

Article

# Application of a Psychosocial Approach to the Identification and Strengthening of Adaptation Mechanisms of Humans and a Small Social Group during the Isolation Experiment “SIRIUS 2017–2023”

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**Abstract:** **TOPIC:** The task of the 21st century is the implementation of manned flights in Earth’s orbit with the view to building orbital and planetary bases. This requires addressing the impacts on people and small social groups in terms of psychological, psychosocial, physiological and health. The author presents her own comprehensive research and intervention approach to exploring and supporting the operation of the space crew in the four-month isolation period of “SIRIUS-18/19”, which can be used in the future for manned flights into deep space. **GOAL:** The main goal is to present three main areas, within the implementation of social research, designed to analyze the operation of the crew in a simulated space flight: **1. WORKING CONDITIONS, WORKING ENVIRONMENT AND SOCIAL ATMOSPHERE;** **2. the STRUCTURE AND DYNAMICS OF RELATIONSHIPS and TIES;** **3. a set of other specific areas.** The key outputs of the comprehensive analysis of the “SIRIUS-19” crew operations concerning the level of satisfaction with the working environment and conditions, the structure and dynamics of relationships and other specific areas are presented. The suitability of the implementation of intervention activities for isolated crews is pointed out. The purpose is to contribute to the preparation of human crews for manned flights in deep space and to reduce the risks of damage to human biopsychosocial health. **METHODS:** For a comprehensive analysis, a set of the author’s own questionnaire methods, verified over 25 years in the normal and extremely demanding conditions of specific professions, was used. The diagnostic and intervention method sociomapping, based on fuzzy theory and the mathematical modeling of outputs, was used for the analysis of the structure and dynamics of relationships as it is a technique suitable for the analysis of nonlinear dynamical systems. The methodology enabled the author to obtain a comprehensive view of the experimental situation from a psychosocial and sociological point of view. **RESULTS:** The model of the author’s analytical approach confirmed the legitimacy of its implementation in the case of isolation experiments. A comprehensive analysis of the “SIRIUS-18/19” crew’s work environment yielded outputs from the 10 main and 48 sub-areas analyzed. The analysis of the six-member, gender-mixed, multicultural crew in the area of structure and dynamics of relationships focused on 35 areas; a total of 344 sociomaps were created. The files were analyzed qualitatively and quantitatively using control diagrams. **CONCLUSIONS:** Outputs have the potential to be used in other isolation experiments as sociotechnical measures for project organizers and as verification of the need to introduce work with the crew in the form of development workshops using the sociomapping method.



**Citation:** Bernardova Sykorova, K. Application of a Psychosocial Approach to the Identification and Strengthening of Adaptation Mechanisms of Humans and a Small Social Group during the Isolation Experiment “SIRIUS 2017–2023”. *Aerospace* **2023**, *10*, 771. <https://doi.org/10.3390/aerospace10090771>

Academic Editor: Vadim Gushin

Received: 2 July 2023

Revised: 16 August 2023

Accepted: 24 August 2023

Published: 31 August 2023



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**Keywords:** exposed professions; small social group; relationships and ties; isolation; social action research; sociomapping

## 1. Introduction

The permanent state of threat to the life and health of humans and small social groups—in the form of space crews—residing and working for varying periods of time in the space environment, the financial complexity of space programs and the complexity of technological solutions require the implementation of many simulation studies for the purpose of research and astronaut training and have done so from the beginning of space exploration and the existence of cosmonauts. Exposed professions generally have their own complex system of personnel selection, which is subject to a number of rules and strict requirements in the psychological, psychosocial, social, physiological, health and physical condition and preparation fields, as well as requirements for a required degree of moral integrity. For each of the exposed professions, highly specific guidelines are drawn up to define which individuals are to be selected for the target group. The methodological demands of studying crews, which are often assessed over many months in a small, unchanging composition, have a number of limitations. The financial and organizational complexity associated with the long-term duration of these isolation experiments does not allow the collection of research data for large sets of target groups. Similarly, differences in the organization of these studies and the methods used are associated with different results when investigating similar phenomena. Due to these requirements, the study of individual psychological, social, sociological, medical, biological and physiological aspects takes place worldwide in broad international cooperation during long-term simulated or real stays of crews in space but are mostly isolated and unconnected, often without a holistic view and only at the level of basic research. However, a holistic approach is key to the ability to apply the results in practice, which was pointed out by the head of the Czech research team “KOSMOW” in their studies, as well as by the National Aeronautics and Space Administration, USA. In its materials on the area of so-called “Team risks”, under which most of the risks associated with a long-term crew stay in space fall, it emphasizes a holistic approach as one of the key conditions for the success of long-term missions which is no less important than, for example, the influence of radiation and state of weightlessness on the human organism [1]. In the same way, there is more and more demand for and emphasis on not only basic research, but especially applied operative research, which makes it possible to put the results of research into practice and verify their functionality in the longer term.

The Czech team was formed on the basis of many years of experience gained during the study of one of the exposed and highly specific professions—the military profession—and also follows the biggest challenges of current space research; therefore, it performs the study of the long-term stay of crews in space in a multidisciplinary, interdisciplinary, holistic and applied manner.

**THE MAIN GOAL** of the Czech team of scientists involved in the unique international research project “Scientific International Research In Unique terrestrial Station” (hereinafter “SIRIUS”) is to contribute to the implementation of simulated space flights and thus 1. to the preparation of human crews for real manned flights and deep space stays and 2. to the reduction of the risks of physical and psychological damage and the risks to the psychosocial health of the 21st-century man.

