



SKILLING, UPSKILLING, RESKILLING IN THE FUTURE AIR TRANSPORT

D3.2 VET training portfolio and test sessions plan

*Results from T3.3 “Design content for
training modules”*

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SKILLING, UPSKILLING, RESKILLING
IN THE FUTURE AIR TRANSPORT

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List of Acronyms

Acronyms List	
AI	Artificial Intelligence
ATCO	Air Traffic Control Officer
CRM	Crew Resource Management
CTKI	Chief Theoretical Knowledge Instructor
DCS	Departure Control System
IATA	International Air Transport Association
ML	Machine Learning
NTS	Non-technical skills
RPAS	Remotely Piloted Aircraft System
SPO	Single Pilot Operations
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
VET	Vocational Education and Training

Executive summary

The main purpose of the document is to present the results and conclusions of two tasks within the skill-UP project, namely:

- Task 2.3 - Validation of study pathways
- Task 3.3 – Design contents for training modules

Each contributor described the activities conducted in order to validate the study pathways that had been defined in D2.2 (“Study pathways: Skilling, Upskilling and Reskilling”). Each partner conducted focus groups on the targeted groups. Feedback was collected from 19 experts in total. Globally, the study pathways were validated, and only slight changes were made.

At the end of the validation process of the study pathways, decisions were made to design the seven following training modules:

- Transversal training modules:
 - Problem solving and decision making (QSR)
 - Artificial intelligence and Machine Learning for Aviation Applications (University of Malta)
 - Deepening of situation awareness (ENAC)
- Specific training modules:
 - For RPAS operators (QSR): workload management and stress management
 - For ATCOs (Deep Blue): change adaptability and stress management
 - For airport operators (ESTU-KU): change management for automation and emerging technologies
 - For pilots (ENAC): learning and practice of new aircraft procedures

The pilot sessions (that will be organized within task T3.4) are planned to be conducted with at least 6 participants for the specific training modules and at least 3 participants for each target group for the transversal modules.

The next step will be the more detailed design of the training modules, specifically the content of the video lessons for the asynchronous parts of the training modules that will be uploaded in the skill-UP e-learning platform (WP5). Moreover, assessment procedures for each training module will be designed in the next work package (WP4).

1 Project overview

The skill-UP project aims to define the knowledge, skills and competencies required by the current and future workforce of the air transport industry so that the educational and training programmes can be better aligned to the requirements of different occupational profiles. The project looks at four occupational profiles: air traffic controllers, pilots, airport operators and drone operators. The project seeks to develop initial and continuing VET training programmes based on suitable and innovative teaching and training methodologies and study pathways to aid in the skilling, upskilling and reskilling of the future workforce of the air transport sector. The skills and knowledge required by the future workforce will change, mainly because of an increase in digitization, automation and advancement in artificial intelligence. New competencies will become essential, amongst which are: the ability to work with data to perform descriptive diagnostics, predictive and prescriptive tasks; increased ICT knowledge, including multimodal interaction with advanced HMIs, automation and robotics; and teamwork and communication skills, in scenarios where the team would be composed of both humans and advanced automation. The skill-UP project aims to identify such new required competencies and address the training needs required to address the current gaps in skills and knowledge.

1.1 Purpose of the document

The first objective of this deliverable is to report results of the validation activities of the study pathways defined for each target user. The second objective of this deliverable is to report results of Task 3.3, “design content for training modules” of Work Package 3, “Implementation of training and work-based learning”. The deliverable presents an overview of Skill-UP key previous results and then presents details of the validation activities conducted by each partner. Then the training portfolio is described for each training module, first the transversal modules and then the specific modules. The last part of the deliverable reports some preliminary information about the pilot sessions that will be delivered by each contributor.

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1.2 Deliverable structure

This document is divided into four parts.

Section 1 – *Project overview* – gives a brief overview of the skill-UP Project, the purpose of the document and its structure.

Section 2 – Overview of skill-UP previous results – gives key results from survey and interviews. This section also presents the validation activities that have been conducted by each partner in order to validate the defined study pathways. This section ends with implications regarding the training modules that will be designed by the partners.

Section 3 – Description of VET training portfolio – first describes the methodology used to collect information regarding the training modules. Secondly, it gives an overview of each training module that will be designed by the partners: Three transversal modules and four specific training modules, one for each target group.

Section 4 – Preliminary elements concerning pilot sessions – describes how each partner plans to conduct the pilot sessions in order to test the developed training modules.

2 Overview of Skill-UP previous results

The first work package (WP1) of the project led to the identification of four future scenarios in air transport:

- For ATCOs: new operations in single and multiple remote rowers
- For pilots: single pilot operations
- For RPAS operators: RPAS integration into the U-SPACE
- For airport operators: new technologies for managing the flow of passengers

Further information about the scenarios can be found respectively in Deliverable D1.1.

The second work package (WP2) aimed at identifying any misalignment between educational and labour skill requirements as a consequence of the future scenarios. For that purpose, a survey and interviews were designed and administered.

The survey and interviews conducted with air transport professionals revealed several gaps and challenges for the training of future air transport actors. Some of these gaps and challenges arise from training deficiencies, while others are due to the initial lack of experience of the employee or the unique characteristics of each workplace environment. Technology is one of the key drivers of change. Changes will be disruptive in the case of UAS operations while, for other VET users, changes will be incremental. Some of the most in-demand skills in the future will be adaptability, IT and technology-related skills (see Deliverable D2.1 for more details).

As follow up of the results of the Skill-UP survey and interviews, twelve future competency profiles (namely the Personas) were defined (two or three for each of the four target populations of the Skill-UP project namely air traffic controllers, pilots, RPAS pilots and airport operators). In the framework of the Skill-UP project, the Personas represent the target users of future aviation training programmes. In line with this, the aim of the personas was to visualise future aviation job profiles and provide inputs for the design of the related study pathways.

Competences needed for each of these target users were listed in the so-called study pathways (see Deliverable D2.2 for more details). These study pathways are composed of the formal training (theoretical and practical) and the competences (behavioural and technical) needed for the future target users (see Deliverable D2.1 for the detailed descriptions of the Personas and D2.2 for the detailed description of the study pathways).

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2.1 Validation activities of study pathways

In order to validate the defined study pathways by external subject matter experts, each partner conducted validation activities of identified study pathways. These activities consisted of focus groups and are detailed in the following sections, one for each partner (in alphabetical order). In total these focus groups involved 19 experts, each focus group collecting feedback from at least two experts. Globally, all the study pathways were validated.

2.1.1 Deep Blue's validation activities

Deep Blue carried out the validation of the study pathways by which a Tower controller can take up the role of a remote tower controller within a remote airport operational scenario. Two types of individuals were considered: a new entrant assumed to have had no prior air traffic control

experience and/or qualifications and an experienced professional air traffic controller whose role would change to that of a remote air traffic controller.

Methodology

Two Focus Groups were organized.

The first involved air traffic controller representatives. The focus group was held online and a collaborative whiteboard platform was used to aid in the validation of the study pathways. Two participants, both with years of experience in air traffic control and training, took part in the focus group. The participants were first presented with a summary of the project leading up to the design of the study pathways. They were then asked to complete several tasks on the collaborative whiteboard. After each task, a discussion with the moderators took place during which the consolidated study pathways were discussed. The participants were thus able to comment on the proposed study pathways and review as necessary.

The second Focus Group involved one air traffic controller representative and a representative of the training academy of Italian air traffic controllers. The participants were first presented with a summary of the project leading up to the design of the study pathways. They were then asked to validate the study pathways as consolidated in the first Focus Group. Then they were asked to complete several tasks on the collaborative whiteboard. After each task, a discussion with the moderators took place during which a draft structure of the reskilling training module was developed. The participants were thus able to comment on the proposed structure and review as necessary.

Observations and discussions

During the design of the study pathways, the theoretical subjects that currently form part of ATCOs training were considered.

Thus, in the first Focus Group, the participants were asked to select the subjects which they felt were still required to form part of the remote air traffic controller's study pathway, with a specific focus on non-technical skills (NTS). The results can be seen in Figure 1 and Figure 2.



SKILLING

Situational awareness	<p>Absorbs information to form an overall picture.</p> <p>Consistently able to form an overall traffic picture based on all information available. She/he is able to selectively pick the right information needed for the overall picture.</p> <p>Keeps a clear overview of the situation by scanning regularly</p>
Self-management and continuous development	<p>Demonstrate personal attributes that improve performance and maintain as active involvement in self-learning and self-development.</p>
Workload management	<p>Adapt workload to the traffic complexity. Manage personal efficiency and work tempo</p> <p>Remain concentrated with various traffic levels</p> <p>Skill to be consistently concentrated and alert throughout the whole duty period.</p>
Teamwork	<p>Operate as a team member building relationship based on trust and cooperation in order to make the team strong and performative</p>
Communication	<p>Makes all communications in a clear and concise way</p> <p>Uses standard phraseology or non-standard phraseology where needed</p> <p>Monitors the frequency and responds to pilots' calls or requests in time</p> <p>Obtains and verifies acknowledgements and read-backs when required</p>
Problem solving and decision making	<p>Find and implement solutions for identified hazards and associated risks</p> <p>Makes well timed decisions</p> <p>Sets priorities correctly</p> <p>Takes initiative and acts accordingly</p>
Coordination	<p>Manage coordination between personnel in operational positions and with other affected stakeholders</p>

communication styles & teamwork with non-millennials, resilience



Figure 1. Non-technical skills for the “skilling” study pathway.



Figure 2. Non-technical skills for the “reskilling” study pathway.

Both participants immediately highlighted that probably all of the subjects would be beneficial. In fact, all subjects were selected by at least one participant. This observation was similarly raised during the design of the study pathways. During the subsequent discussion, the participants gave their views about the subjects and how they may be adapted to better suit the needs of the new air traffic controllers’ role. We asked them the following:

- What NTS are missing?
- What NTS you already cover in the HF/recurrent training courses?
- What NTS you would like to train more?

For the skilling study pathway, the participants mentioned that all the mentioned NTS are relevant and covered by their training activities. However, a more detailed course on communication and teamwork would be very helpful to complement their initiatives. This would help participants to grasp the difference among the various communication styles and apply an assertive way of interacting with colleagues. A module on coordination and teamwork would be also helpful to improve shared situational awareness and detect coordination hazards (as for example communication between millennials and non-digital native people).

For the reskilling study pathway, the participants mentioned that self-development and change management are missing and would be very relevant for the transition in the new remote roles.

This was confirmed in the second Focus Group, during which we learned that the proposed discussion is in line with what is being discussed at national level about the reskilling curricula of remote tower ATCOs. The participants suggested to focus on change adaptability and include case studies of success in dealing with organisational change.

Conclusions

This exercise had the main goal to validate the study pathways for the air traffic controllers and start defining the content for the specific training module for future rTower ATCOs. The following conclusions have been obtained:

- the reskilling profile was considered as the most relevant to focus on, in line with the current debate on the transition towards remote tower operations. Thus, it was decided that this profile will be the main target of the specific training module for future rTower ATCOs.
- It was decided that it is necessary to include change management as relevant topic/competency and include case studies of change as examples.
- It was agreed that one of the participants (an ATCO) would help with the design of the training material, especially for case studies and operational examples.

2.1.2 ENAC's validation activities

ENAC organised a focus group the 15th of July from 10:30 to 11:30 with two pilot instructors at ENAC:

- The Head of ENAC pilot training
- The Chief of Theoretical Knowledge Instructors (CTKI) of ENAC pilot training

Before the focus group, the two pilot instructors read the study pathways for the single pilot scenarios (new entrant and reskilling). During the meeting, ENAC collected their feedback regarding these study pathways. More specifically, they firstly had to validate or not the relevance for each of the competences listed in the study pathways. Secondly, they had to add any missing important item or competency. Thirdly, they had to validate the choice of the selected topic for the specific and the transversal training module to be designed within the Skill-UP project.

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To sum up, the pilot instructors gave following feedback concerning the study pathways designed in work package 2:

- Each listed competency was relevant and important for future pilots, especially in a single pilot scenario
- A few changes should be made:
 - In the “**situation awareness**” behavioural skill, add the “**startle effect**” in the knowledge part in the list of factors affecting situation awareness
 - Replace “specific AI and automation knowledge related to automated systems used in the single pilot aircraft” by “**Application of knowledge** related to AI and automated systems used in the single pilot aircraft”
 - Add “**Leadership and teamwork**” in the list of behavioural skills.
 - Emphasize “**fatigue and stress management** in the “workload management” skill. by replacing the item “Aviation psychology (human overload and underload, fatigue and stress management, etc,)” by the following two items:
 - Overload and underload management
 - Fatigue and stress management

To synthesize, the study pathways identified for pilots comprised following technical and behavioural skills (see Appendix 1 for the complete validated study pathways):

- Technical skills:
 - Aircraft Flight Path Management manual control

- Application of Procedures
- Application of knowledge to AI and automated systems used in the single pilot aircraft
- Behavioural skills:
 - Situation awareness
 - Problem solving and Decision Making
 - Leadership and teamwork
 - Communication skills
 - Workload Management

For the specific training module for pilots, the choice has been made to focus on the technical skill related to the application of procedures. Indeed, the single pilots are supposed to adapt quickly to new type of aircrafts and to learn new procedures.

2.1.3 ESTU's validation activities

ESTU and Fraport-TAV organized an online meeting the 5th of October from 14.00 to 16.00 with nine external participants. The participants and which company they work for are given in Table 1..

Table 1. Participants list.

Role	Organisation
Head of Training Department	Turkish CAA
Training Specialist	Turkish CAA
IT Assist. Manager	TAV-Fraport Antalya
Quality Expert	TAV-Fraport Antalya
Station Manager	Sunexpress Airlines
Vice Operational Manager	Corendon Airlines
Traffic Manager	TGS
Traffic Manager	HAVAŞ

At the beginning of the meeting, the participants were introduced to each other. Then their consent was taken verbally for the online meeting record to have better resolution of the meeting for reporting. Afterwards, all participants were informed about the Skill-Up project. After the project was introduced, it was explained what we would do within the scope of this meeting in line with the aims of the project. At this stage, what Personas meant was explained. A detailed explanation was given about the two personas we created. After the explanations, questions were asked to the participants. The questions were explained in detail when necessary. The structured interview questions we asked to the participants were:

- Are all the necessary skills mentioned?
- Are any skills missing?
- Are any skills unnecessary/to be modified?
- What training topics would you keep?
- What would you change?
- What would you add?

After the questions were asked, the expected outputs were also explained and the opinions of the participants were taken in order. During this process, additional open-ended questions were asked to the participants in order to obtain more detailed data and to receive their feedback on the intended topic. The participants' feedback we received was as follows:

To develop behavioral skills;

- Communication (verbal and body)
- Stress management
- Fatigue management (Also techno/mental fatigue)
- Problem Solving

To develop technical skills;

- Multi-Language
- Crisis Management
- Emergency Management
- Proactive Risk Management
- Crowd Management
- Digital Awareness

These concepts were said to be important by all participants.

When we evaluated the feedback obtained at the meeting under the category of trainings that the check-in agent should receive, the following list was formed:

Formal-basic education (legislations):

- Basic aviation information,
- Knowledge of business processes,
- DCS trainings, system trainings,
- Travel documents, (issues such as the intelligibility/detection of forged documents)
- IATA standards, certifications,
- Travel documents,
- Language skills,
- Dangerous goods,

- Airport emergency action plans.

