The aerocrew mission: training space session at Ny Aalesund Arctic base

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ABSTRACT

The Aerocrew mission was realized at Ny-Aalesund Arctic Base in December 2007, in the frame of the International Polar Year, and in cooperation with the French Polar Institute. The team made an original training experience, constituting an integrated space crew, including physicians, aerospace trainers and engineers, implied in a seminar with 4 sessions, dealing with the training capabilities of Arctic Bases. This kind of base constitutes a pertinent and affordable facility for aerospace teams, and the specific aerospace crew training techniques, are fruitful for the polar scientists (glaciologists, geologists, specialists of the atmosphere).

The sessions, given by professionals of aerospace, robotics and medicine, covered the training methods for crews, robotics for outdoor and indoor activities, engineering of embedded systems, and the arrangement of crafts. The experience has shown the efficiency of a transverse visiting multidisciplinary team for training, and possible synergies with the resident scientists. In addition, the sessions were enriched by demonstrations such as mini-robot for observation, micro-helicopter, and also the comparison between EVA Russian glove and Polar Suits.

1) Introduction

In the frame ot the International Polar Year, the Alfred Wegener Institut and Institut Polaire Français Paul-Émile Victor have welcome the AEROCREW Mission at Ny-Ålesund, during one week in December 2007. This short mission was nevertherless original in its scope, Organized by Terre&Espace, a French Association devoted to applications of space techniques (www.terrespace.org), after discussion with the Polar Institute.

The AEROCREW mission aimed at training and identify possible spinoff between aerospace crews preparation and techniques on one hand, and scientific research in polar bases on the other hand. One fundamental scope was actually the demonstration of training synergies between arctic and aerospace crews, as the scientific and human challenges are similar : high level scientific team in hostile and isolated medium, with operational scopes.

The AEROCREW

After the presentation of the general context of the mission, the paper describes the training sessions, and then the activities devoted to man-machine complementarity in base. The conclusion and perspectives are finally mentioned.

2) Scope and General Context

The previous works developed with Swedish and Norwegian specialists aimed at using the polar bases as testbed for space crew management – risk, isolation, scientific team in exotic situation – and spacecraft internal arrangement. Concerning the risk, a specific list had been published (ref.[5]), including the classical concepts mentioned in fundamental studies realized on arctic and space crews (ref.[1]), but pointing in addition some other ones such as : hearth paradigm, training in relation with telework, and even mourning in space. Concerning the internal arrangement, the basic study was published by Louise Jagger in 1998 (ref.[4]), concluding a study financed by Matra Marconi Space and dealing with the Minimal Artificial Weightiness Concept. During the following studies (Reine Kurth, Francesca Molendini), it appeared clearly that the internal arrangement of arctic (an Antarctic) bases were in strong synergy with spacecraft for long range flight, including in particular the perception of light in polar night (and day). Consequently, the scientific cooperation with northern bases and centers went on during the following years, and it appeared that the International Polar Year could be an excellent opportunity to make a concrete mission with realistic resources, and in a specific scientific frame.

The goal defined for this mission was not only the investigation of classical direct spinoff from arctic bases in relation with space training, but also the inverse one considering that space techniques – with focus on training and robotics – are unique for the users of polar bases. In addition, the crew aspect has been emphasized, considering that any technique is finally useful for human purpose (again, this is valid in space and in base…).

For this purpose, the crew for the AEROCREW Mission was chosen in function of coherence and complementarity with an actual planetary crew, taking into account the training priority. It gathered eleven members (four women & seven men) with three physicians (one surgeon, one aerospace & sport specialist, one ear specialist), one specialist in life sciences, one specialist in physical sciences, one satellite engineer, one researcher in robotics and command systems, one aircraft crew trainer, one researcher in aerospace embedded systems, and two researchers and professors in mechanics and space techniques.

3) Training Sessions

Four technical sessions were realized during the mission, each session dealing with a specific thematics, with a formal presentation by the specialist, and a practical application of proposed protocols. The first one was precisely devoted to Astronaut Training Methodology, and possible applications for the preparation and follow-up of arctic crews .This session was proposed by Delphine Gourdou, former trainer for astronauts and currently trainer for aircraft crews (which also represents an interesting spinoff).

The different procedures were presented, with emphasis on the necessity of rigorous and clear specification for any hugh level technical training for crews, and also the importance of initial consideration of crew communication protocols for defined tasks. The different approaches of written documents (in particular in US an Russian context) was highlighted.