Project “SIRIUS” is being performed at the IBMP of the Academy of Sciences of the Russian Federation in Moscow, Russia, organized in close cooperation with the NASA HRP in preparation for lunar flights. The research project is being implemented in cooperation with partner organizations with the broad participation of specialists from Russia, the USA, Italy, Germany, France, the Czech Republic, Belarus and others, a total of 11 countries. The “SIRIUS” project program is designed for a period of up to five years. Several series of isolation experiments are planned for this period, lasting 2 weeks and 4, 8 and 12 months. The “SIRIUS” program is a continuation of the “Mars-500” project and concerns mainly the medical and psychological risks during long-term, independently piloted space flights and the operation of orbital and planetary bases and is aimed at examining the state of

health and the physical, psychological and professional performance of a person and small social groups.

The Czech research team “KOSMOW” looks at man and his preparation for a long space flight through the lens of psychology and sociology using mathematical modeling. The width of the team’s focus is limited, and so far sparsely interdisciplinary, which does not lag behind the international research environment. However, the goal of the Czech team is a biophysical approach based on a single research team. The cornerstone of this vision is an exceptional research project focused on the study of human behavior in the extreme conditions of long-term isolation.

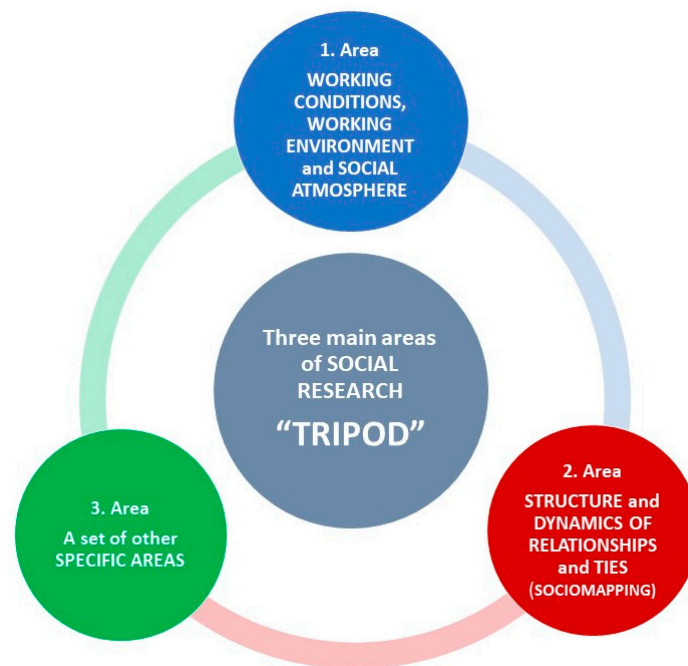
**THE PRIMARY FOCUS** in the preparation of long-term space missions so far lies more at the technical level and in technical solutions (development of space shuttles, key components, etc.). However, only a focus on man, his possibilities, needs, limits and behavior, but also attitudes to the whole thing and the resulting risks, which have not yet been explored in detail, will allow a holistic view of the planned expeditions into deep space with a human crew.

**THE EXPERIENCE** of the “KOSMOW” research team relates to the functioning of people and groups/teams of exposed professions in specific working conditions, often including long-term isolation and other stressors, who perform specific activities; their management and leadership requires specific knowledge, skills and abilities on the part of management whose common denominator is an extreme, multifaceted, long-term and therefore specific load. This is mostly a wide range of military professionals, including combat units for the first line of deployment, military fighter pilots and other persons and groups in the environment of the Armed Forces of the Czech Republic, with whom Sykora and Bernardova Sykorova worked, and also pilots—and cosmonauts within research projects related to space flights—with whom Sykora, Solcova, Dvorak, Drahota, Bahbouh, Bernardova Sykorova and others worked [2–12]. The appointed researchers of the “KOSMOW” team have been working for these target groups for many years in the field of analytics, but also in the subsequent and extremely valuable and useful for both parties—for the target groups and teams themselves and for their managers/military commanders—intervention field, according to Bernardova Sykorova.

The “KOSMOW” team uses, in its involvement in international cooperation in the field of space research, **a comprehensive, homogeneous and internally connected theoretical conceptual project and the resulting purposefully built practical approach to investigate men and small social groups in exposed professions** from a psychological, psychosocial and sociological point of view. This Model of Social Action Research, created by Bernardova Sykorova in the 1990s during her work in the Armed Forces of the Czech Republic, was deployed, used and verified by the Ministry of Defense of the Czech Republic from 1990 to 2015. From 2016 to now, it has been fully integrated into the space research of the Czech “KOSMOW” team [13–15]. As is shown in Figure 1.

The basic conceptual framework of the project has the form of a “TRIPOD”, which includes, when analyzing the functioning of a person and a small social group, three basic areas for analysis:

1. **Area of WORKING CONDITIONS, WORKING ENVIRONMENT AND SOCIAL ATMOSPHERE** in the target group (e.g., motivation, expectations, concerns, quality of preparation, etc.);
2. **Area of the STRUCTURE AND DYNAMICS OF RELATIONSHIPS AND TIES** (e.g., the area of communication, cooperation, support, natural trust, the influence of intercultural and gender aspects, etc.);
3. **A set of other SPECIFIC AREAS** according to the focus of the target group (e.g., sleep, fatigue, rest, war kills and hardships, etc.) [3].



**Figure 1.** Model of social action research, created by Bernardova Sykorova in the 1990s during her work in the Armed Forces of the Czech Republic, 1995–2015.

#### *Topic Definition and Research Objective*

The project of this **comprehensive study** relating to levels of living, working and psychosocial satisfaction, team structure and dynamics and other specific factors (fatigue, sleep quality, etc.) focuses on the **functioning of a small social group in extremely demanding working conditions**—the space crew of “SIRIUS-18/19”, a space mission with a stopover on the Moon with a precise and detailed scenario of activities performed by crew members for a period of **120 days**.

**THE GOAL** of the project is to obtain key **information in the field of human resources** in extremely demanding conditions of isolation, which the simulated space manned flight undoubtedly includes.

