Summary Report

A Portable Learning Application
Executive Summary

Today’s astronauts have a tight schedule, both in orbit as well as during the preparation phase before a mission. The preparation phase includes a strict training program in a classroom environment, focusing on maximum efficiency of the mission outcome. However, for future astronauts on long-duration manned missions beyond low-earth orbit, the scope of the actual mission and the experiments performed are expected to exceed the scope as anticipated during the mission preparations. On these missions, a shift of autonomy from ground to in-flight training by the crew is expected, and therefore astronaut training needs to be adapted accordingly. The extensive duration of the mission, the delayed communications due to distance and visibility, the autonomy shift, as well as on-going changes in the mission goals, the environment, and the tools at hand, all imply a need for self-study, motivation, and a means to provide dynamic training content during the mission rather than before. APLA (A Portable Learning Application) is a study performed for the European Space Agency to identify and fulfill these needs. The study is based on the premise that gaming concepts can help to promote self-study, motivation, efficiency and effectiveness, and on-site training among astronauts. The gamification aspects that are evaluated include avatar representation, leaderboards, short ‘quest’ lessons, immediate rewarding, the notion of achievements, the classification of training content using a skill-graph, and character development. These are implemented in a prototype that also integrates training execution, monitoring and evaluation, designed around the aforementioned gaming aspects. Subsequently, the prototype has been used to evaluate the applicability and efficiency of gaming concepts for training. The evaluation has been performed with representatives test subjects including ESA astronaut instructors, using a structured walkthrough with the prototype. The results of the evaluation are reported in this document, in addition to the lessons learned for this project.

This report summarizes the study activities related to the ESA study contract# 4000102351, titled “A Portable Learning Application”, developed under the GSTP-4 (under number G312-01 EM) program.
ABSTRACT:
A study was performed on training systems for crew on missions beyond low earth orbit. Aspects such as motivation and self-study are assumed to be important aspects in the efficiency for training on Long Duration Missions. The use of gaming aspects in the training system may help to increase and sustain motivation and the need for self-study for training the operations of payload. To study these effects, a prototype training system that uses gaming principles is developed and evaluated. In this report the overall approach, findings and lessons learned is reported.

The work described in this report was done under ESA Contract. Responsibility for the contents resides in the author or organization that prepared it.

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** ESA BUDGET HEADING
E/0904-01-K-21-03
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Introduction

The longest consecutive duration in space ever logged was by a Russian cosmonaut, who stayed for just under 438 days in orbit around the Earth inside the MIR station. This was in itself an interesting study on long duration missions, and many studies on the effects on human physiology, psychology and social interactions in similar situations have been performed ever since. Recently, with the Mars 500 study, a simulation of a manned mission to Mars to study the effects on the social and psychological state of astronauts can be added to the long list of such studies.

The scope of the study on which this document reports, also involves long duration manned missions. In particular the premise that astronauts may not be fully trained prior to the mission, or may be in need of extra training during the mission to effectively operate payloads sits at the core of this study. As astronauts will be on mission the training objectives may change, but also as an effect of the long duration it may be difficult to stay well-trained and to keep knowledge as current as possible. In the context of a GSTP-4 study we have looked at these potential problems, and proposed a solution to introduce gaming elements into the training system, in order to keep astronauts motivated and current on their knowledge.

The study is performed by a consortium of both knowledge institutes and industry alike. Both the companies ‘Nspyre’ and ‘Science & Technology’ represent industry by developing the prototypes to evaluate the assumptions and expectations that are put forth by ‘TNO’, a knowledge institute on human factors and usability, and ‘NLR’, a knowledge institute with a broad track record on space operations execution, operations preparations and training tools. In this consortium of 4 partners, ‘Nspyre’ acted as prime.

Scope of this report

To execute the study a project was initiated. The project is titled ‘APLA: A Portable Learning Application’, although it originally started off with a different name. The objective of the project is to define a payload learning application for long duration missions, to develop a prototype, and with that to evaluate the claims that govern the definition of the learning application.