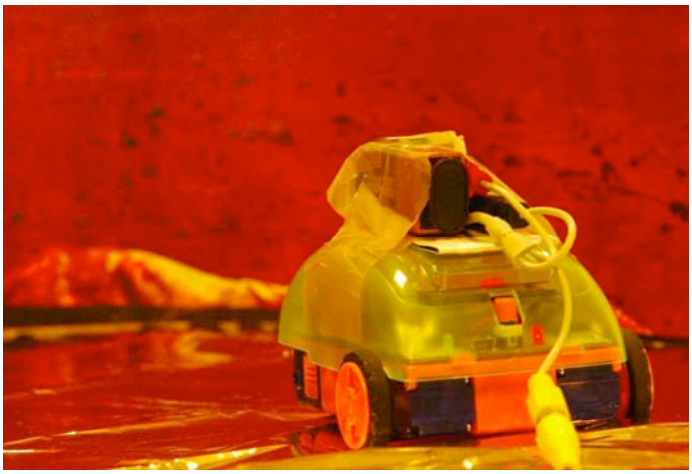
A practical exercise was then made about Extra Vehicular Activities, with time limitated action and standard orders given by the base to the crew member in EVA. This is directly applyable for external worker in polar medium, with the safety and performance stakes. This exercise was made in the context of robotic assistance in EVA, which was developed in other sessions.

It is also necessary to precise that the crew human context was comparable, for training, to the context for space crews : coexistence specialized high level scientists, with major mission scopes, in an exotic context, and transverse crews whose mission is rather technical and

organisational. Actually, this matricial aspect of crew activity must be reflected by the organisation of training strategy and communication method.
In fact, the three other sessions were devoted to scientific presentations for all the other crew members : command and autonomy in robotics, system engineering and specification, space mechanisms and long range flights. These sessions aimed at sharing the technical stakes in a international and multicultural team, which is the common case for a polar base.

4) Man-Machine Interface and Robotics

Beside the sessions devoted to training and crew management aspects, a specific session conducted by Marc Bertin - researcher in command theory at Paris Sorbonne - dealed with robotics and commandability of systems, and had a direct impact on human-machine complementarity for planetary exploration, in the arctic context. The demos showed two micro-vehicles, and demonstrated in particular ability for transmission from the boarded camera to vritual-reality glasses. The stake is here, on one hand the possibilities open for pioneering robots (in new medium), and on the other hand, the autonomy in repetitive tasks for servitude robots in the craft itself.



This kind of small and adaptative robot will certainly constitute the standard facility both for ice researcher, in order to search, find and examine the convenient specimens out of the base, and for planetar future explorations. At the end of the session, a micro-helicopter (6” long) was tested in external flight, with difficult control due to temperature, wind and polar night ; the pertinence of this kind of micro flying vehicle is clear for observation and access to sharp places.

These techniques are also commonly envisaged for terrestrial applications such as the observation of animals, vegetation, and any mission for survey where the environment could be hostile.

As the human capability cannot be replaced by robot in all situations, the Orlan Russian Extra Vehicular spacesuit glove (given by Space City, Toulouse) was tested in the snow, as it could be used by ice specialists or by planetar geologists. As already observed in space, it appeared that the thermal protection on silicon finger tips is relatively weak.

The test of space suits and garments in arctic zone, with enventual ice and ground drilling in situation is an excellent testbed not only for space planetar applications – future lunar or martian missions – but also constitutes a good opportunity to prepare the use in severe Antarctic conditions.

5) Spacecraft and Base Arrangement

The goal is here to use the arctic base as an analogue for a spacecraft or a future base on the Moon or Mars; extreme terrestrial environments are indeed privileged places to conceive and investigate habitats for space exploration. The first activity (A. Pacros) consisted in a general survey about the overall architectural design of the polar base; it will be done using a questionnaire adapted from the one developed by the MDRS Crew 43.

The second theme (Y. Gourinat) was a study of the importance of Hearth and Light in hostile environments, based on previous studies devoted to spacecraft (ref. [4]). Lectures and panel sessions have been performed in a collective approach about the hearth paradigm (fireplace, light, wardroom, crew quarters), to initiate an exchange between the scientists staying in the station and the visiting Aerocrew.

The third aspect was called “Art-Habitat” (R. Binot). Exploration is often facing hostile conditions for which psychological balance is necessary. How can the technicalities of the habitat and the local environment conditions be used towards an esthetical environment and psychological balance ? The idea is here to use Art to overcome the contrast between the nature (cold temperatures, boreal auroras, very primitive world dominated but rich/diverse, rare/very localised biology), and the functional habitat and motivated scientific/technical crews. It should be an evolutionary art that depends on the competences and interests of the crew (residents and [successive] visitors), the availability of materials, and the actual base architecture. Examples could be to use video sequences, painting with light to reflect seasons, or creating a Japanese garden.

6) Conclusion and Perspectives

The mission demonstrated clearly the pertinence of aerospace training methodology for polar crews, the challenge and context being similar. It was also the occasion to demonstrate some particular situations such as a visio-conference with training session in France, which also induces analogies with space missions : the astronauts keeping in touch with their terrestrial job. In any way, the crossed cooperation between aerospace trainers and arctic teams is obviously promising and opens wide and affordable possibilities.

The Arctic bases constitute are unique to organize high level scientific seminars, not only for the exceptional environment, but also for the human context : specialized crew with competences in complementarity. The space training techniques are also very pertinent for the training of polar crews. In addition, the specific robotic applications are the occasion to test space systems, but also to help the polar researchers in particular activities such as ice specimen return, atmosphere analysis on site and in flight or bio-specimens in extreme media.

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