**THE MAIN OBJECTIVE** is to **estimate trends** in the functioning of persons and small human clusters isolated in a simulated space flight and to **answer questions** aimed at perceiving the broader context of the human factor when in long-term isolation and carrying out specific activity in all areas of the extremely demanding and specific conditions of a space mission.

**THE PURPOSE** of this research is to **obtain a comprehensive and representative overview of the data and findings**, revealing **factors so far little known or even unknown**, such as crew composition in terms of gender and, furthermore, to **detect favorable factors** with apparently fundamental influence on the **successful functioning of people in extremely demanding conditions of isolation** so that they can be used in further experiments. In addition, it aims to **detect the “deltas”** in the activities of crews designed to develop **individuals and groups/teams** and also to appropriately influence preparation for the experiment, e.g., **compiling a program of activities** for space crews in simulated flight and in other experiments for crews heading to near and deep space in real manned flight.

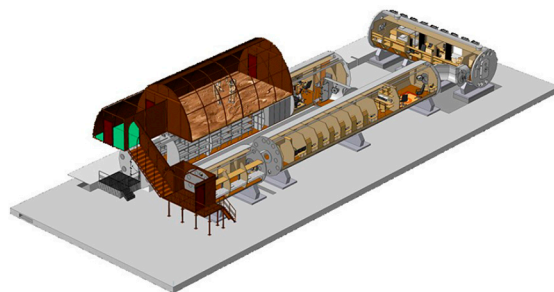
## **2. Research Methodology and Research Project Design**

The “KOSMOW” team based its research organization and drawing up of a methodology for the 2nd project stage of “SIRIUS 18/19” on the following facts:

1. In the **Ground Test Complex**, in Russian—Nazemnyj Experimentalnyj Komplex (NEK), in an isolation simulator, located on the premises of the IBMP RAS of the Russian Federation in Moscow, a **mixed-gender crew of 6 persons** was sealed for a

period of **4 months** (March–July 2019), i.e., **120 days**, in a simulated flight to the Moon **with a precisely defined work agenda**. Within this given and unalterable experiment design, the project concerning this simulated space mission applied a **combination of the proprietary methods** created and developed by Bernardova Sykorova and the team of expert human resources functioning team of the Ministry of Defense of the Czech Republic and the Armed Forces of the Czech Republic, used repeatedly in the past and verified many times, particularly as part of foreign military missions. **These questionnaire techniques were modified** with respect to the characteristics of the cosmonauts'/astronauts' professions and the fixed scenario of the "SIRIUS" project. The crew dynamics were then monitored during the experiment using the following methods:

- a. To identify non-relationship aspects, we chose a questionnaire survey method focused on topics of work and life satisfaction;
  - b. The mapping of the structure and dynamics of social relationships and ties within the crew used the unique method of sociomapping [2] based on sociometric principles;
  - c. The analysis of specific areas of the reality in isolation also used a questionnaire survey technique focused on the selected following topics: **fatigue, sleep quality**. As is shown in Figure 2.
2. **Data collection** throughout the crew's isolation was organized by employees of the IBMP RAS on the experiment execution site in Moscow, right on IBMP RAS premises; it proceeded in three stages—"BEFORE" the start of the experiment, "DURING" it and "AFTER" its termination in the post-isolation phase;
  3. **Data processing**—collective data processing was ruled out due to the small numbers of experiment participants ( $n = 6$  persons); the data were analyzed at an individual level and in the context of the group and its long-term functioning;
  4. In the post-isolation stage of the experiment, the completion of the data collected and the findings and confirmation of the validity of the data obtained from the questionnaire survey and sociomapping and the direct developmental work with the crew necessitated semi-structured interviews with all the crew members of "SIRIUS-18/19" at the place of isolation, the IBMP RAS in Moscow, in July 2019;
  5. **Processing of the research data acquired**—the statistical processing of data acquired was performed using **mathematical and statistical models** in the computer software Microsoft Excel, IBM SPSS version 25 and RTS. The analysis concerned both **relational and non-relational variables**. The resulting data were transferred using the chosen software **into tables, charts, control diagrams and sets of sociomaps** and are presented accompanied with **interpretation text**.



**Figure 2.** Diagram of the current form of the Ground Test Complex, in Russian—Nazemnyj Eksperimentalnyj Komplex (NEK). Taken from: <http://sirius.imbp.info/nek.html>.

## 2.1. Brief Introduction to Main Methods

### 2.1.1. Sociomapping Method

**The sociomapping method** was developed in the 1990s and has been continually developed ever since. This technique is a sociometric method enabling analysis/diagnostics,



data visualization and intervention work with given human units. It enables the analysis of the structure and dynamics of social relations and ties in the group and their subsequent visualization using a landscape metaphor. Its basis is a subfield of mathematical logic—the fuzzy logic approach—derived from the theory of fuzzy sets, in which logical statements are evaluated by the degree of truth. This basis enables the subsequent mathematical modeling of the analyzed social entities. The output is a so-called sociomap, which has the form of a synoptic map that shows individual social systems and which is very illustrative, understandable and easy to grasp. It is used to analyze group/team relationships, ties and affiliations [2].

**Sociomapping** of relationships and ties has been massively used since the beginning of the 1990s by research and expert workplaces of the Armed Forces of the Czech Republic; the method has been deployed in military units at a diagnostic **level** to analyze relationships in many areas that have a significant impact on group cohesiveness. In the Czech army, its intervention **level**, aimed at the development of relationships and ties in military units, was significantly developed with the help of a series of **development workshops** using the sociomap files of a given group/team [3]. Sociomapping **offers an immediate solution to situations in interpersonal and intragroup relations**; it is also a **unique method for forecasting the development of relationships in human groups**, which is especially valuable when analyzing the functioning of **exposed professions**. It is therefore also an intervention method with a high degree of effectiveness, as has been possible to verify for many years.