The project was performed in 3 phases.
- The first phase involved a familiarization with current space operations preparations and training tools, and the definition of a user requirements baseline for APLA.
- The second phase involved the design and development of a prototype for APLA
- The third and last phase involved the evaluation of the APLA prototype with representative users of APLA

In the remainder of this document a summary of activities, results and lessons learned is given for each of these 3 phases. This summary report does not provide all details on the evaluation of the APLA prototype, but summarizes the most important findings. The reader is invited to read the relevant documents that are delivered as part of this project.
Phase 1: State-of-the Art and Requirements Baseline

Since ‘operations on long duration manned missions’, the scope of the study, is not yet current reality, the project started off with a blank slate. Many missions have been launched and operated over the last 6 or 7 decades, but none involved humans in space beyond low-earth orbit. And as a consequence, the training of such operations is not yet put in place either. However, current training principles provide us with important insights into how training are setup, and applied and if this can be successfully implemented on the missions under investigation. Therefore an identification and familiarization with current training systems for space operations was performed, as well as an overview of current trends in training systems and technologies. These are reported into a technical note that lists the current state-of-the art. In parallel the requirements that are expected to be valid for long duration missions are identified and recorded into a requirements baseline. These requirements cover both a learning system itself, as well as an authoring environment that allows the creation of learning material; the content of the learning system.

State-of-the-art of Training Systems

In the technical note reporting on training systems there are 2 main lines of study. The first covers the current crew / operator training facilities used to train operators for ISS payloads, such as the European Robotic Arm, the European Drawer Rack and its payloads, as well as training for defense systems, and civil infrastructure objects such as tunnel technical installations which are monitored and operated. The systems under investigation are all related to what is expected for the APLA context:

- Being able to train both nominal and non-nominal situations
- The ability of a training system to adapt to changing goals and training objectives
- The ability of a training system to adapt to cognitive a/o affective load of the trainee
- The way training is provided; whether the training system is used for procedure, rote-skill, knowledge, or skill-based training
- The possibility to use the training system both pre-mission as well as on mission.
- Collaboration possibilities; can a tutor be consulted during a training or with a time-delay, and is it possible to train collaboration with multiple trainees.
- The implementation, portability and environmental constraints of the training facility.

Furthermore, the current trends in technology and computer based training tools that are deemed relevant for training in general, and potentially for future APLA evolutions are summarized and categorized. The following categories and related technologies are described:

- Technologies related to the Man in the Loop:
  - Motion and gesture control of systems
  - Voice control of systems
  - Automated detection of emotional state and behavior
  - Augmented reality for overlaying information
  - Advances in 3D technology
  - Serious Gaming and on the job training
  - Force feedback, virtual reality and haptic devices
  - Computer AI for collaborative learning

- Trends in computer based training at astronaut training centers:
  - The use of 3D models for training and familiarization
- Computer platform independency, and use of mobile devices, Computer Based Training (CBT)
- Integrated procedures, virtual reality, and onboard training

Based on the extensive descriptions of the current training systems and trending technologies for training and as well extensive analyses for future payload operations support trainer, a vision for what APLA should be targeting is provided in a Technical Note. This vision has been the basis for the requirements baseline that was put forth afterwards. In the description of the APLA tool as put forth in the Technical Note, strongly adaptable and flexible use of multimodal user interfaces, both collaborative and single person training, as well as an expanding library of information as a source for the training is foreseen as a core of the APLA training application.

Finally, the Technical Note also comprised of a trade-off of three target payloads for APLA prototyping, and as a conclusion the selection of the Cardiopres payload is elaborated.

Mission Execution Crew Assistant
The Mission Execution Crew Assistant (MECA) project is a European Space Agency (ESA) research effort that aims to boost the cognitive capacities of astronaut/machine teams during long-duration missions in order to allow them to cope autonomously with unexpected, complex and potentially hazardous situations. MECA software acts in a ubiquitous computing environment as an electronic partner, helping the crew to assess a situation, to determine a suitable course of (problem-solving) actions, and to safeguard the astronauts and the mission from failure.