Individual training – human factors:

- Personal development trainings: Training programs that address the human factor,
- Time management, stress, communication skills,
- Mental workload, fatigue, motivation, workload planning, teamwork,
- Demonstrating proactive employee behaviors,
- Having employees with high problem-solving skills and providing training on this subject,
- Gaining quick decision making and implementation skills to employees,
- Employees' ability to manage stress, empathize,
- Crisis management, creation of crisis management teams and even providing crisis management within the scope of basic education.

Technology-based training:

- Technology-based needs should be determined,
- Trainings for emergency response processes to technological problems,
- Basic technology knowledge,
- Electronic ticket systems,
- Technological innovations (online check in, auto baggage etc.).

At the meeting, it was emphasized that in all these processes, on-the-job training should be more than in the past.

As a result of the study pathway validation meeting held, future airport employees wanted colleagues with the following characteristics:

- Should have received training specific to the field of work,
- Should know the airline rules,
- Should be able to manage customer relations well,
- Should be able to make quick decisions and show a solution-oriented approach,
- Should be in a constantly learning structure,
- Should be friendly,
- Should be an easy-to-communicate employee, team worker,
- Should have a good command of the subject, strong persuasion skills,
- Should be able to demonstrate an empathetic approach,
- Should be able to recognize the passenger profile and have the ability to manage relations well,
- It should be established with a redundant structure; uninterrupted service should be aimed.

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2.1.4 QSR's validation activities

On 10th November of 2021, the QSR team held a focus group in order to validate the RPA study pathways, which were developed in T2.3 and that are included in Deliverable 2.2.

The session started at 4:00 PM (GMT) and ended at 5:30 PM (GMT). Firstly, the QSR team started by welcoming the participants and carrying out a short ice-break activity in order to understand the participants' backgrounds and allow everyone to present themselves. The focus group consisted of with two people, which for identity protection would be named H and D. Both H and D belong to the same company, a leading drone company in the knowledge and marketing of UAVs (Unmanned Aerial Vehicle) and services provided by these vehicles. They provide not only consulting solutions, but also, hardware and software suited to the specific needs of each client. Nowadays, their main clients and projects are on agriculture, public safety, and security services.

D is a new entrant, working for almost 8-months in the company. He finished a bachelor's degree in Geography and Territory Planning, where he was able to contact with the drone industry. Since he joined the company, he had the opportunity to operate and pilot UAVs within the project's scope. H is a head manager, with vast experience in drone piloting and operations, and also has a master's degree in Social and Organizational Psychology.

After the ice-break dynamic, the QSR team presented the Skill-UP project, its context, goals, team and main expected results of the project. Additionally, the QSR team presented previous project results – The Future Scenarios (D1.1) and Personas: The Future Competence Profiles (T2.2) - which led to the Skill-UP study pathways, in order to give context and explain our working path so far.

The introduction ended with the Skill-UP study pathways definition and structure presentation, where the QSR team presented the study pathways template and explained the purpose of each section.

Methodology

The main purpose of the study pathways focus group was to validate the RPA study pathways, mainly the competence section, which will be the basis for the Skill-UP training modules development. With that purpose, a Miro dashboard was created with four sections, which corresponded to the four sections of the study pathways template.

Each section comprised:

- 1) A post-it board on the left, which contain the main topics (for formal training) or main competencies (for competency training);
- 2) A three-column board on the right, divided into the three RPA profiles designed:
 - New entrant: Skilling to Open-Category;
 - Professional in Open-Category: Upskilling to Specific-Category
 - Professional in Specific-Category: Reskilling to Air Taxis in the context of U-Space operations.

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To facilitate the comprehension of the present report, the three RPA profiles will be referred to by their learning goal. Thus, the new entrant will be referred to as “Skilling Profile”, the Professional in Open-Category as “Upskilling Profile” and the Professional in Specific-Category as “Reskilling profile”.

- 3) A board with empty post-its, to allow participants to add any topic or subjects, which they think are missing from the post-it board.

The exercise presented to the participants consisted of four tasks. In all the tasks, the participants were required to allocate the subjects considered in the study pathways to one or more of the 3 professional RPAS profiles previously designed by the consortium. In the end, the participants could add any topic or subject that wasn't previously considered if they saw fit.

Observations

Following the methodology previously defined, in the first task, the participants were asked to select the subjects from the theoretical subjects, that currently are part of the RPA training, and allocate them to the profiles that they considered would require this type of training.

The participants considered that some of the subjects would be necessary to include in the training of any professional, regardless of their entry-level. Some of these topics would be, *Regulations and Air Safety, UAS General Knowledge, Privacy and Data Protection and Aircraft Systems*.

Also, the participants noted that *Weather* should be integrated into all of the categories, but they also stated that the subject of learning is not something that needs to be constantly updated. One of the participants even added that the subject *Weather* should be integrated into the topic *Principles of Flight* (D: “...a person knows, from the basics of flying, to not fly when it's raining... I think that [Weather] is inside of the Principles of Flight”). A subject that the participants highlighted

as the most important one was *Risk Assessment and Management*, they considered this topic relevant and necessary in training on all of the three categories.

Some topics would only be necessary for someone who's having their first encounter with UAVs (Skilling profile), topics such as *Principles of Flight* and *Air Law*, because a professional, or someone who already has some experience with these, would know these subjects already, so the training would be redundant, as stated by the participants.

On the other hand, the participants also considered that some topics, such as *Operational Procedures*, *Human Performance and Limitations*, *Communications*, *Performance and Security* and *Cybersecurity*, would only be relevant and useful for someone who already has the basics down, in this case, the profiles for an Upskilling Profile and Reskilling Profile. Similarly, the topic *Mass and Balance* was considered necessary in both of these two previous profiles, but one of the participants added that, even though it is important in both, it is especially important in the Reskilling profile.

The subject *Crew Resource Management/Multi Crew Coordination* was only considered to be necessary for the Reskilling profile.

As mentioned before, after going through all of the topics already considered in the Study Pathway, the participants were asked if there was any topic, they thought relevant that wasn't mentioned or if there was a topic that was mentioned but they considered it irrelevant. One of the participants started by suggesting a topic that wasn't mentioned, *Maintenance*, adding that it is something that needs to be present in all of the profiles, but especially in the Reskilling profile. In the same line of thought, the other participant stated that the professionals from Upskilling profile should have some knowledge about the structures (e.g. buildings) in which they are going to fly the UAV (*Knowledge of the area of intervention*). Lastly, the first participant added that, in the Reskilling and Upskilling profiles, *Emergency Procedures* should be a subject added (H: "...in case of an emergency what should be done?").

In the image below (Figure 3), it can be seen how the table was in the beginning (left) and then how it was filled out in the end (right).

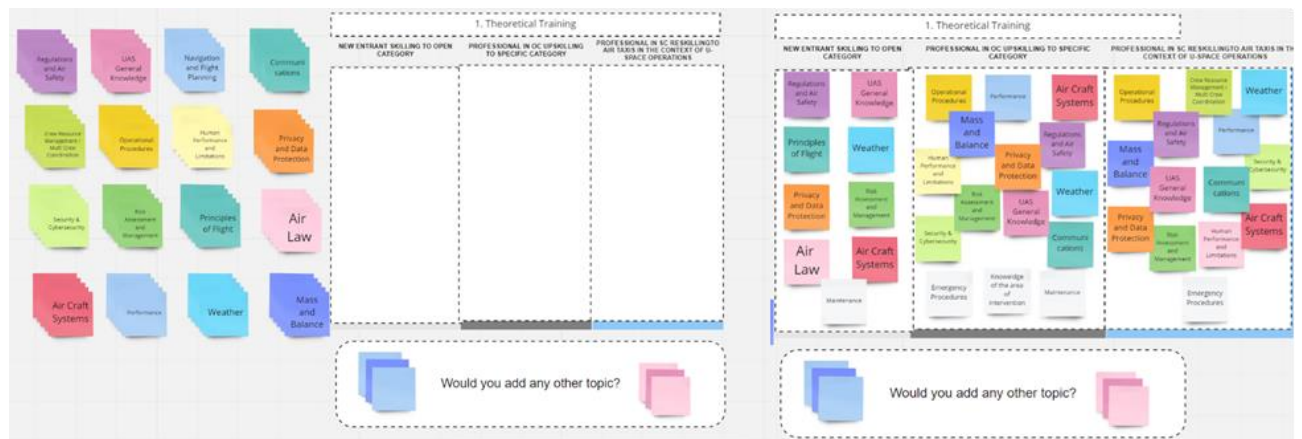


Figure 3. Theoretical training topics.

The same logic was used in the second task. The participants were again asked to select the subjects, this time from the Practical Training of an RPAS professional and allocate them to the profiles that they considered would require this type of training.

One of the participants started by saying that *Simulation Training* should only be present in the Reskilling Profile since this category needs this validation and training. Adding to that, the participant stated that at a new entry-level (Skilling Profile) it's not necessary to have simulation training because the UAVs are automatized and safe, besides this, the participant also added that at an entry-level, the training is really basic, so it doesn't justify this type of training. This comment was relevant since there is a possibility that the Skill-UP project will contain Simulator training. This consideration of simulator training at an entry-level was previously discussed at the time of the Study Pathways design. On the other hand, if a pilot is training to specialize in a specific category

(Upskilling Profile) it is not possible and economically viable to design a simulator training for every specific machine.

Continuing, the topic *Real Flight Training* was considered to be necessary for the training of the three profiles. The *Initial and Intermediate practical real-flight training on basic UA* topic was considered, by the participants, to only be necessary for a Skilling and Upskilling Profiles.

Lastly, it was asked to the participants if there was any subject/topic that they would like to add. Participant H, which has more experience in the sector, stated that the industry/sector in which the professional in training is going to act should be taken into account in the training. Adding on to this, participant D stated that this “*Consideration for the industry/sector*” could be added in the *Real Flight Training* topic (D: “...for example, if we are going to give training to a topographer, we’re going to give a topography flight...”).

In the image below (Figure 4), it can be seen how the table was in the beginning (left) and then how it was filled out in the end (right).



Figure 4. Practical Training topics (before and after).

The third task was related to Technical Competencies. In a first instance, the participants were asked again to allocate the topics to the profile(s) that they thought to need the competence. This time the participants, instead of going subject by subject and allocating them to the profile, decided to select all of the competencies they thought fit in each profile. Thus, starting with the Skilling Profile, the participants decided that the competencies necessary for this profile were *Application of Procedures, Assessment of Operational Scenarios and Risk Assessment and Safety-based judgement*.

The participants considered competencies, such as *Hand-eye coordination & UA flight path control and management, Operation of GCS, UA flight path control and management, automation, Operation of UA and flight path control and management, manual, fly-by-wire*, needed to be present in the training for the Upskilling Profile and the Reskilling Profile but added that both of these profiles also needed competencies such as *Application of Procedures, Assessment of Operational Scenario and Risk Assessment and Safety-based judgement*.

On a second moment, the participants were asked, in their opinion, which of the previous competencies were the most important, to which, one of the participants stated that *Application of Procedures* is one of the most important, and the other participant added that *Assessment of Operational Scenario*, even though is a basic competence, is one of the most important as well.

Lastly, the participants stated that competencies such as *Distinction of scenarios* should be added because the professionals should be aware of the type of scenario that they are going to fly in and which laws exist in each one (H: “...for example, if I fly within the civil law is one thing, if I fly in a military area is something completely different.”).

In the images below, it can be seen how the table was in the beginning (Figure 5) and then how it was filled out in the end (Figure 6).

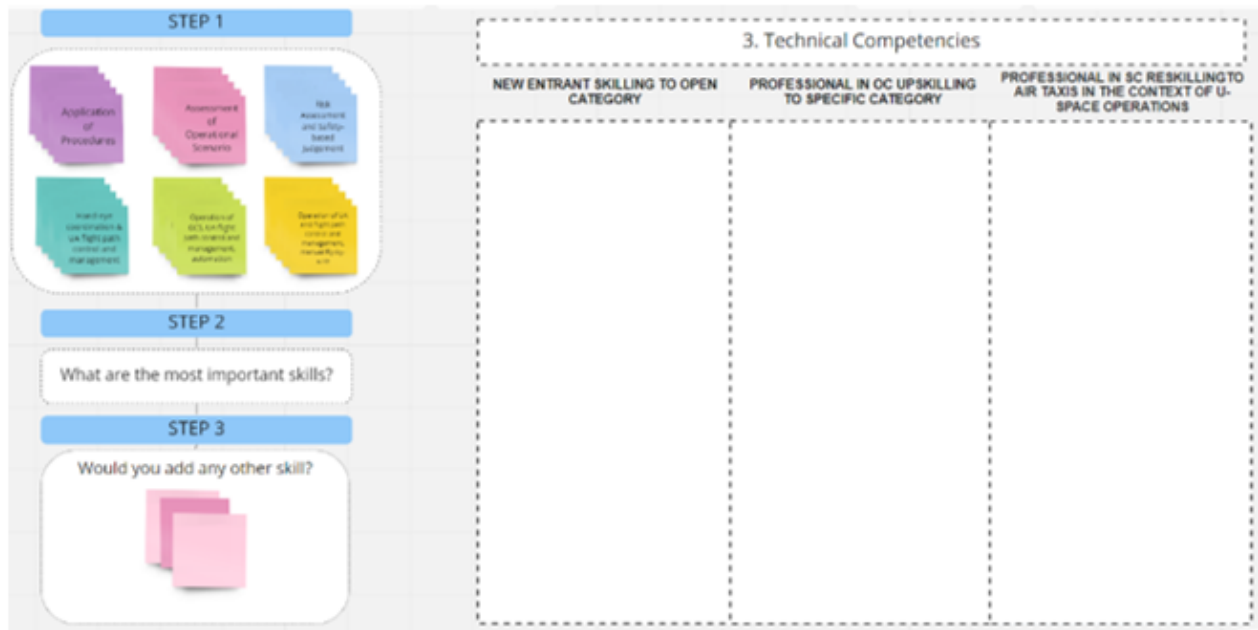


Figure 5. Technical Competencies topics (blank).

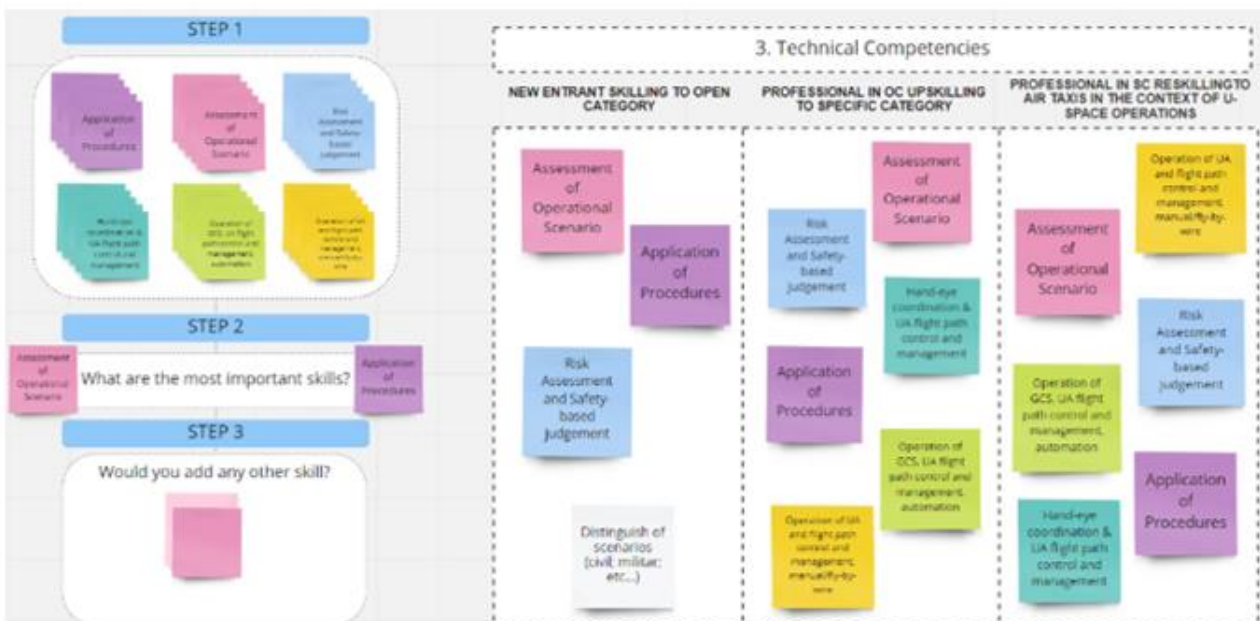


Figure 6. Technical Competencies topics (filled in).