Its other significant period of use took place in the 1990s, **also in the field of space research, as part of international simulation experiments “HUBES 94”, “ECOPSY 95” and “Mars 105”** [3]. Its contribution to space flight simulations and real manned flights into space are described in detail in the publication “Mars-500: Facts and considerations from a simulated flight to the Red Planet” [12] and in the book *Team Sociomapping* [2]. The method is currently being used within the international research project “SIRIUS 2017–2023”.

#### 2.1.2. Frequency Content Analysis

Frequency content analysis, sometimes shortened to content analysis, is used for systematic and quantitative description of the contents of a document or audio recording or other written or voice records such as parts of dialogues and various lectures and other situations.

#### 2.2. Statistical Processing of Research Data

As part of the statistical processing of research data in the 1st area of life/work satisfaction level, and in the 3rd set of specific areas, **descriptive statistics** were used, enabling the analysis of quantitative properties of data sets in the form of combining the monitored data into frequency tables and graphs. As part of the statistical processing of research data in the 2nd area of structure and dynamics of relationships and links, statistically more advanced methods were used, including **exploratory analysis** [2].

A combination of the above diagnostic and analytical methods, mathematical modeling and organization, is a solid foundation for the **comprehensive interpretation of the psychosocial, psychosocial, social and sociological aspects of isolation** experienced by the space crew, as well as the formulation of **proposed measures**.

### 3. Theory and Calculation

Research projects to date, focused on examining the functioning of a person and a small social group, carried out by a Czech team from the 1990s to the present day, confirmed that the Model of Social Action Research by Bernardova Sykorova is one of the possible paths for the psychological and psychosocial analysis of the level of life/job satisfaction of exposed professions in highly specific working conditions. The above-mentioned “**TRIPOD**” model brings key outputs that 1. map the monitored target group and 2. at the same time, become

the basis for the organization and preparation of human resources for further simulated or real space missions. The challenge for the present and the near future is the implementation of further studies that allow a detailed comparison of outputs in all three of the areas presented above. Further long-term, comprehensive research/research in the psychosocial and psychological fields will contribute to the successful performance of the extremely demanding and highly specific profession of cosmonaut/astronaut through the following chain of steps: **1. description** → **2. analysis** → **3. intervention** → **4. prediction**.

#### 4. Results

In the final research report—**Human Factors Monitor No. 3** (HF Monitor 3): **“Comprehensive analysis of quality of psychosocial conditions as part of a simulated space flight to the Moon by crew SIRIUS-18/19; 2nd stage of project “SIRIUS 2017–2023”**—which includes 335 pages of text and 130 pages of graphic appendices in the form of graphs, tables and sociomap files, a total of 465 pages, outputs from all three analyzed areas in three stages of the simulated space mission are described in detail. Due to the considerable extent of the analyzed areas, one key output for each main area is demonstrated below.

##### 4.1. Area of Working Conditions, Working Environment and Social Atmosphere

The data acquired relating to the degree of life/work satisfaction were evaluated using quantitative and qualitative analysis.

The outcomes of the quantitative analysis were processed using mathematical and statistical models in the computer software Microsoft Excel and IBM SPSS version 25.

The outcomes of the qualitative analysis were processed using frequency content analysis and sorted into synoptic summary tables according to content categories.

In the field of mapping **working conditions, working environment** and **social atmosphere**, 10 basic areas and 85 sub-areas were analyzed:

##### 4.1.1. Personal and Work Characteristics of Crew Members

- S1. Experience with isolation in the past;
- S2. Motivation to participate;
- S3. Expectation for isolation;
- S4. Fears in isolation;
- S5. Possible reasons for not participating;
- S6. Personal importance of the SIRIUS project;
- S7. Hardships during isolation;
- S8. Preparation for homecoming;
- S9. Professional prospects after isolation;
- S10. Expectations for personal life after returning;
- S11. Looking for help—other problems.

##### 4.1.2. Crew Attitude to Space Research

- S12. Attitudes to statements;
- S13. Implementation of space experiments, own opinion;
- S14. Implementation of space experiments, opinions of others;
- S15. Positive/negative opinions of others regarding implementation of space experiments;
- S16. Expectations of experiment vs. reality;
- S17. Typical Russian cosmonaut;
- S18. Typical American astronaut.

##### 4.1.3. Preparation for Isolation

- S19. Knowledgeableness level for participation in the experiment;
- S20. Sources of information on the experiment;
- S21. Quality of professional preparation;

- S22. Useful aspects of training;
- S23. Useless aspects of professional preparation;
- S24. Characteristics of professional preparation;
- S25. Level of psychological preparation;
- S26. Useful aspects of psychological preparation;
- S27. Useless aspects of psychological preparation;
- S28. Quality of physical preparation;
- S29. Useful aspects of physical preparation;
- S30. Useless aspects of physical preparation;
- S31. Characteristics of physical preparation;
- S32. Satisfaction with quality of experiment logistics;
- S33. Shortcomings in preparation;
- S34. Degree of trust in experiment organization;
- S35. Overall quality of preparation for isolation;
- S36. Satisfaction with the level of training after the mission experience;
- S37. Satisfaction with the level of psychological preparation after the mission experience;
- S38. Satisfaction with the level of physical preparation after the mission experience.

#### 4.1.4. Preparation for Isolation

- S39. Characteristics of working conditions;
- S40. Satisfaction with working conditions;
- S41. Satisfaction with work position;
- S42. Affiliations within the job position;
- S43. Support of the control center;
- S44. Comparison of expected and real work performance;
- S45. Three things to improve working conditions;
- S46. Saturation of needs in isolation.