MECA is dealing with many of the same issues and challenges APLA is facing: the lack of experience with long duration missions, the need for technology that does not exist yet, etc. But MECA tries to solve more generic problems of overall situational awareness and astronaut/software partnerships. In fact, „training“ is one of the components that has been identified as part of the overall MECA architecture.

As for APLA, the main deliverable of the MECA project is a comprehensive Requirements Baseline (RB) that details the overall requirements for a MECA system as it might be designed and implemented in ten, fifteen years’ time. And for MECA, too, prototype demonstrators are being built, using present-day technology in order to validate and demonstrate the wider concepts.

Requirements Baseline
The requirements baseline that is written for the APLA training application as well as the courseware is defined iteratively. A set of 5 Use Cases for different operational scenario’s including nominal, non-nominal, real-time, just-in-time training and collaborative training give the operational context for APLA. The requirements are categorized into 4 distinct categories;

1. **Cognitive Requirements**: define what the system is expected to do or ask for. These are termed cognitive because of the human-machine collaboration and the cognitive empowerment APLA should provide;
2. **Management of Human Resources**: define planning and distributions of tasks and training activities, planning of premeditated and emerging activities
3. **Technical Requirements**: these requirements define which technologies should be used to define the architecture, addressing constraints and quality issues;
4. **Software and Hardware Requirements**: to define the specific platform for APLA.

All requirements are based on explicit claims that justify the requirement. The claims are defined with references to metrics or measurements in order to empirically evaluate the claims, and related pros and cons. The chosen structure and definition of requirements is based on what was done previously in the MECA baseline. This way, the APLA requirements can be easily integrated with the requirements baseline for MECA [RD1].

**Results**

As part of the familiarization and concept definition for both the technical note as well as the requirements baseline, a group of experts at the European Astronaut Centre was consulted. This was instrumental for getting insight in current astronaut training, which historically perseveres focus on skill-based training. Furthermore, the structuring of training material into the Astronaut Training Database and the metadata used for this structuring provided an important insight in how to organize the training data, and how to model the user, the payload, and the training courses into the APLA knowledge base.

In this phase we also decided on a payload to be used for the APLA demonstrator. Different payloads have been assessed. We have based the assessment on existing training environments and the flexibility and availability of (components of) these environments for the APLA demonstrator. Out of the payloads identified, the Cardiopres payload was selected, the rationale being the strong compatibility with the MECA framework of the training environment, as well as the fact that at EAC the Cardiopres is widely known. The Cardiopres payload is built and used on the ISS to continuously measure blood pressure and other vital signs of astronauts.

At the end of this phase the following documents were delivered and reviewed by all stakeholders, including the project team, ESA as well as EAC. The documents provide both the state of the art concept definition as well as the requirements baseline needed to design and develop a prototype for evaluation. Because of strong synergy between the two, both the requirements baseline for APLA as well as the authoring environment is combined into a single document.

<table>
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<tr>
<th>Doc Id.</th>
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<tr>
<td>APLA-TN-001</td>
<td>“CR-2010-480-APLA-TN”, Issue 2.0</td>
<td>Technical Note: Refresher Trainer for Long Duration Missions gives and overview on the current state-of-the-art for ground crew and astronaut training as well as relevant technological advances.</td>
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<tr>
<td>APLA-RB-001</td>
<td>“CR-2010-588-APLA-RB” Issue 2.0</td>
<td>Requirements Baseline for generic payload refresher trainer provides the user requirements for a training system.</td>
</tr>
<tr>
<td>APLA-RB-002</td>
<td>“CR-2010-588-APLA-RB” Issue 2.0</td>
<td>Requirements Baseline for courseware authoring environment provides the user requirements for the courseware authoring environment</td>
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**Lessons Learned**

Training of flight crew in operating payloads usually takes a skill-based approach, strongly focused on the physical handling of a payload. The training of ground crew and operators...
usually takes a procedure based approach. Technological advances such as serious gaming for training are not yet found to be used in current “short mission” training ground and flight crew.