The fourth and last task was relative to the Behavioural Competencies. *Communications* was a competence thought, by the participants, to be only required in the more advanced profiles (Upskilling and Reskilling). Likewise, *Teamwork* and *Adaptability to Change* were competencies

thought to only be required in the Upskilling and Reskilling profiles, seeing that it would be asking a lot of complex competencies to an entry-level professional.

On the other hand, participants stated that *Workload Management* would only be necessary for a Reskilling Profile.

Lastly, competencies such as *Situational Awareness*, *Problem Solving and Decision-Making* and *Analytical Capability* were competencies that the participants thought to be very important and therefore, needed to be required at all levels (Skilling, Upskilling and Reskilling Profiles).

Going to the second step of this task, the participants were asked to choose the skill(s) that they thought to be the most important. *Situational Awareness* was chosen first by participant H (H: “*Situational awareness is really, really, important...*”). Participant D added that *Problem Solving and Decision Making*, even though, that in his opinion if we work the *Situational Awareness* competence, by consequence, we are working the *Problem Solving and Decision-Making* skill, making it almost secondary to the first one (D: “*If we work Situational Awareness we almost don’t need [to work on] Problem Solving [and Decision Making] ...*”).

Lastly, the third step of the task was to ask the participants if there were any competencies that they thought to be required that weren’t mentioned before. Participant H, immediately added that an RPAS professional should be someone that is very *detail-oriented, meticulous* (H: “*There are a set of procedures, and if there is nothing that makes the person go step-by-step, the person will skip ahead...*”).

In the images below, it can be seen how the table was in the beginning (Figure 7) and then how it was filled out in the end (Figure 8).

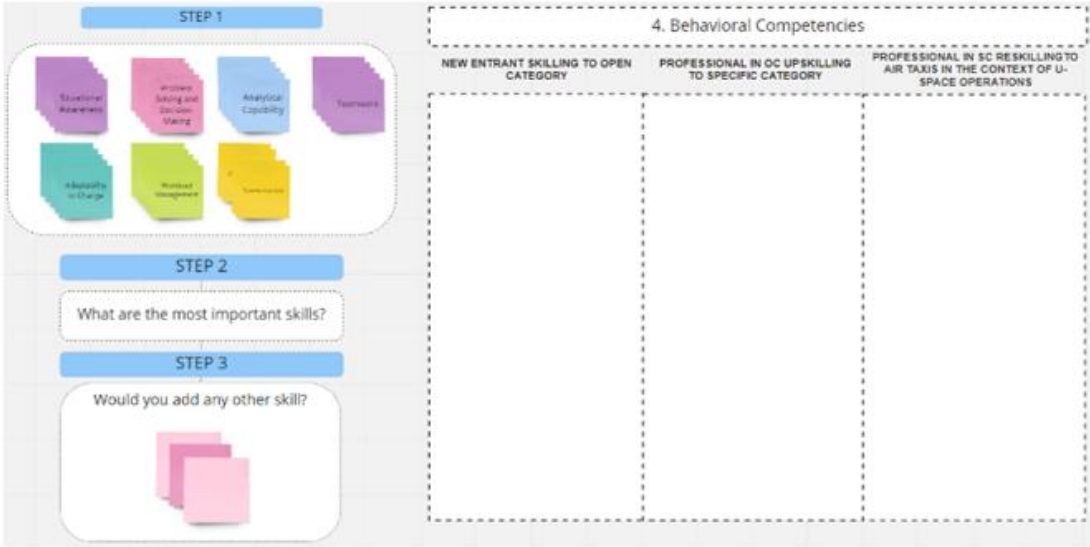


Figure 7. Behavioral Competencies topics (blank).

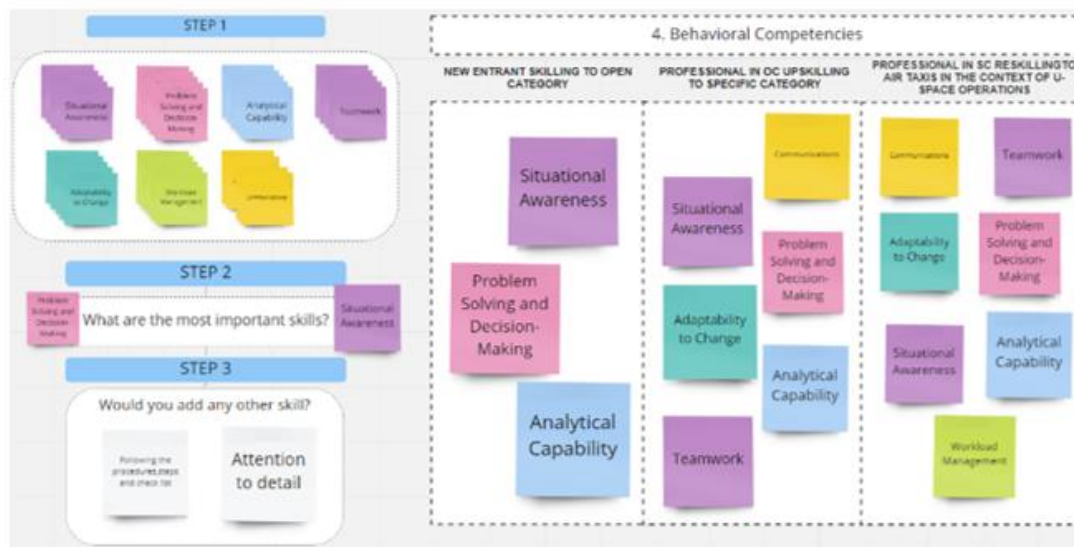


Figure 8. Behavioural Competencies topics (filled in).

Comparison with the initial design of Study Pathway

In this section, to make it more visible and clear we will present tables (Table 2, Table 3, Table 4) with the subjects and competencies considered in the Study Pathways in each profile and compare them to the opinions of the focus group participants.

Table 2. New Entrant Remote Pilot: Skilling.

New entrant Remote Pilot: Skilling			
	Study Pathway	Focus Group	
		Participants Selection	Other Topics
Theoretical Training	Regulation and Air Safety	Regulation and Air Safety	Maintenance
	UAS General Knowledge	UAS General Knowledge	
	Privacy and data protection	Privacy and data protection	
	Risk Assessment and Management	Risk Assessment and Management	
	Operational Procedures	Principles of Flight (including Weather)	
	Human Performance and Limitations	Aircraft Systems Air Law	
Practical Training	Real-flight training on operational UA	Real-flight training	Consideration for the industry/sector (added to the Real-flight training)
	Initial and Intermediate practical real-flight training on basic UA	Initial and Intermediate practical real-flight training on basic UA	
	Simulation Training		
Technical Skills	Application of Procedures	Application of Procedures	Most important: Application of Procedures; Assessment of operational scenario
	Assessment of operational scenario	Assessment of operational scenario	
	Risk assessment and safety-based judgment	Risk assessment and safety-based judgment	Distinguish of scenarios
	Hand-eye coordination & UA flight path control and management		
Behavioural Skills	Situational Awareness	Situational Awareness	Most important: Situational Awareness; Problem solving and Decision-making
	Problem solving and Decision-making	Problem solving and Decision-making	Detail-orientation
	Analytical Capability	Analytical Capability	Meticulousness
	Adaptability to Change		

Note: the green background in part of the table highlights overlaps between the original study pathways and the opinions of the focus group participants.

Table 3. Professional Remote Pilot in the Open Category Upskilling for Specific/Certified Category.

Professional Remote Pilot in the Open Category Upskilling for Specific/Certified Category			
	Study Pathway	Focus Group	
		Participants Selection	Other Topics
Theoretical Training	Performance	Performance	Maintenance
	Aircraft Systems	Aircraft Systems	
	UAS General Knowledge	UAS General Knowledge	
	Mass and Balance	Mass and Balance	
	Operational Procedures	Operational Procedures	
	Communications	Communications	
	Human Performance and Limitations	Human Performance and Limitations	Emergency Procedures
	Security, Privacy and data protection	Privacy and data protection	
		Security and Cybersecurity	
	Safety, Risk Assessment and management	Risk Assessment and Management	
	Air Law	Regulation and Air Safety	Knowledge about the area of intervention
	Principles of Flight		
	Navigation and Flight Planning		
	Weather		
Crew Resource Management / Multi-crew coordination			
Practical Training	Simulation Training	Initial and Intermediate practical real-flight training on basic UA	Consideration for the industry/sector (added to the Real-flight training)
	Real-flight training	Real-flight training	
Technical Skills	Application of Procedures	Application of Procedures	Most important: Application of Procedures; Assessment of operational scenario
	Assessment of operational scenario	Assessment of operational scenario	
	Risk assessment and safety-based judgment	Risk assessment and safety-based judgment	
	Operation of GCS, UA flight path control and management, automation	Operation of GCS, UA flight path control and management, automation	
		Hand-eye coordination & UA flight path control and management	Distinguish of scenarios
	Operation of UA and flight path control and management, manual, fly-by-wire		
Behavioural Skills	Situational Awareness	Situational Awareness	Most important: Situational Awareness; Problem solving and Decision-making
	Problem solving and Decision-making	Problem solving and Decision-making	Detail-orientation
	Teamwork	Teamwork	Meticulousness
	Communications	Communications	
	Workload Management	Analytical Capability	
		Adaptability to Change	

Note: the green background in part of the table highlights overlaps between the original study pathways and the opinions of the focus group participants.

Table 4. Professional Remote in the specific category reskilling to fly optionally piloted aircraft/air taxis in the context of U-space operations.

Professional Remote in the specific category reskilling to fly optionally piloted aircraft / air taxis in the context of U-space operations			
	Study Pathway	Focus Group	
		Participants Selection	Other Topics
Theoretical Training	Performance	Performance	Emergency Procedures
	Aircraft Systems	Aircraft Systems	
	UAS General Knowledge	UAS General Knowledge	
	Mass and Balance	Mass and Balance	
	Operational Procedures	Operational Procedures	
	Communications	Communications	
	Human Performance and Limitations	Human Performance and Limitations	Maintenance
	Security, Privacy and data protection	Privacy and data protection Security and Cybersecurity	
	Crew Resource Management / Multi-crew coordination	Crew Resource Management/Multi Crew Coordination	
	Safety, Risk Assessment and management	Risk Assessment and Management	
	Principles of Flight	Regulation and Air Safety	
	Weather		
	Navigation and Flight Planning		
	Air Law		
Practical Training	Simulation Training	Simulation Training	Consideration for the industry/sector (added to the Real-flight training)
	Real-flight training on basic UA	Real-flight training	
Technical Skills	Operation of UA and flight path control and management, manual, fly-by-wire	Operation of UA and flight path control and management, manual, fly-by-wire	Most important: Application of Procedures; Assessment of operational scenario
	Operation of GCS, UA flight path control and management, automation	Operation of GCS, UA flight path control and management, automation	
	Application of Procedures	Application of Procedures	
	Assessment of operational scenario	Assessment of operational scenario	Distinguish of scenarios
	Risk assessment and safety-based judgment	Risk assessment and safety-based judgment Hand-eye coordination & UA flight path control and management	
Behavioural Skills	Situational Awareness	Situational Awareness	Most important: Situational Awareness; Problem solving and Decision-making
	Analytical Capability	Analytical Capability	Detail-orientation
	Problem solving and Decision-making	Problem solving and Decision-making	Meticulousness
	Workload Management	Workload Management	
	Communications	Communications	
		Adaptability to Change	
	Teamwork		

Note: the green background in part of the table highlights overlaps between the original study pathways and the opinions of the focus group participants.

Final Conclusions

This exercise had the main goal to validate the study pathways for the RPAS pilots. In comparison with the initial design of the study pathway the following conclusions have been taken:

- The Upskilling profile was the one where there were more differences between the initial design of the study pathway and the participants' view.
- Contrary to the initial design of the study pathway, the participants considered that in this profile it was necessary to have these topics/competencies: “*Regulation and Air Safety*” (Theoretical Training); “*Initial and Intermediate practical real-flight training on basic UA*” (Practical training); “*Hand-eye coordination & UA flight path control and management*” and “*Operation of UA and flight path control and management, manual, fly-by-wire*” (Technical Skills); “*Analytical Capability*” and “*Adaptability to Change*” (Behavioural Skills)
- Overall, the design of the study pathway and the opinion of the two participants were mostly in accordance.

2.1.5 UNIMALTA’s validation activities

The University of Malta was tasked with the validation of the study pathways by which an individual can take up the role of a ground pilot within a Single Pilot Operation (SPO) context. Two types of individuals were considered: a new entrant assumed to have had no prior flying experience and/or qualifications and an experienced professional pilot whose role would change to that of a ground pilot.

Methodology

Personnel involved in commercial aviation and pilot training were invited to participate in a focus group. The focus group was held online and a collaborative whiteboard platform (miro) was used to aid in the validation of the study pathways. Two participants, both with years of experience in commercial aviation and training, took part in the focus group.

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The participants were first presented with a summary of the project leading up to the design of the study pathways, without revealing any details of the study pathways themselves. They were then asked to complete several tasks on the collaborative whiteboard. After each task, a discussion with the moderators took place during which the designed study pathways were presented. The participants were thus able to comment on the proposed study pathways and review as necessary.

Observations and discussions

During the design of the study pathways, the theoretical subjects that currently form part of pilot training were considered. Thus, in the first task, the participants were asked to select the subjects which they felt were still required to form part of the ground pilot study pathway. The results can be seen in the top part of Figure 9. Both participants immediately highlighted that probably all of the subjects would be beneficial. In fact, all subjects were selected by at least one participant. This observation was similarly raised during the design of the study pathways. During the subsequent discussion, the participants gave their views about the subjects and how they may be adapted to better suit the needs of the ground pilot role. One of the participants mentioned that *Radio Navigation* will probably become obsolete as a subject due to the advances and changes in technology related to navigation. The participant pointed out that navigation is already mostly satellite-based and that in the future this will be the main navigation method. As such, the subject of *Radio Navigation* - in its current form - will no longer be required, and should therefore be adapted to cover the newer methods of navigation.

The same participant also had reservations regarding the inclusion of the subject *VFR/IFR Communication*, stating that this would largely depend on whether voice communication would still be the primary means of communication. The participant explained that traditional voice communication is already being replaced by other means and it was also expected that, in a future SPO scenario, technology would have advanced to a point where it probably would not be required.