#### 4.1.5. Relationships and Affiliations, Social Atmosphere, Communication

- S47. Social atmosphere in the team;
- S48. Satisfaction with team composition;
- S49. Own influence on decision making in team;
- S50. Occurrence of misunderstandings;
- S51. The level of interpersonal relations;
- S52. Trust in colleagues, officials, institutions;
- S53. Communication level assessment;
- S54. Own effect on team decision;
- S55. The occurrence of misunderstandings;
- S56. Own influence on team decisions.

#### 4.1.6. Crew Members' Current Psychological Condition

- S57. Emotional experience;
- S58. Current psychological state;
- S59. Looking for help—psychological problems.

#### 4.1.7. Crew Commander

- S60. Crew commander's professional abilities;
- S61. Characteristics of the commander;
- S62. The vision of an "IDEAL" commander;
- S63. Satisfaction with the commander's work;
- S64. The reality of the "IDEAL" SIRIUS crew commander.



#### 4.1.8. Equal Opportunities, Aspects of Intimacy during Isolation

- S65. Women's position in the crew;
- S66. Expectations of the gender-mixed team;
- S67. Attitudes to statements;
- S68. The role of women cosmonauts/astronauts, own opinion;
- S69. The role of women cosmonauts/astronauts, opinions of social circles;
- S70. Positivity/negativity of the presence of the opposite sex in the team;
- S71. Effect of physical and sexual attraction on performance;
- S72. Recommendations vs. non-recommendations of gender-mixed crew for real flight;
- S73. Presence/absence of being brought closer together during isolation;
- S74. Experience with long-term sexual abstinence in the past;
- S75. Comparison of expected and real frustration from long-term sexual abstinence;
- S76. Solving sexual frustration.

#### 4.1.9. Equal Opportunities, Aspects of Intimacy during Isolation

- S78. Family provision;
- S79. Family support;
- S80. Family attitude to participation in the experiment.

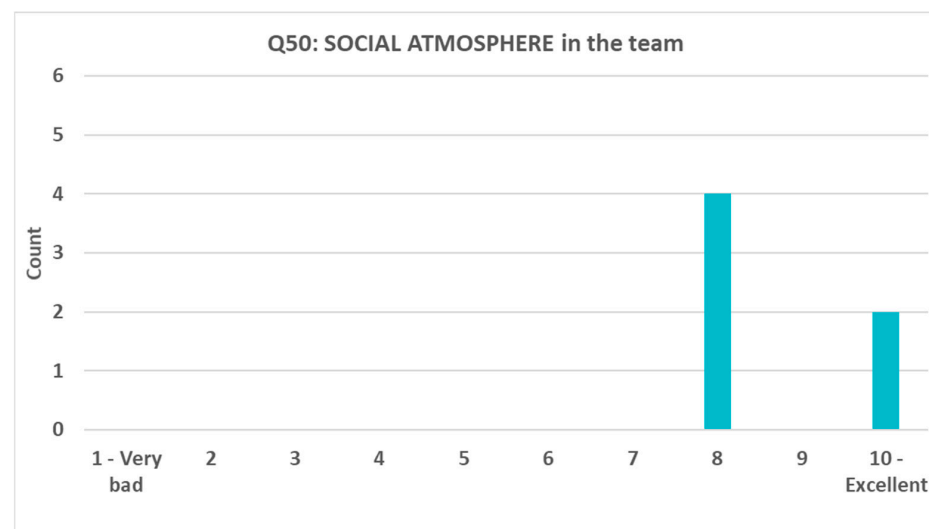
#### 4.1.10. Additional Areas of Assessment of SIRIUS 18/19 Isolation Experiment

- S81. Sources of joy upon return;
- S82. Recommendations to the crew of the next mission;
- S83. Best experience;
- S84. Worst experience;
- S85. One word—characterizing isolation.

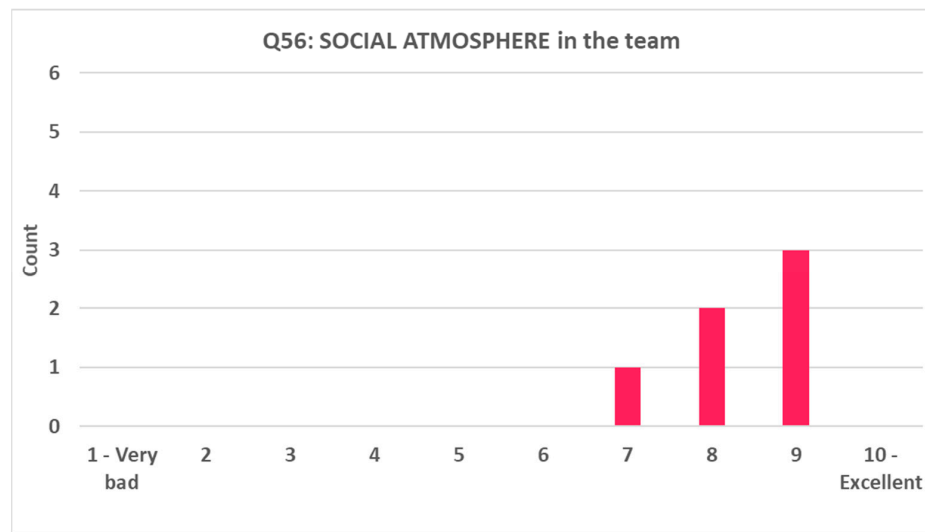
#### 4.1.11. Example—Social Atmosphere in the Team

For the sake of illustration, the outputs relating to the evaluation of the social atmosphere in the crew during the period of isolation are presented here.