**Phase 2: Prototype Development**

Development of the APLA prototype was started after the SRR was successfully passed. Input to the prototype was the technical note and the requirements baseline, both of which gave a fairly complete vision and set of requirements on APLA and the courseware. A subset of requirements, together with the aspects on APLA provided in the technical note, provided the initial setup of the prototype design. Although serious gaming was mentioned in the first phase, it was during one of the design meetings that the concept of gamification for APLA as a way to deliver the training, rather than provide a new training method was conceived. The basis for this was that self-study and motivation were seen as two of the main issues in training on long duration missions. The Astronaut Training Database as used at EAC and the identification of motivation and self-study as important human aspects for long duration missions pushed the team towards gamification as a potentially interesting mechanism.

**Gamification – The APLA Prototype**

Gamification is the notion of introducing gaming elements into ‘normal’ activities in order to make these activities more attractive and less prone to unwanted repetition. This is done by tapping into two human emotional motivators (see [RD2]);

1) **Fiero**: an extreme positive emotion a person can feel by the rush one gets after achieving a goal that required a considerable effort, such as winning a marathon or solving a complex puzzle.

2) **Flow**: the emotional state a person can achieve when performing a task so intensely that time seems to pass without noticing. These are usually moments of pure joy and happiness.

Games are usually quite good at tapping into these 2 emotional motivators. The reason is clear, the more people want to play those games, and the more copies eventually will be sold. Therefore games are being designed such that ‘flow’ and ‘fiero’ are maximized, by using relatively simple game mechanics. The game mechanics all cater to initiate and extend flow, as well as to use fiero as a reward mechanism. Some of these game mechanics can be applied to training, in order to achieve higher efficiency and higher motivation for (self)-study. The following game mechanics are used in this context:

- **Short quests or missions**: be able to catch a flow by having short and rewarding sessions
- **Instant rewarding**: provide fiero soon enough so the user wants more before he turns away, and help achieving a flow this way
- **Personification**: using avatars as the personification of the virtual character. Provide awareness that the user is part of the game or training system. Rewards are likely to have more value when applied to oneself, rather than to an abstract entity
- **Leaderboards**: competition as a driving force to become the best. This is only achieved by trying to get better every time, either individually, or if collaborative training is allowed, as a team
- **Certifications and achievements**: this rewards the user for prevailing in the training or gaming system. Achieving something ‘grand’ provides a great source for fiero.

![Figure 1 Context Diagram APLA](image)

In the context of APLA, in addition to the issues of self-study and motivation, the direction towards gamification came also from the fact that the European Astronaut Centre is using a training database with a clearly defined set of trainings, levels and currencies of the skills of astronauts. This organization of training material and of the trainees lends itself very well for introducing gaming elements into training; it already implicitly structures users around skill sets, and courses towards enhancing those sets.

The prototype of APLA was conceived first in the technical specification (TS). In the TS, the APLA application is mapped onto the generic MECA architecture. The MECA architecture provides a logical structure for implementing functional coherent components that intercommunicate using a shared data model. The architecture itself is not scope of APLA; it provides the structure in which APLA provides further detailing of the functional components within the given architecture. These components cover the application layer, data access layer, as well as an external interface layer specifically for APLA. The user interface is added to aggregate the functionality of these components.

The technical specification provides also a sketch of the user interface. The sketch merely provided a user interface flow, i.e. which screens follow each other. In the TS the gaming elements as mentioned above are also identified and embedded into the APLA prototype.
Development of the Prototype

The technical specification was input to the actual implementation of the prototype. The implementation is based on a branch of the MECA codebase, which is adapted and extended with the APLA specific functionality. The components that are described in the technical specification are implemented into the APLA prototype. During this phase, the GUI is further fleshed out, taking the sketches from the technical specification as a guideline. The OWL/RDF data model is written to implement a model for the user, the courses, the achievements, certifications and the training results.