The participant also explained that, in such a scenario, the concept of VFR and IFR itself will likely become obsolete.

In the second task, the participants were asked to list any additional subjects which they deemed as necessary for the ground pilot role. The results can be seen in the bottom part of Figure 9. On *decision making* the participants explained that, since the ground pilot will not be physically present on board the aircraft, the latter's effect on the decision making of the ground pilot must be emphasized. When physically present on board the aircraft, the element of self-preservation in adverse conditions influences decision making. This will not be the case for the ground pilot and thus, one must be aware of the possibility of unintentionally taking decisions which result in a greater risk. The participants agreed that this may actually be an added learning objective within a human factors related subject.

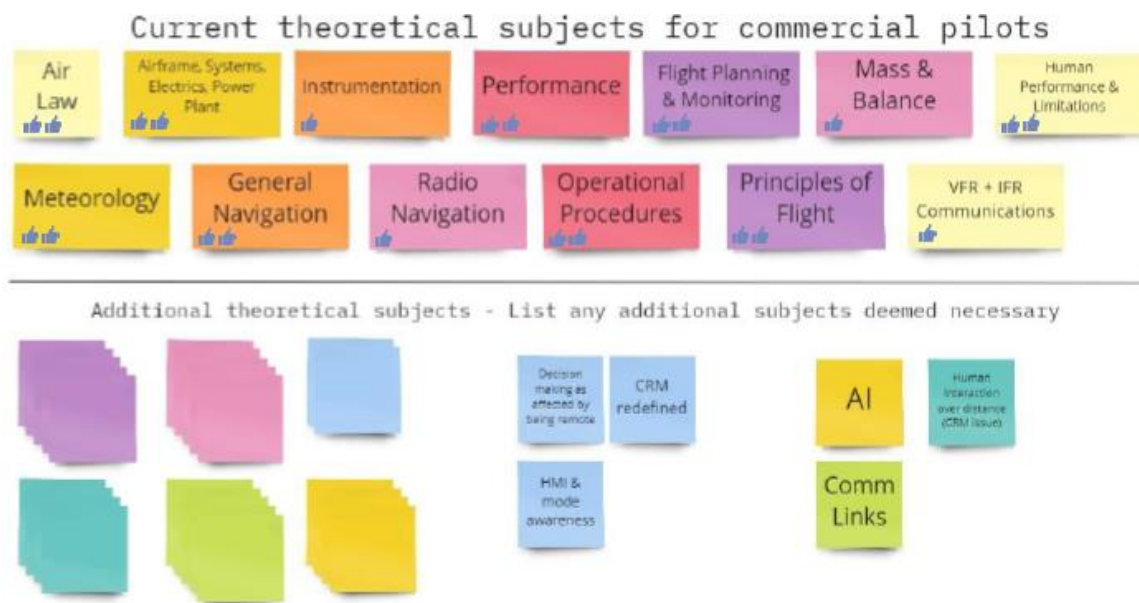


Figure 9. Theoretical training.

Crew Resource Management (CRM) was also mentioned by both participants, with one participant naming the subject as *CRM redefined*, in the sense that the traditional CRM topics must be catered specifically for the ground pilot role and the different environment which one would be working in. The other participant emphasized that the different types of human interaction between the two crew members (i.e. the single pilot on board and the ground pilot) must also be taken into consideration. Both participants agreed that, as with *decision making*, *CRM redefined* is a human factors related subject and can therefore be incorporated within existing related subjects.

The participants also explained that a ground pilot would be required to have a solid understanding of *Human-Machine Interface* and *Mode Awareness*. They stressed that the ground pilot is assumed to be obtaining all the information on the flight through the interaction with a machine, and must therefore be able to understand and comprehend the situation through this information only. Once again, the participants agreed that it is yet another human factors related topic and that, therefore, a solid understanding of human factors, adapted specifically for the ground pilot role, is required. The participants also mentioned that some knowledge on *Artificial Intelligence (AI)* may also be required.

The participants were then shown a list of theoretical topics which had been included in the first design of the study pathway. On *Cybersecurity*, they agreed that a basic knowledge leading to the understanding of cybersecurity-related threats may be beneficial. On *Intervention Training*, the participants explained that this is definitely a CRM issue, and the challenges related to authority gradient between the single pilot on board and the ground pilot must be understood.

The focus then shifted onto practical training. The participants were asked to list practical training topics and scenarios and to state whether such training should be done by new entrant ground pilots only, by pilots with previous flying experience only, or by both. The results can be seen in Figure 10. Both participants agreed that *3D Spatial Awareness* is very important, mostly for the new

entrant ground pilot with no prior flying experience. Furthermore, the new entrant ground pilot must also be exposed to the flight deck environment during training. A discussion ensued on whether exposure to real flight is important or whether simulator sessions would suffice. The participants agreed that some exposure to real flight may be essential but ultimately agreed that simulator sessions would also serve to train the ground pilot to gain 3D spatial awareness.

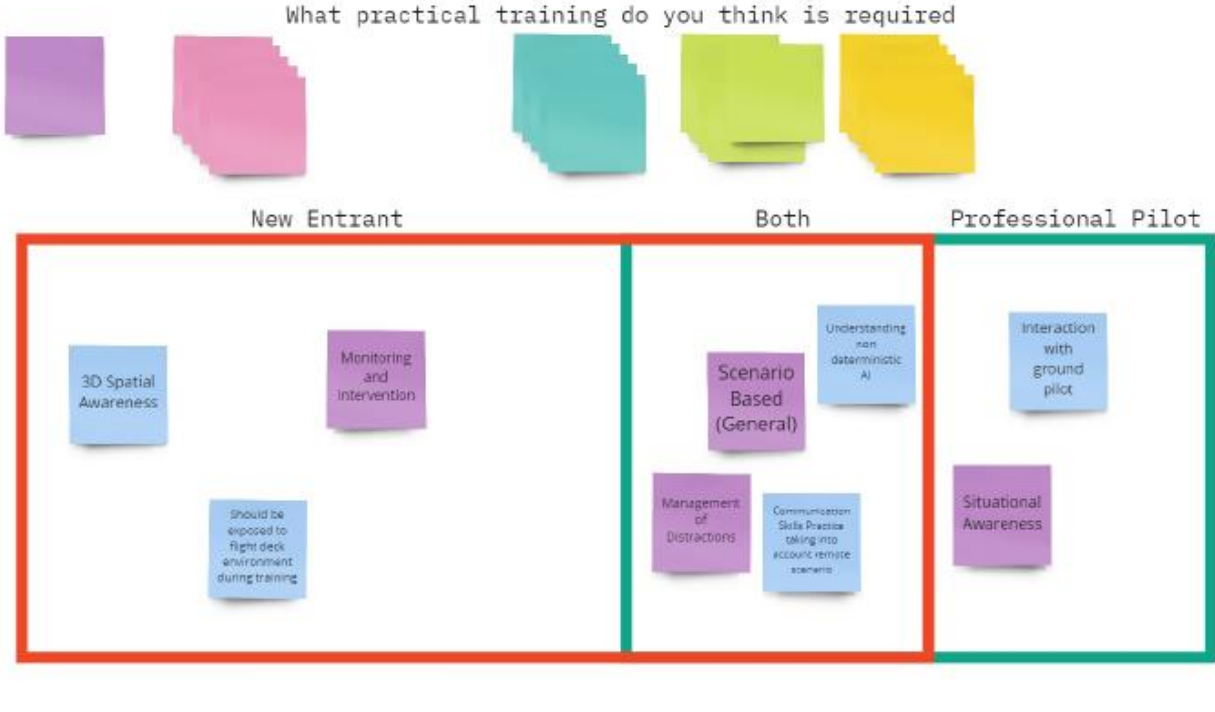


Figure 10. Practical training.

One of the participants suggested that the importance of understanding non-deterministic AI should also be emphasized during practical training. Whilst this can also be explained during theoretical training, practical training should also include scenarios which show the trainee that, as opposed to traditional systems, the input into an AI system may not necessarily lead to a known or expected outcome. An AI system behaves differently, and these differences must be experienced during practical training sessions. Both participants agreed that, for both new entrants and experienced individuals, scenario-based training is essential.

The participants were then shown a list of practical topics which had been included in the first design of the study pathway. On *VFR & IFR Radio Telephony Training* the participants argued similarly to the case on theoretical training. They claimed that, in view of the fact that future technology may render traditional radio communications obsolete, trainees need not undergo specific radio telephone (RT) training. Furthermore, the participants agreed that the practical training topics they had listed (in Figure 10) may be put under the *Advanced/Type specific ground pilot training* defined in the study pathways.

The final task in the validation exercise concerned technical and behavioural skills in relation to the ICAO defined core competencies. The participants were asked to consider each of these competencies and sort them out according to whether each competency is more important for the new entrant ground pilot or for an experienced pilot, or for both. The results are shown in Figure 11. Both participants agreed that in general, all competencies are important for both. However, it is assumed that the experienced pilot is expected to be already very proficient in all these competencies. As such, it is the new entrant ground pilot who will likely require more emphasis on these competencies during training. This can be clearly seen in Figure 11. The participants were also asked to pick the most important competencies for both the new entrant and the experienced pilot. Both participants agreed that for the new entrant, the top competency would be *Application of procedures*, followed by *Communication, Decision Making & Problem Solving* and *Leadership & Teamwork*. For the experienced pilot, *Workload Management* would be the most important competency.

The participants were finally asked to come up with any further competencies which they deem as necessary for the role of the ground pilot, in view of the fact that the ICAO core competencies were designed with an onboard pilot in mind. The participants stated that, since it is expected that AI will play a significant role in future single-pilot operations scenarios, competencies related to AI will be a necessity, both for the new entrant ground pilot and the experienced pilot.

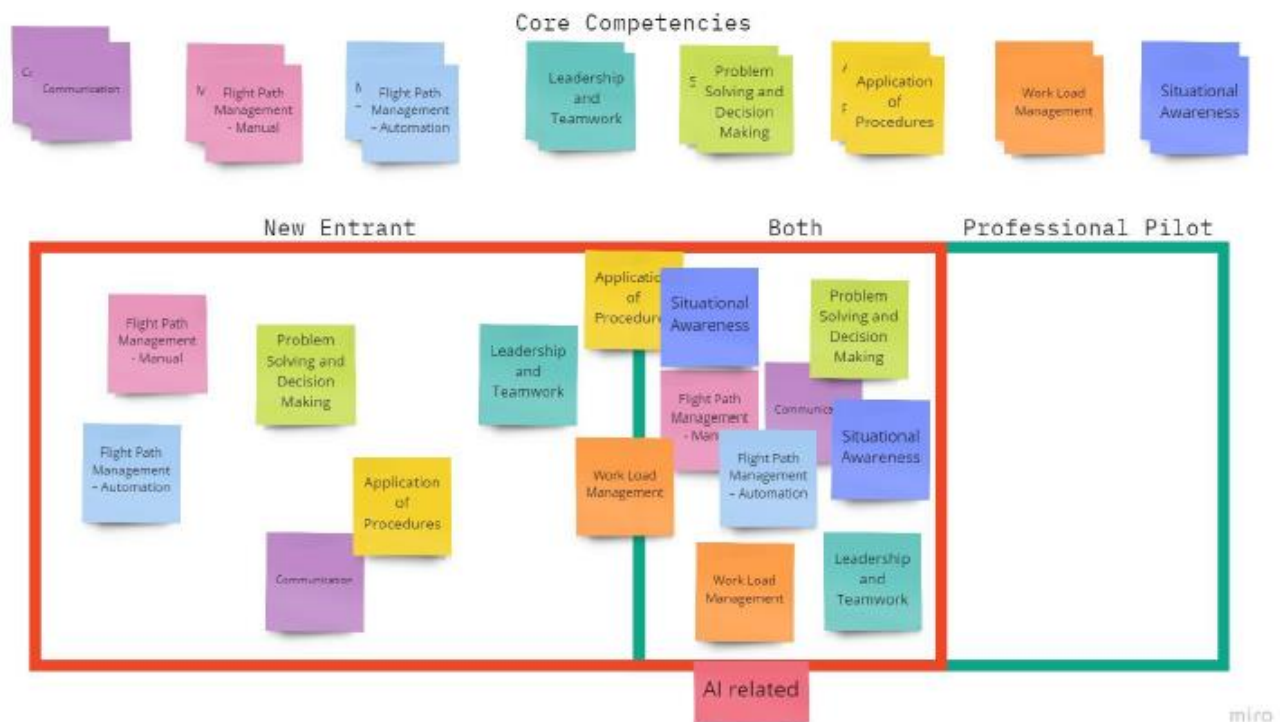


Figure 11. Core competencies.

Conclusions

This exercise was intended to validate the study pathways for the role of the ground pilot. In comparison to the initial design of the study pathways, the following conclusions were reached:

- In general, all current theoretical subjects required by pilots can be included in the study pathway for ground pilots, with the following exceptions:
 - *Radio Navigation* may not be required as a topic but may be adapted to cover navigation technologies in use in a future single-pilot operations scenarios;
 - *VFR/IFR Communication* would probably be unnecessary since it is highly probable that traditional voice communication will no longer be required.
- Additional human factors related topics may be considered to take into consideration the specific environment in which a ground pilot will operate within a single-pilot operations scenario, specifically:
 - *Decision making*;
 - *Crew Resource Management* (including *Intervention Training* focusing on the authority gradient in this specific environment;
 - *HMI & mode awareness*;
 - *Artificial Intelligence*.
- *Cybersecurity* can be limited to raising awareness on possible related threats.
- On practical training, *Radio Telephony* training would probably not be required for reasons outlined previously.
- Practical training should be scenario-based and, more importantly for new entrants, focus a lot on *3D spatial awareness*.
- Practical training should also take AI into consideration, as this may be an integral part of the SPO environment.
- New entrants require exposure to the flight deck environment which can be achieved through:
 - Exposure to real flights;
 - Simulated scenarios in a flight simulator.

- In addition to the ICAO core competencies, both new entrants and experienced pilots should also receive training to improve their proficiency in AI-related issues.