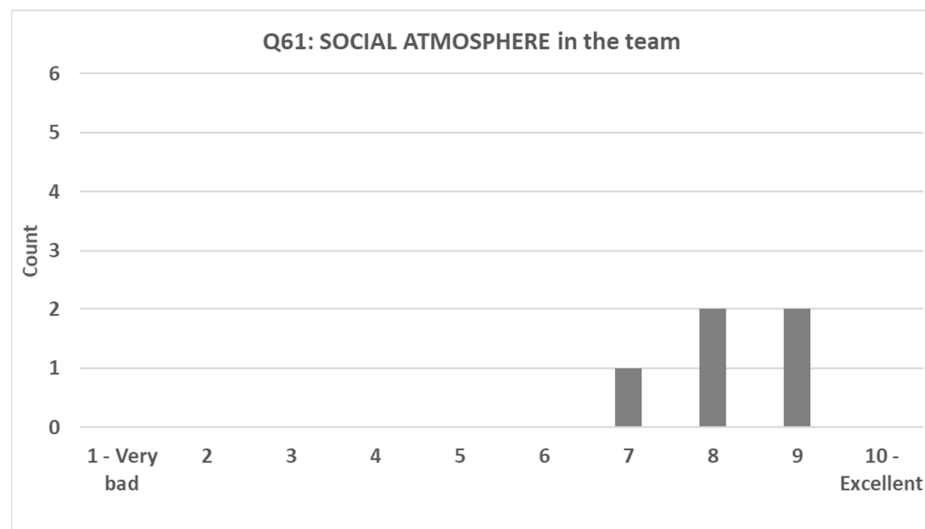
Social atmosphere in the crew of "SIRIUS 18/19" was rated by the respondents as high throughout the isolation. It was the highest in the stage before isolation (8 to 10 on a 10-point scale). Halfway through and after the isolation, the ratings of the social atmosphere decreased slightly (7 to 9) but still remained at a high level. This is generally understandable given the mission length, demands and socially monotonous environment. The positive finding is that the absolute rating of social atmosphere did not decrease dramatically. As is shown in Figures 3–5.



**Figure 3.** Social atmosphere in the team before isolation.



**Figure 4.** Social atmosphere in the team halfway through isolation.



**Figure 5.** Social atmosphere in the team after isolation.

#### 4.2. Area of the Structure and Dynamics of Relationships and Ties

The project paid a great deal of attention to the structure and dynamics of relationships and affiliations among SIRIUS 18/19 crew members throughout the isolation experiment. The relationship analysis selected key areas for analysis in three stages of the isolation: before isolation, during and halfway through the isolation, as well as in the post-isolation stage, i.e., after isolation, placing an emphasis on capturing the development of relationships within the crew in the course of several months (the 4 months of isolation itself + preparatory period).

As part of the second stage of the “SIRIUS-18/19” project, a total of 172 non-scaled and 172 rescaled sociomaps were created based on the continuous collection of research data during the entire period of isolation, i.e., a total of 344 sociomaps. The complete sets of sociomaps are a separate appendix to the final research report (HF Monitor No. 2).

- For the first stage of the research → before isolation, we made 15 sociomaps;
- For the second stage of the research → halfway through isolation, we made eight sociomaps;
- For the second stage of the research → every seventh day of the whole isolation, collecting data 17 times between March and July 2019, covering eight areas each time, we made a total of 136 sociomaps;
- For the third stage of the research → after isolation, we made 13 sociomaps;

- In total, we obtained 172 unscaled sociomaps (NO rescale in the program Real Time Sociomapping—RTS), which were used in this form for comparison of the individual outcomes. For finer differentiation of the outcomes, these map sets were further rescaled (Rescale THIS in RTS) and were designed for direct intervention with the target group; thus, we obtained another 172 scaled sociomaps (Rescale THIS in the program Real Time Sociomapping—RTS); the total number was 344 sociomaps.

The analysis using sociomapping selected the following areas:

#### 4.2.1. Areas Sociomapped before the Isolation

- A1. Knowledge → current;
- A2. Knowledge → desired;
- A3. Working relationship;
- A4. Personal relationship;
- A5. Cooperation;
- A6. Support in difficult situation;
- A7. Natural authority;
- A8. Stress coping;
- A9. Work support;
- A10. Professionalism;
- A11. Support for commander;
- A12. Support for crew from commander.

#### 4.2.2. Areas Sociomapped before the Isolation

- A1. Communication → current frequency;
- A2. Communication → desired frequency;
- A3. Cooperation;
- A4. Communication → quality;
- A5. Cooperation → importance;
- A6. Cooperation → availability;
- A7. Cooperation → reliability;
- A8. Cooperation → outputs' quality.

#### 4.2.3. Areas Sociomapped in the Middle of the Isolation

- A1. Working relationship;
- A2. Personal relationship;
- A3. Cooperation;
- A4. Stress coping;
- A5. Influence on working performance;
- A6. Work support;
- A7. Support for commander;
- A8. Support for crew from commander.

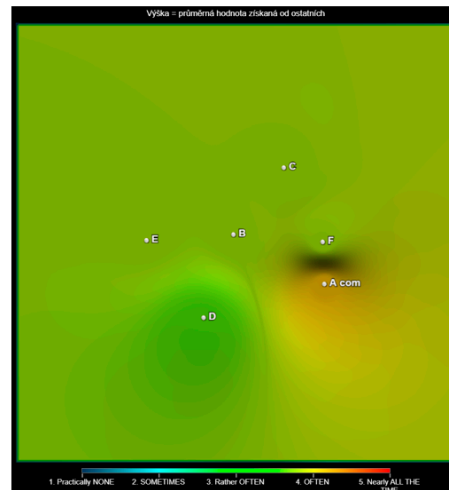
#### 4.2.4. Areas Sociomapped after the Isolation

- A1. Knowledge → current;
- A2. Knowledge → desired;
- A3. Working relationship;
- A4. Personal relationship;
- A5. Cooperation;
- A6. Support in difficult situation;
- A7. Natural authority;
- A8. Stress coping;
- A9. Work support;
- A10. Professionalism
- A11. Support for commander;