During the development, a further iteration of the courseware was made. The courseware was carefully written such that the gaming aspects are present. This means that extensive training procedures were cut down into smaller chunks, in order to be able to provide ‘fiero’, as well as the defining of the skills required and gained for each training session. Also, an avatar system was developed to allow trainees to personify with the results he was making and thereby building up a reputation of an Ace trainee. Leaderboards were implemented along with a schedule that allows planning of training sessions. The goal of the APLA prototype is not to define new training courses, but to demonstrate and evaluate a different approach to deliver the training. For that end, we used existing training material from Cardiopres as our object for training. The requirements and claims in the requirements baseline, in addition to the gamification in the technical specification of the APLA prototype and the further refinement of the APLA courseware have led to 6 distinct core functions that are implemented in the APLA prototype. The 6 core functions of the APLA prototype are:

1. The use of a **Skill Tree**: shows an overview of the trainees skills with dependences and requirements for certification
2. A transparent **Learning Space**: showing the trainees completed training, the active and potential training, as well as the list of achievements and the set of skills gained from training
3. Use of **Social Comparison**: providing a view on the trainees progress, compared to that of others
4. Stay informed by **Notifications**: notifying the trainee of events related to training completion, upcoming events, and achievements
5. Use of **Annotations**: allows adding information to the training database, in order to share observations, and store relevant information.
6. Use of **Procedural Training Guidance** as a means of training: a means to start training sessions. Training in itself is not the purpose of the APLA demonstrator, but the way training is encouraged, evaluated and used to promote self-study and motivation.

The software for the APLA prototype was developed in Java, using the MECA architecture and existing component implementations as a starting point. However, the APLA prototype is a self-contained installable product that can easily be installed on a laptop for evaluation purposes.

**Results**

This phase of the APLA implementation has resulted in the software delivery of the final version of the APLA prototype. Furthermore, the documentation that describes in detail the technical specification and the design of the prototype has been written as well. As part of the courseware, a report containing all courseware as used for the evaluation was written as well.

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<tr>
<td>APLA-TS-001 “ST-ESA-APLA-TS-001”, Issue 1.1</td>
<td>Technical Specification for APLA and the APLA Demonstrator</td>
<td>The technical description of the APLA demonstrator. The main functions and architecture for the demonstrator as well as the software requirements.</td>
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<tr>
<td>APLA-SDD-001 “APLA-DDF-001”, Issue 1.2</td>
<td>The APLA Demonstrator Design Definition File</td>
<td>The detailed design of the APLA demonstrator.</td>
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<tr>
<td>APLA-CW-001 “TNO-ESA-CW-001”, Issue 0.3</td>
<td>Courseware for APLA Demonstrator</td>
<td>The electronic courses for the APLA demonstrator. Information on the Cardiopres payload that is used for the training, as well as a full set of training sessions for use in the APLA demonstrator.</td>
</tr>
<tr>
<td>APLA-S1 Demonstrator, v1.1.0</td>
<td>APLA Demonstrator S/W</td>
<td>Full software package with an executable APLA Demonstrator.</td>
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</table>

**Lessons learned**

One of the lessons learned in this phase was that the eventual prototype was actually only conceived in this phase, and projects like APLA should allow for flexibility, creativity, and major last-minute changes in project direction because in highly explorative studies the
necessary leap from requirements to architecture may be far greater than in conventional engineering. At no point earlier in the project, for instance during the first phase, did we really intend to implement the gamification as it was eventually done. This is because of the explorative nature of this project. The use of gamification really is pioneering in the context of astronaut training. We have had discussions on the subject with the EAC, and it is clear that although there is no development on this matter, there clearly is an interest in gamification as part of training.