2.2 Implications regarding training modules

As a result of the validation of study pathways, the project partners decided to design the following training modules (see Figure 12):

- Transversal training modules:
 - Problem solving and decision making (QSR)
 - Artificial Intelligence and Machine Learning for aviation applications (University of Malta)
 - Deepening of situation awareness (ENAC)
- Specific training modules:
 - For RPAS operators (QSR): workload management and stress management
 - For ATCOs (Deep Blue): change adaptability and stress management
 - For airport operators (ESTU-KU): change management for automation and emerging technologies
 - For pilots (ENAC): learning and practice of new aircraft procedures

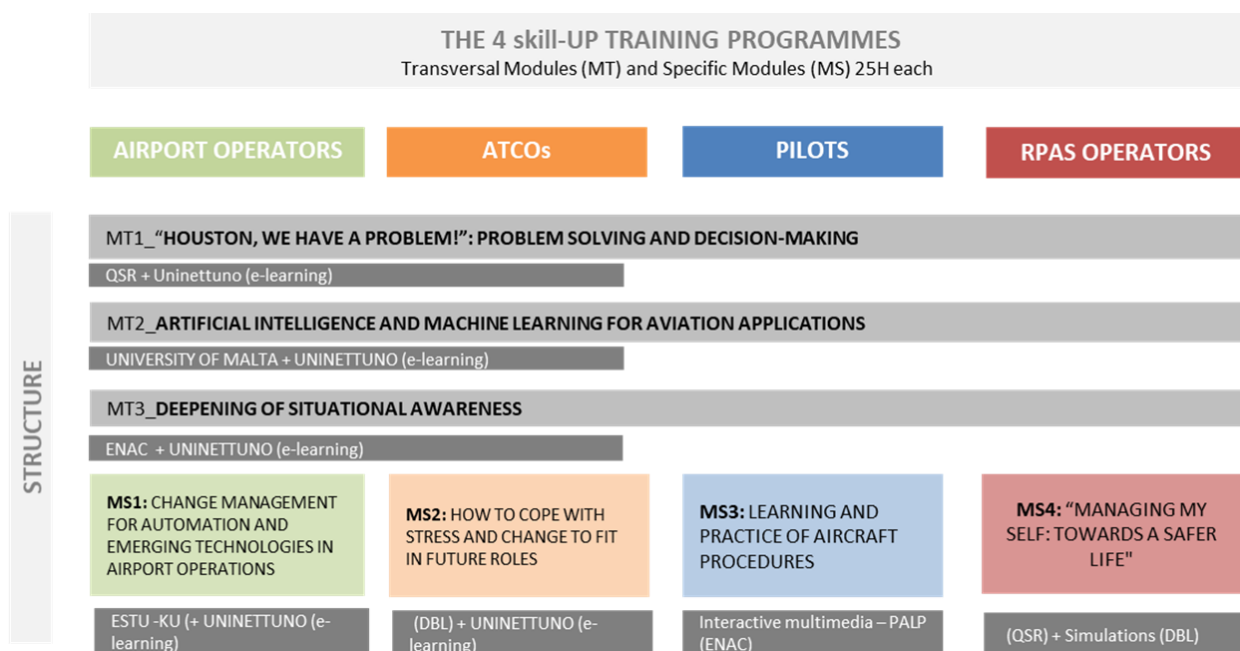


Figure 12. The 4 skill-UP training programmes.

In sum, seven training modules will be developed, three transversal and four specific modules, one for each target group (Airport operators, ATCOs, Pilots and RPAS operators). They will consist of blended synchronous and asynchronous lessons, available on the skill-UP e-learning platform (WP5). The next section describes the learning objectives and the content of each training module.

3 Description of VET training portfolio

The detailed descriptions of the training modules are listed in Appendix 2. The next subsections describe the design methodology used and provide a short description of the scope and general learning objectives of each module.

3.1 Training modules common design template

Each designer of a training module had to fill in a common design template in order to describe the content of each training module (see Figure 13). The following information was provided in each template:

- Type of training module
- Target audience
- Module title
- Short abstract describing the scope of the module
- General learning objectives: what the learner will be able to do at the end of the training module
- Pre-requisite knowledge: prior knowledge that is necessary to understand the training module
- Sequence of learning tasks: a learning task is associated to a specific learning objective, and the sequencing of the learning tasks will enable to reach the general learning objectives
- For each learning task:
 - Training topic
 - Type of knowledge targeted
 - Specific learning objective
 - Instructional method
 - Group size
 - Delivery mode
 - Any additional comment

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More details on the points listed above are given in D3.1. All the templates filled in with the complete information are available in Appendix 2.

Please fill in the blanks (light blue cells). You'll find more explanations and details about Learning Objectives, Types of Knowledge and Instructional methods in the "Explanation" sheet.							
Type of training module		Target audience		Training module designer		Module Title	
Short abstract describing the scope of the module							
General learning objectives	At the end of the training module, the learner will be able to...						
						
						
						
<i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i>							
Prerequisite knowledge						
						
						
Sequence of learning tasks	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Comments (if needed)
1 Learning task 1							
2 Learning task 2							
3 Learning task 3							
4 Learning task 4							
5 Learning task 5							
6 Learning task 6							
7 Learning task 7							
8 Learning task 8							
9 Learning task 9							
10 Learning task 10							
11 Learning task 11							
12 Learning task 12							

Figure 13. Empty template that had to be filled by partners in order to describe the training modules.

3.2 Skill-UP Transversal modules

3.2.1 Problem solving and decision making (QSR)

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This transversal training module, designed for the four aeronautical professional profiles targeted in the skill-UP project (pilots, air traffic controllers, RPAS operators and check-in agents), will develop the trainees' problem-solving and decision-making skills.

At the end of the training module, the learner will be able to:

- Understand how problem solving and decision making interrelate
- Understand different strategies of problem solving and decision-making
- Apply in daily life problem solving and decision-making tools

For this training module the following learning tasks will be designed:

- **Problem solving and decision-making, aren't they the same?** - in this learning task the trainees will be able to understand the concepts of problem-solving and decision-making, and also how they differ but also interrelate
- **What's my problem? Time to solve it!** - in this learning task the trainees will be able to recognise a problem and understand how to solve it
- **I made a decision! Oh, wait...maybe not?** - in this learning task the trainees will be able to understand the process of decision-making
- **I have 99 problems, and 100 ways to make a decision** - in this learning task the trainees will be able to distinguish ways to solve a problem and tools to make a decision

3.2.2 Artificial intelligence and Machine Learning for Aviation Applications (University of Malta)

This transversal course gives an introduction to Artificial Intelligence (AI) and Machine Learning (ML) and is intended for aviation professionals (including pilots, air traffic controllers, drone operators, and airport operators) of all levels who would like to get a basic understanding of AI/ML and who would like to explore some of the challenges associated with AI/ML and their application to the aviation industry.

At the end of the training module, the learner will be able to:

- Understand basic AI and ML concepts
- Understand the differences between supervised, unsupervised and reinforcement learning
- Understand and analyse commonly used AI/ML algorithms
- Understand and give examples of applications of AI/ML in different areas of the aviation industry
- Understand the human factor challenges associated with AI
- Understand the key challenges associated with the certification of AI systems for aviation applications
- Analyse and identify future AI trends and applications in the aviation sector
- Evaluate the impact of an AI/ML system on human behaviour and human-machine interaction
- Evaluate and select appropriate AI/ML techniques and algorithms to solve simple real-world problems

Several learning tasks will be designed to address the following topics:

- Basic AI/ML concepts and terminology
- History of AI/ML and current applications
- Types of ML
- Basic AI/ML techniques & algorithms
- Current, emerging and future AI applications in aviation
- Certification of AI
- Human factor implications of AI

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3.2.3 Deepening of situation awareness (ENAC)

This transversal module will enable trainees to have a deep understanding of the concept of situational awareness. In particular, they will practice their self-assessment of their situational awareness.

At the end of the training module, the learner will be able to:

- Understand the concept of situational awareness
- Apply the concept of situational awareness to his/her real-world situations
- Evaluate his/her self-assessment of situation awareness

Several learning tasks will be designed and address following topics:

- Fundamentals of situation awareness: theory and measurement
- Human perception
- Mental models
- Visual scanning training
- Meta-cognition and self-assessment
- Practice of situation awareness self-assessment
- Self-assessment of situation awareness

3.3 Skill-UP Specific modules

3.3.1 For RPAS operators (QSR): workload management and stress management

This specific module will develop the RPAS trainees' safety-based judgement skill as a whole, with a particular focus on workload management and stress management.

At the end of the training module, the learner will be able to:

- Understand workload and stress management concepts and their role to a safer work-life balance
- Understand different strategies of workload and stress management
- Apply in daily life workload and stress management tools

For this training module the following learning tasks will be designed:

- **Workload and Stress Management: Why do I need them to be safe?** - in this learning task the trainees will be able to understand the concepts of workload management and stress management
- **So much to do, and so little time: How to manage my work** - in this learning task the trainees will be able to understand and implement strategies for workload management
- **Feeling Stressed: Why, when and how to cope with it** - in this learning task the trainees will be able to understand the basic stress triggers, signs and coping strategies

3.3.2 For ATCOs (Deep Blue): change adaptability and stress management

This training module is titled "How to cope with stress and change to fit in future roles". It is specifically targeted to Tower Air Traffic Controllers that will face the transition from real to remote tower operation for air traffic control.

The training will enable trainees to be aware of how they deal with change and stress when the environment requires them to fit in new roles. The participants will learn about stress and change mechanisms and will receive tools for self-empowerment. At the end of the training module, they will be able to:

- Understand the mechanisms of stress and reactions to change
- Analyse their natural tendencies in coping with stress and change
- Understand the different coping strategies in dealing with new and difficult situations

The module addresses tower controllers to be reskilled into rTower controllers, so it refers to the reskilling persona as shown in Figure 14.

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Figure 14. Reskilling of a professional Tower ATCO into rTower Controller.

The course meets the need to support the transition from current airport operational scenarios to new remote scenarios, with air traffic control provided remotely. Therefore, it is intended to complement the wide reskilling process able to enhance the internal resources of the air navigation service provider: a win-win process, which ensures professional growth, optimization of human resources, and scalability of production processes.

The competences addressed are non-technical skills, such as the ability to cope with stress and the ability to adapt to change, deemed necessary for the reskilling of air traffic controllers (in line with the results of the Skill-UP survey). In fact, in the survey we asked the air traffic controllers to indicate what are the top 3 skills which are most likely to become very important in the future of air transport according to their opinion. Adaptability was the most mentioned skill, as shown in Figure 15.

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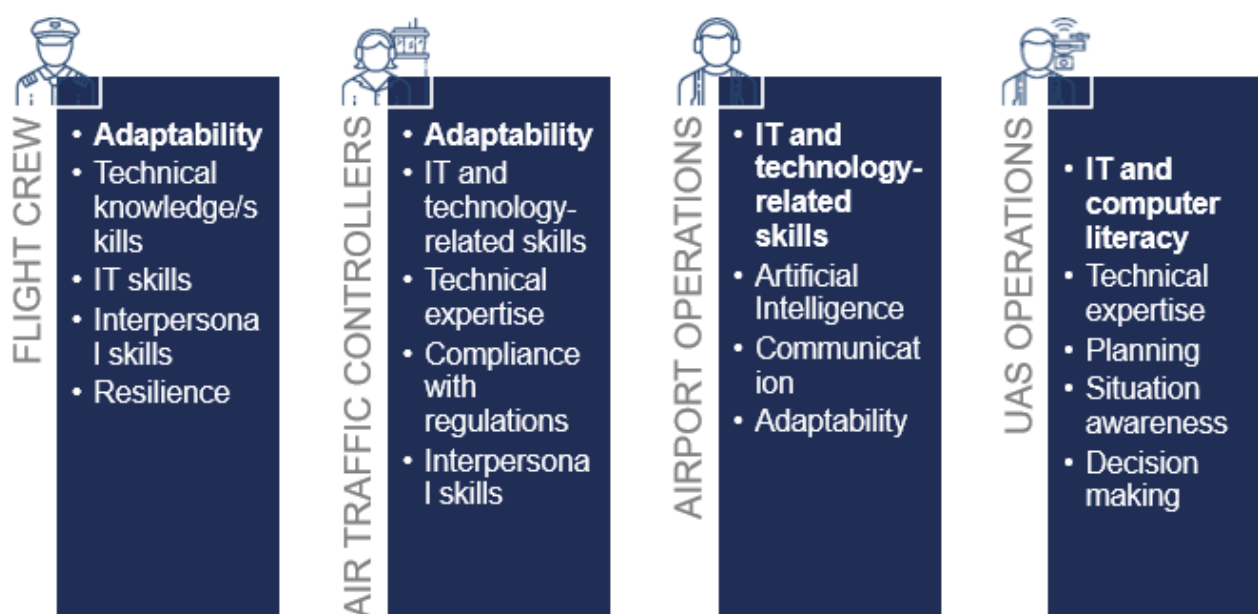


Figure 15. Most important skills in the future of air transport.

Apart from identifying the most in-demand knowledge and skills in the near future, the respondents of the survey and interviews were asked whether the importance of different competency areas will

change. As can be observed, adaptability, IT/computer literacy and technical expertise are three competency areas whose importance is most likely to increase for three of the groups of VET users, as depicted in Figure 16.

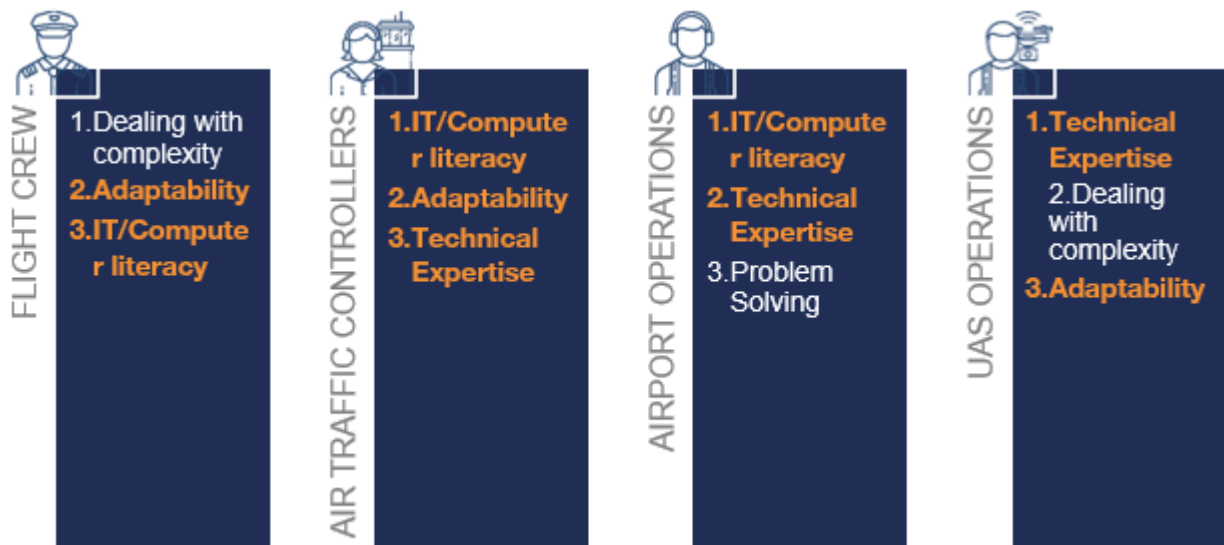


Figure 16. Competency areas whose importance is most likely to increase.

Such results fed the development of the Personas and associated study pathways. The validation of the study pathways confirmed the relevance of the proposed topics.

The module is broken down into 9 learning tasks. The learning tasks from 1 to 7 address stress, as follows:

- The learning task 1 will be asynchronous. In this task, the participants will learn how the stress mechanism works, what are their personal contributing factors (stressors) and the areas of impact (emotional, physical and behavioural).
- The learning task 2 will be synchronous. In this task, the participants will learn the stressors and they will be asked to self-assess their own in the current situation.
- The learning task 3 will be asynchronous. In this task, the participants will understand and apply the criteria of optimism and Locus of control to the stress management.
- The learning task 4 will be synchronous. In this task, the participants will learn how to apply the "circles of control" techniques to their personal situation. This tool will enable the participants to have a better understanding of what they can change, what they can influence and what they need to accept in the situation they are living.
- The learning task 5 will be synchronous. In this task, the participants will learn what are the resources we can use to maximize our stress management. They will self-assess their present resources, the actual and the potential.
- The learning task 6 will be synchronous. In this task, the participants at the end of this session will know how to self-detect their emotional state using the mood meter tool. They will also be able to understand how their emotional reaction fits in a healthy and functional way with the specific situation they are living.
- The learning task 7 will be synchronous. In this task, the participants will understand the differentiation among short and long coping strategies, they will be able to correctly understand where to proactively apply the most effective one due to the situation.