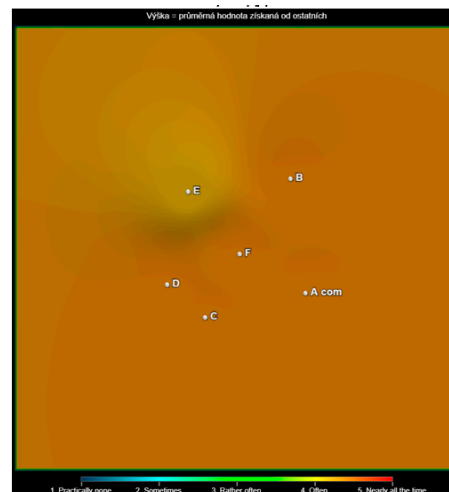
- A12. Support for crew from commander;
- A13. Influence on working performance;
- A14. Team agreement;
- A15. Repeated isolation.

#### 4.2.5. Example—Work Support

From the mentioned analyzed areas, a set of sociomaps relating to revealing the attitudes of the “SIRIUS-18/19” crew members to the mutual work support among the crew members was selected to illustrate the outputs. As is shown in Figures 6–8.



**Figure 6.** Work support among the crew members, no rescale, before isolation.



**Figure 7.** Work support among the crew members, no rescale, halfway through the isolation.

In the area of mutual work support, at a general level, the results spoke of a very high level of mutual support; the team “pull together and cover each other’s backs”. At the start of the isolation, commander A supported his people “highly and very often”, and the persons B, C, E and F also supported other team members “highly and often”. Halfway through the mission, the degree of mutual support increased even more; commander A and crew members B, C, D and F supported the crew “almost constantly and often”. The person E did often too, even if somewhat less than the others. A rapid growth in mutual support was related to the final stage of the isolation, when everybody supported the others “often to almost constantly” and increasingly pulled together and helped each other. As is shown in Figure 9.

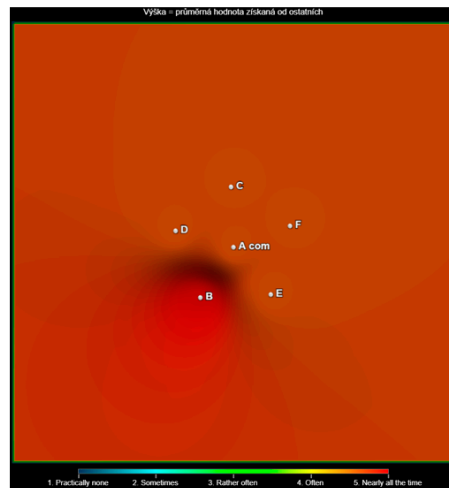


Figure 8. Work support among the crew members, no rescale, after isolation.

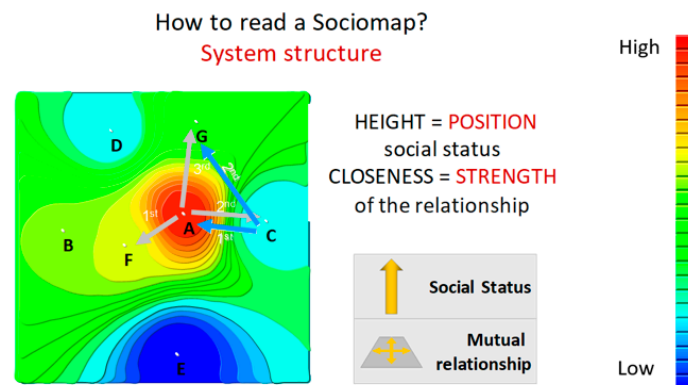


Figure 9. Reading sociomap.

The sets of sociomaps related to the collection of research data in the above-mentioned stages of isolation—before, halfway through and after—were examined through qualitative analysis, which allowed examination of the positions of individual members in the team, their mutual social distance, the arrangement of people in the given grouping, the degree of cohesion of the given group/team, event creation, subgroups, affiliation and other factors affecting the functioning of the group.

In addition to standard statistical procedures, the first eight areas (relational issues visualized by sociomapping) made use of the following statistical procedures, closely linked to the sociomapping method:

(a) **Regulatory diagrams** are a standard method in quality control used in repeated measurements of quantitative characteristics in time. Regulatory diagrams examined the average degree of the mutual rating of the crew members and its deviations in time. They made it possible to distinguish statistically insignificant fluctuations from significant oscillations in the mutual rating and trends in data that may have been less conspicuous than a singular significant oscillation [2].

In the case of regular data collection, e.g., every 14 days during the entire isolation, sociomaps were processed, in addition to qualitative analysis, with quantitative analysis. The output was then regulatory diagrams which showed the development of the average values of the mutual evaluation of the crew members in the given area;

(b) **Two-group separation tests**, which make it possible to analyze the presence or absence of the tendency to form subgroups. The separation test is a suitable tool for indicating a situation where “it holds for two subteams that communication within the subteams is statistically significantly higher than communication between the two subteams” (Bahbouh et al., 2012) [2]. Specifically, the two-group separation test uses median

values and deviations in the parameters analyzed to compare whether the value of the parameter within the potential subteams statistically significantly outweighs the value of the parameter between the two potential subteams [2].

For illustration, diagram no. 4 is presented regarding the development of values in the assessment of relationships and ties in the “SIRIUS-18/19” crew when collecting data every 14 days.

The mutual ratings of cooperation were stable throughout the isolation, not deviating outside the central zone (CL = 4.33; UCL = 4.77; LCL = 3.87). In the first five measurements, it was above the central line (with a maximum in data collections 3 and 4), then it decreased and reached a minimum in the sixth data collection and then showed another insignificant but noticeable decrease in data collection 10. From the 11th data collection onwards, the mutual ratings were stable and close to the central line. As is shown in Figure 10.