Another lesson learned is that the development was related to a prototype for which key decisions on direction and what we want to achieve were made quite late in the project. This obviously does not always fit into a clear define / build / test scheme, since define and build activities are somewhat entwined. This has at some times led to the situation that the documentation may not have been at par to what is expected in a less explorative project, however we are convinced that the end result really is interesting from the point of view of training astronauts for long duration missions.
Phase 3: Evaluation & Results

The APLA prototype is evaluated with a set of representatives for both training and trainees. The evaluation focuses on two main demands on training for future manned missions beyond low earth orbit:

- a crew that operates on higher levels of autonomy,
- with high challenges to resilience and motivation.

The evaluation plan covers the evaluation of the claims that correspond to the six core functions implemented in the APLA prototype:

1. Skill Graph. APLA provides an up-to-date overview of trainee’s skills, and their mutual dependencies, which are required for certification.
2. Learning Space. APLA shows trainee’s learning space, comprising (a) an overview of completed, active and possible learning activities, (b) a list of achievements, (c) the progress in skill level, and (d) the current certifications.
3. Social Comparison. APLA discloses the training results of all trainees, so that each one can see the results of him or herself and of others.
4. Notifications. APLA notifies the trainee on relevant-upcoming or happened-events (e.g., course events) and realizations (e.g., achievements). For a screenshot of this area.
5. Annotations. APLA provides a multimedia annotation service.

The structured walkthrough presents an extensive procedure with steps that cover the evaluation of these core functions, and if evaluated positively, justify the claims and the requirements baseline.

![Figure 3 Evaluation with trainers at EAC](image)

**Evaluation method**

The evaluation was based on a structured walkthrough. This involves guiding the participants through a step-wise procedure. The experiment was performed by fifteen participants who walked through the APLA demonstrator with the test leader. The participants were from a variety of backgrounds: six participants from EAC, five submarine crew members, one
engineer from ESA-ESTEC, one technical training manager at ESA-ESTEC and two experts on training from TNO (who were not involved in the APLA project). The structured walkthrough is a predefined set of steps that is explained to the subject and subsequently executed step-by-step. During and after the walkthrough a set of questions is used to justify the claims and determine the cognitive and mental state of the subject, and their attitude towards APLA.

Results
The evaluation results are reported into a dedicated evaluation report. This section summarizes the results for the six core functions. In general very positive remarks were made towards the structuring of training content, for instance by using the skill graph and the learning space. Social comparison may have a considerable negative effect on (some) users. It probably should show more the relative position in crew competencies than provide a competitive game-like ranking. Additionally, giving flexibility and autonomy to the trainees was perceived as a positive trait of APLA.

Some negative remarks concerning the implementation of the tool were made, and a concern related to how well this would integrate with current activities. Had more realistic content been available, this might have been better evaluated. This is also the case for the procedural training guidance and the notifications core function: the implementation was not mature enough to fully evaluate this.

Annotations are a core function that was liked by participants and was labeled as important in the explanation of their answers and discussion. Good suggestions were given to improve this function.

The evaluation report provides the full results and analysis of the evaluation, including a breakdown of the answers given and a structuring around the 6 core functions of the APLA prototype.

The list of deliverables:

