonomous motion for long and short path.
Figure 2. ALTEC Mars Moon Terrain Demonstrator (MMTD)

Figure 3. The rover that will be used to perform the procedure on the MMTD
2.2. Maintenance procedure

The objective of the futuristic scenario described above, is to check the status of the rover and charge its battery before starting an exploration mission. The steps of this activity are described in the following procedure:

1. Localize the rover on the Mars surface
2. Check the integrity of the main components of the rover (wheels, structure, etc.)
3. Localize the control panel on the rear side of the rover
4. Verify that the rover is in OFF status by checking that the red key is not inserted in the control panel
5. Localize the emergency/safety red buttons on the rover rear side (left and right side of the rover)
6. Push the emergency/safety red button to assure that the rover is in OFF status
7. Move to the front side of the rover
8. Take the battery charger device box
9. Move on the right side of the rover
10. Localize the rover red battery connector and extract the battery charger device from the box
11. Place the battery charger device close to the rover battery connector (i.e. use the wheel as support)
12. Connect the battery charger device to the rover battery connector
13. Push the button MODE on the battery charger device. (The charging time of the rover battery is about 2 hours. For this reason, the charging period will be simulated, and we will move to the next step as if the charging process has been completed)
14. Push the button Mode to end the charging process
15. Disconnect the battery charger from the battery connector
16. Store the battery charger in the box

In addition, during the execution of the procedure described above, the user will have to handle an external event triggered by one of the sensors of the WEKIT prototype. The user will receive a warning and he/she will have to interrupt the procedure to execute another brief activity. Once the event has been handled, the user will return to his/her previous task. For example:

1. User gets a warning from the sensor (i.e. external temperature too high)
2. User stops the procedure
3. User moves to the “emergency box” position
4. User performs the steps required to fix the problem
5. User returns to execute the previous procedure from the point he/she stopped

As well as in Trial 1, this procedure will be performed by the trainers and by the trainees. The trainers will primarily use the WEKIT recorder to create the procedure, while the trainees will primarily use the WEKIT player to execute the procedure as instructed and guided by the trainers.

At the time of writing this deliverable, the new versions of the WEKIT recorder and player are still being developed, as well as the definition and implementation of the sensors. For this reason, we will not describe the features of the prototype that will be used to perform the procedure. Moreover, these steps describe the activity in general terms. Some of these steps (i.e. checking the integrity of the rover, verify that the rover is on OFF status), will be split in sub-steps when we will approach the trial, according to the features available in the final WEKIT prototype.
These details will be explained in deliverable D6.12 where the results and evaluation of the trial of the second iteration will be thoroughly described and analysed.

3. Analysis of the experience

The prototype developed within Iteration 1 has allowed to achieve good results and to collect a large amount of positive and constructive feedback from the participants. This feedback was used as an input for the development in Iteration 2. Nevertheless, in Trial 1, the prototype was still in its early stage, so it did not permit to conduct a comprehensive analysis of the experience and of the performance of the WEKIT methodology versus the standard approach used for training in the space field.

The prototype that will be developed in Iteration 2 will be more mature and will allow to compare the results of training following the WEKIT methodology versus the non-WEKIT methodology. It will also allow to show the users and the stakeholders the real potential of the WEKIT training approach. The main Key Performance Indicators (KPIs) that will be taken into account are:

- Execution time (total duration of the procedure, duration of each step, etc.)
- Number of mistakes (total number of mistakes, number of mistakes in each step, etc.)

In addition, the satisfaction of the user will be evaluated through questionnaires and interviews including specific areas such as:

- Wearability and comfort
- User Interaction
- Usability
- Technology acceptance
Wearable Experience for Knowledge Intensive Training

WEKIT

Wearable Experience for Knowledge Intensive Training
Project No 687669

WEKIT project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 687669. [http://wekit.eu/](http://wekit.eu/)