Learning tasks from 8 to 9 address change management, as follows:

- The learning task 8 will be asynchronous. In this task, the participants will understand the journey we all do when facing critical changes at work. They will be able to recognise every stage of this path, understand what are the elements that will help them to progress and the ones that will make them regress on early stages of the change management.
- The learning task 9 will be synchronous. The goal of this session is to provide participants with a list of personality traits that have an impact on change management and they will self-assess themselves onto these dimensions to measure their readiness to change.

3.3.3 For airport operators (ESTU-KU): change management for automation and emerging technologies

This specific module will enable trainees to gain an in-depth understanding of the concept of change management which is related to automation and emerging technologies in airport operations. In particular, they will have an idea about the importance of change and adaptation as operators in today's and future aviation industry and how to manage within automation and emerging technologies.

Nine learning tasks will be designed and will address following training topics:

- Concept of change
- Reason and need for change
- Automation and new technologies
- Change planning
- Human factors in change management
- Resistance and resilience to change
- Constantly changing and unchanging in airport operations
- Performance for change management
- Adaptive/innovative solutions for changing environmental

At the end of the training module, the learner will be able to:

- Understand the concept of change management
- Analyses reason for change
- Evaluate the need for change
- Explain automation and new technologies
- Describe change planning
- Analyses human factors in change management
- Understand resistance and resilience to change
- Evaluate constantly changing and unchanging in airport operations
- Evaluate the performance for change management
- Create adaptive/innovative solutions for changing environmental

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3.3.4 For pilots (ENAC): learning and practice of new aircraft procedures

This specific training module will enable pilot trainees to learn new aircraft procedures and train themselves autonomously. Indeed, it will provide an adaptive tool that facilitates the practice of the execution of the sequence of actions to be performed in the procedures and that provides feedback on the correctness of the execution. The objective is to train all the normal and emergency procedures that have to be known without the help of the procedures manual. This module has to be iterated for each procedure.

Four leaning tasks will be designed and address following training topics:

- Knowledge about aircraft controls
- Principles of actions ordering
- Procedure sequence
- Procedure practice

At the end of the training module, the learner will be able to:

- Remember the sequences of actions of X aircraft procedures
- Understand the principles that guide each procedure

4 Preliminary elements concerning pilot sessions

4.1 Skill-UP Transversal modules

4.1.1 Problem solving and decision making (QSR)

The VET course will be transversal; therefore, for the pilot sessions, QSR will seek to attract people from each of the four target groups of Skill-UP, with at least 3 professionals from each of the target groups. The participants will be recruited within the QSR network, which includes European Aerospace Cluster Partnership (EACP) and Portuguese Cluster for Aeronautics, Space and Defence (AED).

The pilot sessions of the course will be carried out using a combination of synchronous and asynchronous online learning activities. The synchronous moment will be used mainly to stimulate communication between the participants, and will be used to deliver dynamic activities. The rest of the course will then be delivered asynchronously (using recorded video lectures, etc.) to allow the students to complete the coursework at their own pace. All the learning moments will include assessment techniques, which will be coordinated with WP4.

4.1.2 Artificial Intelligence and Machine Learning for Aviation Applications (University of Malta)

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This VET course will be transversal; therefore, for the pilot sessions, the University of Malta will seek to attract people from each of the four target groups of Skill-UP, with at least 3 professionals from each of the target groups. In order to attract participants, the University of Malta will engage directly with key stakeholders in each of the target groups, including Air Malta, Malta International Airport and Malta Air Traffic Services Ltd. These stakeholders will be encouraged to promote the VET course to their employees.

The pilot sessions of the course will be carried out using a combination of synchronous and asynchronous online learning activities. Specifically, the first module/lesson will be delivered in a synchronous manner (over *Zoom* or a similar video-conferencing tool) in order to provide an opportunity for the instructors to introduce themselves and meet the students in real-time at the very beginning of the course. The rest of the course will then be delivered asynchronously (using recorded video lectures, etc.) to allow the students to complete the coursework at their own pace. The course will consist of four modules and will be delivered over a period of 4 weeks (1 module per week).

The students' understanding of the course content will be assessed using online discussions, self-assessment questionnaires, and a case study. Following the delivery of the pilot sessions, feedback will be obtained from the participants e.g. by means of an end-of-course evaluation questionnaire and a group discussion with the participants. These assessment activities will be coordinated with WP4.

4.1.3 Deepening of situation awareness (ENAC)

As this VET course is aimed to be transversal, the pilot sessions will be conducted with participants from the four target groups of Skill-UP with the target of 3 professionals from each target group. Participants will be recruited within ENAC network.

The pilot sessions of the course will be carried out using a combination of synchronous and asynchronous online learning activities. The asynchronous sessions will be used to deliver theoretical fundamentals and deepening of situation awareness. Participants will therefore be allowed to complete the coursework at their own pace. Two synchronous sessions will be organized in order to allow discussions around the practical component of the training module, namely the building and the use of a personal tool to self-assess one's own situation awareness.

4.2 Skill-UP Specific modules

4.2.1 For RPAS operators (QSR): workload management and stress management

The VET course will be specific; therefore, for the pilot sessions, QSR and APANT will seek to attract RPA operators, in order to have at least 6 professionals in the pilot session. The participants will be recruited within the QSR and APANT network, which includes European Aerospace Cluster Partnership (EACP) and Portuguese Cluster for Aeronautics, Space and Defence (AED).

The pilot sessions of the course will be carried out using a combination of synchronous and asynchronous online learning activities. The synchronous moment will be used mainly to stimulate communication between the participants, and will be used to deliver dynamic activities. The rest of the course will then be delivered asynchronously (using recorded video lectures, etc.) to allow the students to complete the coursework at their own pace. All the learning moments will include assessment techniques, which will be coordinated with WP4.

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4.2.2 For ATCOs (Deep Blue): change adaptability and stress management

This VET course will be specific for ATCOs; therefore, for the pilot sessions, Deep Blue will seek to engage directly with ANACNA, the Italian association of air traffic controllers, which is supporting the project with high value support and will be encouraged to promote the VET course to their associates.

Since the participants will be selected from the people working in the operation, the organization will be compliant with their schedule and we are planning to start in September 2022. The delivery will be asynchronous and synchronous. The training will not only provide presentations, but also enable participants to brainstorm and discuss case studies. Pre-training expectations and post-training evaluations will be taken from those who will attend the training. The training contents will be updated with the feedback received before and after the training.

Deep Blue is exploring the possibility to use the rTower simulator in the ENAV academy for learning tasks 8 and 9.

4.2.3 For airport operators (ESTU-KU): change management for automation and emerging technologies

ESTU plans to provide these trainings to 10 airport operators in cooperation with Fraport-TAV. This VET course will be specific. There are 9 modules in the training content. Each module is planned to take 25-30 minutes. Since the participants will be selected from the people working in the operation, the organization will be made by planning with them in hours in the training planning. Participants will be motivated for these training sessions. Pilot training will be asynchronous and synchronous. The training will not only provide presentations, but also enable participants to brainstorm and discuss case studies. Pre-training expectations and post-training evaluations will be taken from those who will attend the training. The training contents will be updated with the feedback received before and after the training.

4.2.4 For pilots (ENAC): learning and practice of new aircraft procedures

This VET course is specific for pilots, therefore, for the pilot sessions, ENAC will recruit pilot students. As this training module uses virtual reality to learn and practice aircraft procedures, pilot sessions will be delivered individually at ENAC research laboratory under the supervision of the virtual reality module designer. The pilot session will consist of the learning and practice of one specific procedure of A320. The training will be composed of a familiarization phase of the to be learnt procedure as well as of the virtual reality device.

In order to assess the efficiency of the training using this innovative device, ENAC aims to assess the quality of the learning in an A320 simulator the day after the training (accuracy and latency). A previous study (Matton et al., 2018) had been conducted with a similar method and compared traditional learning (with paper images of the cockpit and the procedure) with a tactile tool providing feedback. The idea is to compare results with the virtual reality tool to results with both traditional and tactile tool. In order to have robust results we aim at recruiting around 20 participants. This pilot session is planned to be conducted from March to June 2022.

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5 Conclusions and next steps

After the validation of the study pathways, seven training modules were designed, three transversal and four specific training modules (one for each target group: Airport operators, ATCOs, pilots and RPAS operators). The transversal training modules will cover following topics: (i) problem solving and decision making, (ii) artificial intelligence and machine learning for aviation applications and (iii) deepening of situation awareness. The specific training modules will cover following topics: (i) workload and stress management for RPAS operators, (ii) change adaptability and stress management for ATCOS, (iii) change managements for automation and emerging technologies and (iv) learning and practice of new aircraft procedures for pilots.

All contributors designed the training modules topics and general content with learning objectives and corresponding learning tasks. The next step will be the more detailed design of the training modules, specifically the content of the video lessons for the asynchronous parts of the training modules. All the training modules will be uploaded in the skill-UP e-learning platform that will be developed within WP5. After the finalization of the design of the training modules, each partner will organise pilot sessions in order to test their training modules (Task 3.4). Moreover, assessment procedures for each training module will be designed in the next work package (WP4).

6 References

- D1.1 *Skills, needs and future work scenarios: Air Sector Skills Transformation Map*, delivered in March 2021, responsible partner DEEP BLUE, skill-UP project deliverable.
- D2.1 *From theory to practice: Understanding user profiles and training needs*, delivered in December 2020, responsible partner University of Malta, skill-UP project deliverable.
- D2.2 *Study pathways: Skilling, Upskilling and Reskilling*, delivered in June 2021, responsible partner QSR, skill-UP project deliverable.
- D3.1 *VET training selection of methodologies for delivery: National quality assurance requirements for each country and guidelines for the design of training modules*, delivered in May 2021, responsible partner ENAC, skill-UP project deliverable.
- Matton, N., Vrignaud, C., Rouillard, Y., & Lemarié, J. (2018). Learning flight procedures by enacting and receiving feedback. *Applied Ergonomics*, 70, 253-259.

Appendices

Appendix 1 Validated study pathways

Single pilot study pathway: new entrant

NEW ENTRANT SINGLE PILOT: Skilling			
FORMAL TRAINING	Theoretical Training: Learning Courses and Instruction required to being ex. Pilot	Main Topic	Description of content
		Theoretical knowledge about the new automated systems specific of SPO	<ul style="list-style-type: none"> - Description of the functioning - logic - rules - failure modes - Context of utilization
		Theoretical knowledge about the systems of the new type of aircraft	<ul style="list-style-type: none"> - Description of the functioning - logic - rules - failure modes - Context of utilization
		Theoretical knowledge about the procedures related to the new type of aircraft	<ul style="list-style-type: none"> - Description of the procedures - Context of use - Prioritizing rules - Philosophy of use
		Theoretical knowledge of specific human factors issues	<ul style="list-style-type: none"> - Mode errors: when the pilot is not aware of the mode in which the automated system is functioning - Complacency and over-reliance: tendency to trust excessively automation - “Out of the loop” phenomenon: with reduction of situation awareness - “Clumsy” automation: when automation adds complexity to a task

		related to automation pitfalls		
		Theoretical knowledge about cabin crew and passenger management	<ul style="list-style-type: none"> - Cabin crew management - Passenger management - Company policies on abnormal procedures 	
		Theoretical knowledge of procedures of communication with the ground pilot	<ul style="list-style-type: none"> - Phraseology associated to communications between onboard pilot and ground pilot - Allocation of roles and responsibilities between onboard pilot and ground pilot 	
	Practical Training: All the hands-on training, which can include simulation, on-site training, supervision flying...	Main Topic	Description of content	
		Simulation training on the specific type of aircraft simulator	<ul style="list-style-type: none"> - Checklists for simulated flight and operations - Flight training preparation - Interaction with automated systems and ground pilot - Decision making - Situation awareness - Briefing and debriefing with ground pilot or instructor - Emergency simulation - Hand-eye coordination - Simulations of high workload situations 	
		Real flight training on the specific type of aircraft with supervisor on-board	<ul style="list-style-type: none"> - Operational procedures - Application of theoretical knowledge - Interaction with automated systems and ground pilot - Decision making - Situation awareness - Briefing and debriefing with ground pilot or instructor - Hand-eye coordination - Pre-flight preparation and inspection 	

			<ul style="list-style-type: none"> - Flight in abnormal conditions - Landing, missed approach <ul style="list-style-type: none"> - Ends with the “release” of the single pilot 				
	Real flight training on the specific type of aircraft with supervisor on ground		<ul style="list-style-type: none"> - Operational procedures - Application of theoretical knowledge - Interaction with automated systems and ground pilot - Decision making - Situation awareness - Briefing and debriefing with ground pilot or instructor - Hand-eye coordination - Pre-flight preparation and inspection - Flight in abnormal conditions - Landing, missed approach 				
COMPETENCES (Select 3 to 5 to each group)	Technical Skills: Considering the competences identified on the Persona, please fill in the theoretical and practical knowledge that the correct acquirement of the skill	Competence	Competence Description	Knowledge	Skill	Level	Preliminary Training Topics
		<i>EX: Name</i>	<i>Short competence description</i>	<i>The individual should have knowledge of...</i>	<i>With this skill someone should be capable of....</i>	<i>Beginner Intermediate Advanced</i>	<i>How to acquire the skill?</i>
		Aircraft Flight Path Management, manual control	Controls the aircraft flight path through manual flight,	- Systems functioning laws (including flight control laws: normal, abnormal, direct...)	Controls the aircraft manually with accuracy and smoothness as appropriate to the situation	Intermediate or advanced	Simulator and real flights with a focus on following training topics:

	<p>should induce</p>		<p>including appropriate use of flight management system(s) and flight guidance systems.</p>	<ul style="list-style-type: none"> - Breakdown modes and consequences - Interactions between systems - 	<p>Detects deviations from the desired aircraft trajectory and takes appropriate action</p> <p>Contains the aircraft within the normal flight envelope—</p> <p>Controls the aircraft safely using only the relationship between aircraft attitude, speed and thrust</p> <p>Manages the flight path to achieve optimum operational performance</p> <p>Maintains the desired flight path during manual flight whilst managing other tasks and distractions</p> <p>Selects appropriate level and mode of flight and guidance systems in a timely manner considering phase of flight and workload</p>		<ul style="list-style-type: none"> - Flight path monitoring - Human performance and limitations
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					Effectively monitors flight guidance systems including engagement and automatic mode transitions		
	Application of procedures	Identifies and applies procedures in accordance with published operating instructions and applicable regulations, using the appropriate knowledge.	<ul style="list-style-type: none"> - Pre-requisites to procedures - Level of priority of procedures - The logic/philosophy behind each procedure - Possibility to delegate the procedure to the ground pilot or to the system 	<p>Identifies the source of operating instructions</p> <p>Follows SOPs unless a higher degree of safety dictates an appropriate deviation</p> <p>Identifies and follows all operating instructions in a timely manner</p> <p>Correctly operates aircraft systems and associated equipment</p> <p>Complies with applicable regulations.</p> <p>Applies relevant procedural knowledge</p> <p>Always checks his/her actions (close-loop procedure)</p>	Intermediate or advanced	<p>Studying, learning and practising on dedicated computer assisted training, with a focus on following training topics:</p> <ul style="list-style-type: none"> - Operational procedures for ground pilots - Air law 	