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<tr>
<td>APLA-RPT-001</td>
<td>Summary Report and Abstract</td>
<td>The final report provides an overview of the activities and results of the project.</td>
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<tr>
<td>APLA-RPT-002</td>
<td>Commercial Evaluation Report</td>
<td>Provides a commercial evaluation of the project.</td>
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<tr>
<td>APLA-RPT-003</td>
<td>Structured Walkthrough and APLA Evaluation Report</td>
<td>The full set of steps for all procedures used in the evaluation of the APLA demonstrator, as well as the questions related to the evaluation. Additionally contains the results of the evaluation of APLA, including an analysis of the results and the conclusions.</td>
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</tbody>
</table>
Lessons Learned
Gamification is seen as an interesting approach to training; however, it cannot replace the current training and is regarded by some of the test subjects as an optional way of working. There seems to be a differentiation between a group of (younger) end-users that are more inclined to value the gaming principles as a positive addition, and the group of end-users that in worst case value these gaming aspects as irrelevant or downright infantile. This is due to the fact that the demonstrator did not contain very elaborate training courses; the training courses are placeholders for more elaborate courses. In the future it may be worthwhile to take in consideration the audience as part of what is presented and what not. The same applies for social features, such as annotations and scoreboards. The competitive social aspects can even be demotivating, if a low score is visible by everybody. It should be possible to implement a ‘privacy strategy’ that allows users to opt-out of certain features, or to have a more elaborate scheme regarding what is visible to others and what not. Control over this should be given to the end-user.

A good next step for APLA is to evaluate it as part of a real training, where participants really have to learn how to use a payload. The participants would preferably be real end-users (e.g. astronauts or astronauts-in-training). If the opportunity arises, then it would be possible to create better courseware, combine the gaming approach with a traditional approach, and potentially better integrate different approaches.
Final results and future work for APLA

Detailed results that are the product of this project can be found in the documents that are delivered in the different phases of this project. In the remainder of this document some of the most significant results are reproduced from the detailed reports. For the detailed analysis the reader is encouraged to read the full set of APLA documents. In general it can be said that the results of the study and the project as a whole are promising. The project has resulted in a thorough body of knowledge on training systems beyond low earth orbit. Both the delivered documentation together and the prototype software are quite an impulse towards the use of gamification in training of astronauts. It can serve as a starting point for ideas of the use of gaming principles in training of crew.

Motivation & promotion of self-study
We analyzed and concluded, but have not empirically investigated, that for flight crew the crucial differences between current manned space missions and future long duration missions are the need for self-study and subsequently the motivation for that to train for payload operations. Therefore, future studies on training for long duration missions should take this into account, either to support the claims based on further research, or in the development of similar training systems.

Use of Gamification
We found that the use of gamification is not yet applied in the field of astronaut training. Astronaut training usually takes a skill-based approach for handling payloads. Serious gaming, and applying gaming principles to encourage training are however interesting developments in domains outside astronaut training. In our study we have therefore applied gaming principles to astronaut training, and the evaluation results show that in general subjects and trainers of EAC are optimistic about the approach. On the other hand it is seen as a nice add-on to the current curriculum. The current APLA prototype (as of yet) is not to be applied in the core of the (current) training curriculum. In the future the developed technology should be applied to a real situation that better matches with the current curriculum and training activities. Also, the APLA prototype is used in a guided walkthrough, rather than a real training situation.

Usability and the use of web technologies
Currently, the APLA prototype is built on the JAVA platform. The demonstrator is a full-fledged application running on the client platform. Furthermore, the current user interface may seem daunting. To be able to reach a larger audience, the use of web technologies such as HTML5, and a more user centric design of the user interface to increase usability can be pursued.
List of references

[RD1] "MECA Requirements Baseline", version 5, Phase 3 / Final, 17/2/2012

Glossary

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<th>Term</th>
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<tr>
<td>APLA</td>
<td>A Portable Learning Application; a system that uses gamification for training of astronauts.</td>
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<tr>
<td>MECA</td>
<td>Mission Execution Crew Assistant; an electronic partner that supports astronauts in their tasks</td>
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<tr>
<td>Gamification</td>
<td>The concept of applying gaming aspects to solve real world problems.</td>
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<tr>
<td>Fiero</td>
<td>The primal rush that arises after achieving success when performing a difficult but interesting task</td>
</tr>
<tr>
<td>Flow</td>
<td>An increased attention to a chain of events that seems to compress time.</td>
</tr>
<tr>
<td>Avatar</td>
<td>A graphical representation of a user inside a computer system.</td>
</tr>
</tbody>
</table>