		Application of knowledge related to AI and automated systems used in the single pilot aircraft	Knows how and when to trigger or disable automation	<ul style="list-style-type: none"> - the use, benefits and consequences of the automated systems and AI used in the single pilot aircraft - the limitations of AI and automation 	Use efficiently the automated systems and relieve his workload	Advanced	Studying and learning + simulator and real flight practice , with a focus on following training topics: <ul style="list-style-type: none"> - use of specific and AI automated systems - simulation of breakdown of specific AI and automated systems
		Competence	Competence Description	Knowledge	Skill	Level	Preliminary Training Topics
		Behavioral Skills: Considering the skills identified on the Persona, please fill in the theoretical and practical knowledge that the correct	EX: Name	Short competence description	The individual should have knowledge of...	With this skill someone should be capable of....	Beginner Intermediate Advanced
	Situation awareness	Perceives and comprehends all of the relevant information available and anticipates	<ul style="list-style-type: none"> - Theoretical model of situation awareness - Factors affecting situation awareness: workload, stress, "startle effect" .. 	Managing his/her activity and select adequate options (search of missing information or diverting to fall back decision)	Intermediate or advanced	Studying and learning with a focus on following training topics: <ul style="list-style-type: none"> - Human performance and limitations 	

	acquisition of the skill should induce		what could happen that may affect the operation.				- Flight path monitoring
	Problem Solving and Decision Making	Accurately identifies risks and resolves problems. Uses the appropriate decision-making processes.	- Theoretical models of decision making in complex situations (e.g., naturalistic decision making) - Consequences of workload, stress and fatigue on quality of decisions	Seeks accurate and adequate information from appropriate sources Identifies and verifies what and why things have gone wrong Employ(s) proper problem-solving strategies Perseveres in working through problems without reducing safety Uses appropriate and timely decision-making processes Sets priorities appropriately Identifies and considers 51 options effectively.	Intermediate or advanced	Studying and learning with a focus on following training topic: - Human performance and limitations	

	Leadership and teamwork	Demonstrates effective leadership and teamworking	<ul style="list-style-type: none"> - Roles and responsibilities of each member of the "team" composed of the single pilot, the ground pilot, the cabin crew, the air traffic controller 	<p>Understanding and agreeing with roles and objectives of each member of the system.</p> <p>Using initiatives and giving directions when required—</p> <p>Communicating relevant concerns and intentions</p> <p>Giving and receiving feedback constructively</p> <p>Engaging others in planning and allocating activities fairly and appropriately according to abilities</p>	Intermediate or advanced	<p>Studying and learning with a focus on following training topic:</p> <p>Human performance and limitations</p>
	Communication skills	Demonstrates effective oral, non-verbal and written communications, in normal and non-normal situations.	<ul style="list-style-type: none"> - Theoretical knowledge on communication with remote operators - Importance of context sharing - 	<p>Ensures the recipient is ready and able to receive the information</p> <p>Selects appropriately what, when, how and with whom to 52 communicate</p> <p>Conveys messages clearly, accurately and concisely</p> <p>Confirms that the recipient correctly</p>	Intermediate or advanced	<p>Role play, games, simulations and real-flights with a focus on following training topics:</p> <ul style="list-style-type: none"> - VFR and IFR communication <p>Human performance and limitations</p>

					<p>understands important information</p> <p>Listens actively and demonstrates understanding when receiving information</p> <p>Asks relevant and effective questions</p> <p>Adheres to standard radiotelephone phraseology and procedures</p> <p>Accurately reads and interprets required company and flight documentation</p> <p>Accurately reads, interprets, constructs and responds to datalink messages in English</p>		
	Workload Management	Manages available resources efficiently to prioritize and perform	<ul style="list-style-type: none"> - overload and underload management - fatigue and stress management 	<ul style="list-style-type: none"> - Maintaining self-control in all situations - Planning, prioritizing and 	Intermediate or advanced	<p>Simulations and/or games with a focus on following training topic:</p> <ul style="list-style-type: none"> - Human performance and limitations 	

			<p>tasks in a timely manner under all circumstances.</p>	<ul style="list-style-type: none"> - Threat and error management - Time management / planning - Multi-tasking strategies 	<ul style="list-style-type: none"> - scheduling tasks effectively - Managing time efficiently when carrying out tasks - Offering and accepting assistance and asking for help early - Reviewing, monitoring and cross-checking actions conscientiously - Verifying that tasks are completed to the expected outcome - Managing and recovering from interruptions, distractions, variations and failures effectively 		
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					- Performing all of the above for one or more aircraft with a single on-board pilot		
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Single pilot study pathway: reskilling

PROFESSIONAL COMMERCIAL PILOT: Reskilling to single pilot onboard			
FORMAL TRAINING	Theoretical Training: Courses and Instruction required to being ex. Pilot	Main Topic	Description of content
		Theoretical knowledge about the new automated systems specific of SPO	<ul style="list-style-type: none"> - Description of the functioning - logic - rules - failure modes - Context of utilization
		Theoretical knowledge about the systems of the new type of aircraft	<ul style="list-style-type: none"> - Description of the functioning - logic - rules - failure modes - Context of utilization
		Theoretical knowledge about the procedures related to the new type of aircraft	<ul style="list-style-type: none"> - Description of the procedures - Context of use - Prioritizing rules - Philosophy of use
		Theoretical knowledge of specific human factors issues	<ul style="list-style-type: none"> - Mode errors: when the pilot is not aware of the mode in which the automated system is functioning - Complacency and over-reliance: tendency to trust excessively automation - “Out of the loop” phenomenon: with reduction of situation awareness - “Clumsy” automation: when automation adds complexity to a task

		related to automation pitfalls	
		Theoretical knowledge of procedures of communication with the ground pilot	<ul style="list-style-type: none"> - Phraseology associated to communications between onboard pilot and ground pilot - Allocation of roles and responsibilities between onboard pilot and ground pilot
		Main Topic	Description of content
		Simulation training on the specific type of aircraft simulator	<ul style="list-style-type: none"> - Checklists for simulated flight and operations - Flight training preparation - Interaction with automated systems and ground pilot - Decision making - Situation awareness - Briefing and debriefing with ground pilot or instructor - Emergency simulation - Hand-eye coordination - Simulations of high workload situations
		Real flight training on the specific type of aircraft with supervisor on-board	<ul style="list-style-type: none"> - Operational procedures - Application of theoretical knowledge - Interaction with automated systems and ground pilot - Decision making - Situation awareness - Briefing and debriefing with ground pilot or instructor - Hand-eye coordination - Pre-flight preparation and inspection - Flight in abnormal conditions - Landing, missed approach
	Practical Training: All the hands-on training, which can include simulation, on-site training, supervision flying...		<ul style="list-style-type: none"> - Ends with the “release” of the single pilot

	Real flight training on the specific type of aircraft with supervisor on ground	<ul style="list-style-type: none"> - Operational procedures - Application of theoretical knowledge - Interaction with automated systems and ground pilot - Decision making - Situation awareness - Briefing and debriefing with ground pilot or instructor - Hand-eye coordination - Pre-flight preparation and inspection - Flight in abnormal conditions - Landing, missed approach 					
COMPETENCES (Select 3 to 5 to each group)	Technical Skills: Considering the competences identified on the Persona, please fill in the theoretical and practical knowledge that the correct acquirement of the skill	Competence	Competence Description	Knowledge	Skill	Level	Preliminary Training Topics
		<i>EX: Name</i>	<i>Short competence description</i>	<i>The individual should have knowledge of...</i>	<i>With this skill someone should be capable of....</i>	<i>Beginner Intermediate Advanced</i>	<i>How to acquire the skill?</i>
		Aircraft Flight Path Management, manual control	Controls the aircraft flight path through manual flight, including appropriate use	- Systems functioning laws (including flight laws: normal, abnormal, direct...)	Controls the aircraft manually with accuracy and smoothness as appropriate to the situation	Intermediate or advanced	Simulator and real flights with a focus on following training topics: - Flight path monitoring

	should induce		<p>of flight management system(s) and flight guidance systems.</p>	<ul style="list-style-type: none"> - Breakdown modes and consequences - Interactions between systems - 	<p>Detects deviations from the desired aircraft trajectory and takes appropriate action</p> <p>Contains the aircraft within the normal flight envelope—</p> <p>Controls the aircraft safely using only the relationship between aircraft attitude, speed and thrust</p> <p>Manages the flight path to achieve optimum operational performance</p> <p>Maintains the desired flight path during manual flight whilst managing other tasks and distractions</p> <p>Selects appropriate level and mode of flight guidance systems in a</p> <p>timely manner considering phase of flight and workload</p>		<ul style="list-style-type: none"> - Human performance and limitations

					Effectively monitors flight guidance systems including engagement and automatic mode transitions		
	Application of procedures	Identifies and applies procedures in accordance with published operating instructions and applicable regulations, using the appropriate knowledge.	<ul style="list-style-type: none"> - Pre-requisites to procedures - Level of priority of procedures - The logic/philosophy behind each procedure - Possibility to delegate the procedure to the ground pilot or to the system 	<p>Identifies the source of operating instructions</p> <p>Follows SOPs unless a higher degree of safety dictates an appropriate deviation</p> <p>Identifies and follows all operating instructions in a timely manner</p> <p>Correctly operates aircraft systems and associated equipment</p> <p>Complies with applicable regulations.</p> <p>Applies relevant procedural knowledge</p> <p>Always checks his/her actions (close-loop procedure)</p>	Intermediate or advanced	<p>Studying, learning and practising on dedicated computer assisted training, with a focus on following training topics:</p> <ul style="list-style-type: none"> - Operational procedures for ground pilots - Air law 	

	Specific AI and automation knowledge related to the automated systems used in the single pilot aircraft	Knows how and when to trigger or disable automation	<ul style="list-style-type: none"> - the use, benefits and consequences of the automated systems and AI used in the single pilot aircraft - the limitations of AI and automation 	Use efficiently the automated systems and relieve his workload	Advanced	<p>Studying and learning + simulator and real flight practice, with a focus on following training topics:</p> <ul style="list-style-type: none"> - use of specific and AI automated systems - simulation of breakdown of specific AI and automated systems
	Competence	Competence Description	Knowledge	Skill	Level	Preliminary Training Topics
	Behavioral Skills: Considering the skills identified on the Persona, please fill in the theoretical and practical knowledge that the correct	EX: Name	Short competence description	The individual should have knowledge of...	With this skill someone should be capable of....	Beginner Intermediate Advanced
	Situation awareness	Perceives and comprehends all of the relevant information available and anticipates	<ul style="list-style-type: none"> - Theoretical model of situation awareness - Factors affecting situation awareness: workload, stress.. 	Managing his/her activity and select adequate options (search of missing information or diverting to fall back decision)	Intermediate or advanced	<p>Studying and learning with a focus on following training topics:</p> <ul style="list-style-type: none"> - Human performance and limitations

	acquisition of the skill should induce		what could happen that may affect the operation.				- Flight path monitoring
	Problem Solving and Decision Making	Accurately identifies risks and resolves problems. Uses the appropriate decision-making processes.	- Theoretical models of decision making in complex situations (e.g., naturalistic decision making) - Consequences of workload, stress and fatigue on quality of decisions	Seeks accurate and adequate information from appropriate sources Identifies and verifies what and why things have gone wrong Employ(s) proper problem-solving strategies Perseveres in working through problems without reducing safety Uses appropriate and timely decision-making processes Sets priorities appropriately Identifies and considers options effectively.	Intermediate or advanced	Studying and learning with a focus on following training topic: - Human performance and limitations	

		<p>Communication skills</p>	<p>Demonstrates effective oral, non-verbal and written communications, in normal and non-normal situations.</p>	<ul style="list-style-type: none"> - Theoretical knowledge on communication with remote operators - Importance of context sharing - 	<p>Ensures the recipient is ready and able to receive the information</p> <p>Selects appropriately what, when, how and with whom to communicate</p> <p>Conveys messages clearly, accurately and concisely</p> <p>Confirms that the recipient correctly understands important information</p> <p>Listens actively and demonstrates understanding when receiving information</p> <p>Asks relevant and effective questions</p> <p>Adheres to standard radiotelephone phraseology and procedures</p> <p>Accurately reads and interprets required company and flight documentation</p>	<p>Intermediate or advanced</p>	<p>Role play, games, simulations and real-flights with a focus on following training topics:</p> <ul style="list-style-type: none"> - VFR and IFR communication <p>Human performance and limitations</p>
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					Accurately reads, interprets, constructs and responds to datalink messages in English		
	Workload Management	Manages available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances.	<ul style="list-style-type: none"> - Aviation psychology (human overload and underload, fatigue and stress management, etc.) - Threat and error management - Time management / planning - Multi-tasking strategies 	<ul style="list-style-type: none"> - Maintaining self-control in all situations - Planning, prioritizing and scheduling tasks effectively - Managing time efficiently when carrying out tasks - Offering and accepting assistance and asking for help early - Reviewing, monitoring and cross-checking actions conscientiously 	Intermediate or advanced	<p>Simulations and/or games with a focus on following training topic:</p> <ul style="list-style-type: none"> - Human performance and limitations 	

					<ul style="list-style-type: none"> - Verifying that tasks are completed to the expected outcome - Managing and recovering from interruptions, distractions, variations and failures effectively - Performing all of the above for one or more aircraft with a single on-board pilot 		
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Appendix 2 Descriptions of training modules

Transversal module, ENAC

Type of training module	Transversal	Target audience	All (transversal)	Training module designer	ENAC	Module Title	Deepening of situational awareness
Short abstract describing the scope of the module	This transversal module will enable trainees to have a deep understanding of the concept of situational awareness. In particular they will practice their self-assessment of their situational awareness.						
General learning objectives	<p style="text-align: center;">At the end of the training module, the learner will be able to...</p> <ul style="list-style-type: none"> - understand the concept of situational awareness - apply the concept of situational awareness to his/her real-world situations - evaluate his/her self assessment of situation awareness <p><i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i></p>						
Prerequisite knowledge	- no prerequisite knowledge is required						
Sequence of learning tasks	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Comments (if needed)
Learning task 1	situation awareness	factual and conceptual	reproduce Endsley's model	lecture	Large group	online asynchronous	
Learning task 2	human perception	factual and conceptual	explain top-down and bottom-up	lecture	Large group	online asynchronous	
Learning task 3	mental models	factual and conceptual	give examples of mental models	lecture	Large group	online asynchronous	
Learning task 4	visual scanning training	factual	cite one study using visual scanning	lecture	Large group	online asynchronous	
Learning task 5	meta-cognition and self-assessment	factual	cite basics of meta-cognition and self-assessment	lecture	Large group	online asynchronous	
Learning task 6	practice of SA self-assessment	meta-cognitive knowledge	assess adequately one's own SA	simulation	Large group	online asynchronous	
Learning task 7	self-assessment of SA	meta-cognitive knowledge	build a personal grid to assess SA	discussion	Small group	online synchronous	discussions with the trainer
Learning task 8	practice of SA self-assessment	meta-cognitive knowledge	use the personal grid	on-the-job-training	Large group	online asynchronous	done while back to their job position
Learning task 9	self-assessment of SA	meta-cognitive knowledge	evaluate personal grid	discussion	Small group	online synchronous	discussions with the trainer

Transversal module, UNIMALTA

Type of training module	Transversal	Target audience	All (transversal)	Training module designer	University of Malta	Module Title	Artificial Intelligence and Machine Learning for Aviation Applications
Short abstract describing the scope of the module	This course gives an introduction to Artificial Intelligence (AI) and Machine Learning (ML) and is intended for aviation professionals (including pilots, air traffic controllers, drone operators, and airport operators) of all levels who would like to get a basic understanding of AI/ML systems and who would like to explore some of the challenges associated with AI/ML and their application to the aviation industry.						
	At the end of the training module, the learner will be able to...						
General learning objectives	Understand basic AI and ML concepts Understand the differences between supervised, unsupervised and reinforcement learning Understand and analyse commonly used AI/ML algorithms Understand and give examples of applications of AI/ML in different areas of the aviation industry Understand the human factor challenges associated with AI Understand the key challenges associated with the certification of AI systems for aviation applications Analyse and identify future AI trends and applications in the aviation sector Evaluate the impact of an AI/ML system on human behaviour and human-machine interaction Evaluate and select appropriate AI/ML techniques and algorithms to solve simple real-world problems						
	<i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i>						
						67	
Prerequisite knowledge	Required: None Desirable: - Operational understanding of one of the aviation domains - Basic IT-related skills and computer skills						

Module	Sequence of learning tasks	Training Topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode
1	Learning task 1	Basic AI/ML concepts and terminology	Factual & conceptual	Explaining basic AI/ML concepts and terminology	Lecture	Small group	online asynchronous
1	Learning task 2	History of AI/ML and current applications	Factual	Summarising major historical milestones and breakthroughs in AI & ML Exemplifying current applications of AI & ML	Lecture	Small group	online asynchronous
1	Learning task 3	Discussion on learning tasks 1 & 2	Factual & conceptual	Students shall be able to discuss the enablers of AI and ML, such as supercomputing and big data, and discuss their impact on major historical milestones in the fields of AI and ML	Cooperative learning	Small group	online asynchronous
2	Learning task 4	Types of ML	Factual & conceptual	Comparing between different types of ML, namely supervised learning, unsupervised learning and reinforcement learning	Lecture & Simulation	Small group	online asynchronous
2	Learning task 5	AI/ML techniques & algorithms	Factual & conceptual	Explaining and critiquing different AI/ML techniques and algorithms	Lecture	Small group	online asynchronous
2	Learning task 6	Discussion on learning tasks 4 & 5	Factual & conceptual	Students shall be able to discuss the challenges associated with different AI & ML techniques and algorithms and be able to put forward relevant arguments on the selection and use of such techniques and algorithms	Cooperative learning	Small group	online asynchronous
3	Learning task 7	Current AI applications in aviation	Factual	Exemplifying the current applications of AI in the aviation domain, across various sectors (flight operations, air traffic control, aircraft maintenance, drones, airport operations and passenger handling, etc)	Lecture	Small group	online asynchronous
3	Learning task 8	Emerging and future applications of AI	Factual & conceptual	Exemplifying emerging and future applications of AI in the aviation domain, across various sectors (flight operations, air traffic control, aircraft maintenance, drones, airport operations and passenger handling, etc)	Lecture	Small group	online asynchronous
3	Learning task 9	Discussion on learning tasks 7 & 8	Factual & conceptual	Students shall be able to discuss both current and emerging/future applications of AI in a particular aviation domain	Cooperative learning	Small group	online asynchronous
4	Learning task 10	Certification of AI	Factual & conceptual	Explaining certification issues concerning AI and associated threats such as cybersecurity issues	Lecture	Small group	online asynchronous
4	Learning task 11	Human Factors implications	Factual	Summarizing human factors implications of AI, including the issue of nondeterministic AI, its trustworthiness and the challenges associated with its integration within a human-centred environment	Lecture	Small group	online asynchronous
4	Learning task 12	Discussion on learning tasks 10 & 11	Factual & conceptual	Students shall be able to discuss the human factor implications of AI and associated challenges	Cooperative learning	Small group	online asynchronous
	Learning task 13	AI Case study	Factual & conceptual	Students shall pick a current application of AI in the aviation domain, evaluate its implementation, and critique the AI/ML techniques and algorithms in use	Case study	Individual	online asynchronous

Transversal module, QSR

Type of training module	Transversal	Target audience	All (transversal)	Training module designer	QSR	Module Title	"Houston, we have a problem!": Problem solving and Decision-making
Short abstract describing the scope of the module	This transversal module will develop the trainees problem-solving and decision making skills.						
General learning objectives	<p>At the end of the training module, the learner will be able to...</p> <p>Understand how problem solving and decision making interrelate Understand different strategies of problem solving and decision-making Apply in daily life problem solving and decision-making tools</p> <p><i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i></p>						
Prerequisite knowledge	N/A						
Sequence of learning tasks	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Comments (if needed)
Learning task 1	Problem solving and decision-making, aren't	Factual + Conceptual knowledge	Understanding the concepts of problem solving and decision-making	Lecture	Large group	online asynchronous	
Learning task 2	What's my problem? Time to solve it!	Factual + Procedural knowledge	Recognising a problem and how to solve it	Lecture + Case study	Small group	online synchronous	Ask the trainees to recall a past problem they faced in their work life. After this, all of the problems will be drawn, based in they profession, and in groups they will solve it to understand the process of problem-solving.
Learning task 3	I made a decision! Oh, wait... maybe not?	Conceptual knowledge	Understanding the process of decision-making	Lecture + Problem-based learning	Small group	online synchronous	
Learning task 4	I have 99 problems, and a 100 ways to make	Factual + Procedural knowledge	Distinguish ways to solve a problem and tools to make a decision	Lecture + Game-based training	Small group	online asynchronous	

Specific module for pilots, ENAC

Type of training module	Specific	Target audience	Pilots	Training module designer	ENAC	Module Title	Learning and practice of aircraft procedures
Short abstract describing the scope of the module	This specific training module will enable pilot trainees to learn new aircraft procedures and train themselves autonomously. Indeed, it will provide an adaptive tool that facilitates the practice of the execution of the sequence of actions to be performed in the procedures and that provides feedback on the correctness of the execution. The objective is to train all the normal and emergency procedures that have to be known without the help of the procedures manual. This module has to be iterated for each procedure.						
General learning objectives	<p>At the end of the training module, the learner will be able to...</p> <ul style="list-style-type: none"> -remember the sequences of actions of X aircraft procedures -understand the principles that guide each procedure <p><i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i></p>						
Prerequisite knowledge	-knowledge of previous aircraft controls and procedures						
Sequence of learning tasks	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Comments (if needed)
Learning task 1	aircraft controls	factual	cite properties of all the aircraft controls	lecture	Large group	online asynchronous	
Learning task 2	principles of actions of aircraft	conceptual	explain principles of the design of aircraft	problem-based learning	Large group	online asynchronous	interactive slides
Learning task 3	procedure sequence	procedural	list sequence of actions to be executed	demonstration	Large group	online asynchronous	video recording of a pilot who executes the sequence
Learning task 4	procedure practice	procedural	execute sequence of actions correctly	simulation	Individual	face to face	needs the use of virtual reality hardware and software

Specific module for airport operators, ESTU-KU

Type of training module	Specific	Target audience	Airport operators	Training module designer	ESTU	Module Title	Change Management for Automation and Emerging Technologies in Airport Operations
Short abstract describing the scope of the module	This specific module will enable trainees to gain an in-depth understanding of the concept of change management which is related to automation and emerging technologies in airport operations. In particular, they will have an idea about the importance of change and adaptation as operators in today's and future aviation industry and how to manage within automation and emerging technologies.						
General learning objectives	<p style="text-align: center;">At the end of the training module, the learner will be able to...</p> <ul style="list-style-type: none"> understand the concept of change management analyse reason for change evaluate the need for change explain automation and new technologies describe change planning analyse human factors in change management understand resistance and resilience to change evaluate constantly changing and unchanging in airport operations evaluate the performance for change management create adaptive/innovative solutions for changing environmental 						
<i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i>							
Prerequisite knowledge	Participants should have general knowledge and experience for airport operations.						
Sequence of learning tasks	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Comments (if needed)
Learning task 1	Concept of change	conceptual	understand concepts and terms related to changing environment	lecture	Small group	online asynchronous	
Learning task 2	Reason and need for change	factual and conceptual	analyse reason and need for change in current and future operations	lecture + discussion	Small group	online synchronous	discussions with the trainer
Learning task 3	Automation and new technologies	conceptual and procedural	explain automation and new technologies in airport operations	lecture + discussion	Small group	online synchronous	discussions with the trainer
Learning task 4	Change planning	conceptual	describe change planning processes for airport operations	lecture	Small group	online asynchronous	
Learning task 5	Human factors in change management	factual and conceptual	analyse human factors in change management in airport operations	lecture	Small group	online asynchronous	
Learning task 6	Resistance and resilience to change	factual and conceptual	understand resistance and resilience to change in airport operations	lecture + case study	Small group	online synchronous	discussions with the trainer
Learning task 7	Constantly changing and unchanging in Airport operations	conceptual	evaluate constantly changing and unchanging in Airport operations	lecture	Small group	online asynchronous	
Learning task 8	The performance for change management	conceptual	evaluate the performance for change management	lecture	Small group	online asynchronous	
Learning task 9	Adaptive/innovative solutions for changing environment	metacognitive	create adaptive/innovative solutions for changing airport environment	brain storming	Small group	online synchronous	discussions with the trainer

Specific module for RPAS, QSR

Type of training module	Specific	Target audience	RPAS operators	Training module designer	QSR	Module Title	Managing my self: towards a safer life
Short abstract describing the scope of the module	This specific module will develop the RPAS trainees will develop the safety-based judgement skill as a whole, with a particular focus on risk management, but also will include topics like: workload management and stress management.						
General learning objectives	<p>At the end of the training module, the learner will be able to...</p> <p>Understand workload and stress management concepts and their role to a safer work-life Understand different strategies of workload and stress management Apply in daily life workload and stress management tools</p> <p><i>(using following verbs: remember, understand, apply, analyse, evaluate, create)</i></p>						
Prerequisite knowledge	N/A						
Sequence of learning	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Comments (if needed)
Learning task 1	Workload and Stress Management: Why do I need them to be safe?	Factual Knowledge	Understanding the concept of workload management and stress	Lecture	Large group	online asynchronous	
Learning task 2	So much to do, and so little time: How to manage my work	Metacognitive + Procedural	Understanding and implementing strategies for workload management	Lecture + Case Study + Problem-based	Small group	online synchronous	Some materials and the lecture will be asynchronous
Learning task 3	Feeling Stressed: Why, when and how to cope with it	Metacognitive + Procedural	Understanding the basic stress triggers, signs and coping strategies	Lecture + Case Study + Problem-based	Small group	online synchronous	Some materials and the lecture will be asynchronous

Specific module for ATC, Deep Blue

Type of training module	Transversal	Target audience	ATC	Training module designer	DBL	Module Title	How to cope with stress and change to fit in future roles
Short abstract describing the scope of the module	This training will enable trainees to be aware on how they deal with change and stress when the environments requires to fit in new roles. The participants will learn about the stress and change mechanisms and will receive tools for self empowering themselves.						_____
General learning objectives	<p>At the end of the training module, the learner will be able to...</p> <ul style="list-style-type: none"> - Understand the mechanisms of stress and reactios to change - Analyse their natural tendencies in coping with stress and change - Understand the different coping strategies in dealing with new and difficult situations <p>(using following verbs: remember, understand, apply, analyse, evaluate, create)</p>						
Prerequisite knowledge	<p>----- ----- -----</p>						

Sequence of learning tasks	Training topic	Type of knowledge	Specific learning objective	Instructional method	Group size	Delivery mode	Content structure	Materiali Gianluca
Learning task 1	Stress mechanism and impacts	Conceptual	The participants will learn how the stress mechanism works, what are their personal contributing factors (stressors) and the areas of impact (emotional, physical and behavioural)	Lecture	Individual	online asynchronous	stress definition, stress elements, the biology of stress, stress types	per Gianluca: quale articolo useresti da Hindsight. Wellbeing, N.30. Spring 2020. Eurocontrol
Learning task 2	Assess personal stressors	Metacognitive knowledge	The participants will learn the stressors and they will be asked to self assess their own in the current situation	lecture and problem based training	Small group	face to face	stressors definition, stressors assessment	same as above
Learning task 3	Personality traits connected with stress management	factual and conceptual	The participants will understand and apply the criteria of optimism and Locus of control to the stress management.	lecture	Individual	online asynchronous	stress signals, including operational signals, LoC	
Learning task 4	Tools to manage stressful situations: the circles of change	metacognitive and procedural	The participants will learn how to apply the "circles of control" techniques to their personal situation. This tool will enable the participants to have a better understanding of what they can change, what they can influence and what they need to accept in the situation they are in.	lecture and case study	Small group	face to face		https://www.youtube.com/watch?v=VVje5Z3K4SU si può usare come teaser per dire: che differenza c'è fra chi dura 1 anno e chi dura 30? Le strategie di coping
Learning task 5	Tools to manage stressful situations: Assessing personal resources	metacognitive and procedural	The participants will learn what are the resources we can use to maximize our stress management. They will self assess their present resources, the actual and the potential.	lecture and case study	Small group	face to face		
Learning task 6	Tools to manage stressful situations: assessing personal emotional state with the mood meter	metacognitive and procedural	The participants at the end of this session will know how to self detect their emotional state using the mood meter tool. They will also be able to understand how their emotional reaction fits in a healthy and functional way with the situation.	lecture and case study	Small group	face to face		
Learning task 7	Coping strategies to better manage the stressful situation	metacognitive and procedural	The participants will understand the differentiation among short and long coping strategies, they will be able to correctly understand where to proactively apply the most effective one due to the situation.	lecture, problem based learning and case study	Small group	face to face		pratiche di coping reattivo e proattivo
Learning task 8	The curve of change	factual and conceptual	The participants will understand the journey we all do when facing critical changes at work. They will be able to recognise every stage of this path, understand what are the elements that will help them to progress and the ones that will make them regress on early stages of the change management	lecture	Individual	online synchronous	casi studio di incidenti aerei: quali differenze nella gestione del cambiamento? Lo tratterei in modo più ampio (non solo focus su comunicazione)	Emergenza del volo Erato - marzo 2021 NTSB, (1990). National Transportation Safety Board, Aircraft Accident Report United Airlines Flight 232 McDonnell Douglas Dc-1040 Sioux Gateway Airport Sioux City, Iowa July 19, 1989 Disastro del volo USair 1493 NTSB (1991). Aircraft accident report runway collision of USair flight 1493, B737 and SkyWest flight 5569 Fairchild Metroliner. Los Angeles International Airport,
Learning task 9	Assess personal readiness to change	metacognitive and procedural	The goal if this session is to provide participants with a list of personality traits that have an impact on change management and they will self assess themselves onto these dimensions to measure their readiness to change.	game based training	Small group	face to face	cosa cambia? Usare il video retina come teaser II concetto di controllore del traffico aereo aumentato Sensi aumentati: visione, udito, tocco aptico, tecnologia indossabile Azioni aumentate: comunicazioni CPDLC, presenza remota, azioni pan-tilt-zoom Cognizione aumentata: E-strips	http://retinavalidations.altervista.org/RETINA_Validations/
Learning task 10							La realtà aumentata in ambito aeroportuale (negare per un coping di breve respiro, accettare per un coping strutturale) Utilizzo dei dati sulle strip elettroniche Utilizzo dei tools per la collaborazione aumentata tra uomo e sistema Coordinamenti da remoto Case study L'implementazione del sistema ERATO	domanda per Gianluca: il caso studio ERATO: hai materiali? Come volevi usarlo?



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