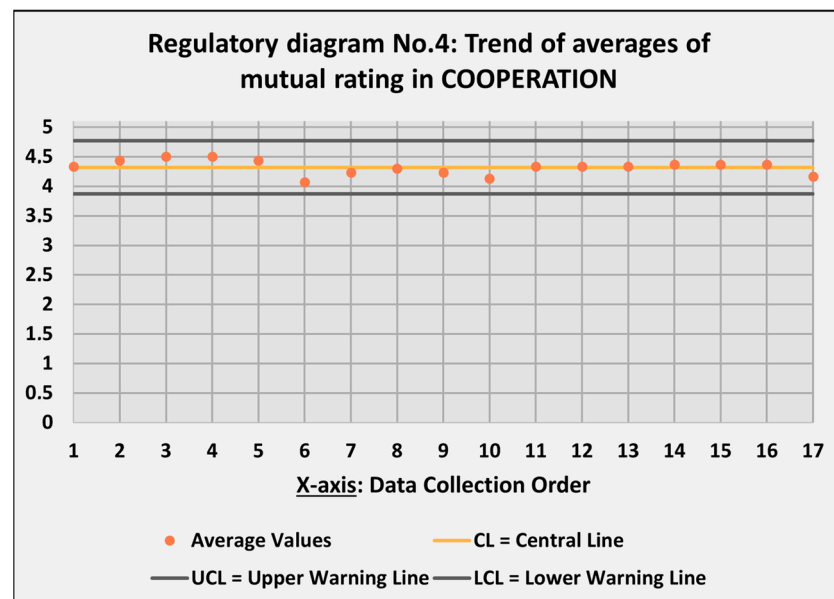


Figure 10. Regulatory diagram for cooperation.

#### 4.3. A Set of Other Specific Areas (Fatigue, Sleep)

The data acquired for the degree of life/work satisfaction were evaluated using quantitative and qualitative analysis.

The outcomes of the quantitative analysis were processed using mathematical and statistical models in the computer software Microsoft Excel and IBM SPSS version 25.

The outcomes of the qualitative analysis were processed using frequency content analysis and sorted into synoptic summary tables according to content categories. In the field of mapping specific areas, 5 basic areas and 30 sub-areas were analyzed:

##### 4.3.1. Fatigue Assessment Scale

S1. Fatigue Assessment Scale (FAS), sum score [16].

##### 4.3.2. Fatigue in Normal Conditions

S2. Frequency of total fatigue in normal conditions;

S3. Causes of fatigue under normal conditions;

S4. Symptoms of fatigue under normal conditions.

##### 4.3.3. Fatigue during Isolation

S5. Frequency of total fatigue in the preparatory isolation period;

S6. Frequency of total fatigue during isolation;

S7. Fatigue intensity in the preparatory isolation period;



- S8. Fatigue intensity during isolation;
- S9. Causes of fatigue in the preparatory isolation period;
- S10. Causes of fatigue in isolation;
- S11. Symptoms of fatigue during the preparatory isolation period;
- S12. Symptoms of fatigue during isolation;
- S13. Fatigue syndrome during isolation.

#### 4.3.4. Sleep in Normal Conditions

- S14. Ways of coping with disrupted sleep under normal conditions;
- S15. Ways of coping with lack of sleep under normal conditions.

#### 4.3.5. Sleep during Isolation

- S16. Sleep characteristics during isolation;
- S17. Sleep characteristics in the preparatory isolation period;
- S18. Assessment of coping with changes in sleep schedule;
- S19. Causes of disrupted sleep in the preparatory isolation period;
- S20. Causes of disrupted sleep in isolation;
- S21. Frequency of need for activities helping to cope with lack of sleep;
- S22. Frequency of need for activities helping to fall asleep;
- S23. Frequency of need for activities helping to fall asleep in isolation;
- S24. Frequency of the possibility to carry out activities helping to fall asleep;
- S25. Possibility to compensate for lack of sleep during the preparation for isolation;
- S26. Possibility to compensate for lack of sleep during isolation;
- S27. Most difficult consequences of changes in sleep schedule;
- S28. Effect of changes in sleep schedule on crew;
- S29. Attitude to dreams;
- S30. Occurrence of dreams.

#### 4.3.6. Example—Fatigue during Isolation

The frequency of overall fatigue, when comparing the stages before, halfway through and after the isolation, was the highest in the period before the isolation. In the period before the isolation, two respondents felt tired every day, two respondents 1x to 3x a week and two respondents never. The frequency of overall fatigue decreased halfway through the isolation. Then, most of the respondents (4x) experienced fatigue several times a month (1x–3x), one respondent 1x a week and one never. In the phase after isolation, the crew members rated their fatigue similarly to halfway through the isolation. Only one respondent said they experienced no fatigue during the isolation. That said, none of the respondents felt they had experienced fatigue regularly every day in the past six months. As is shown in Figures 11–13.

The most frequent cause of fatigue in the phase before isolation was physical activity (3x), followed by trip to and from work (work commute). This corresponded to the strain before the isolation period when the crew members were preparing for the upcoming isolation.

In the phase halfway through the isolation (after 2 months of it), the frequency of answers to this question increased (to 8 units), corresponding to the demands of isolation. The most pressing cause of fatigue (3 out of 8 units) was lack of sleep. Given the timetable of the “SIRIUS-18/19” project and the inclusion of phases of varying sleep length and continuity, its perceived lack is an understandable effect.

After the completion of the whole isolation period, the number of causes of fatigue decreased to 5, the first place being occupied by demanding physical testing. Quite surprisingly, the lack of sleep, dominating the period halfway through the isolation, appeared in only one statement. As is shown in Figures 14–16.

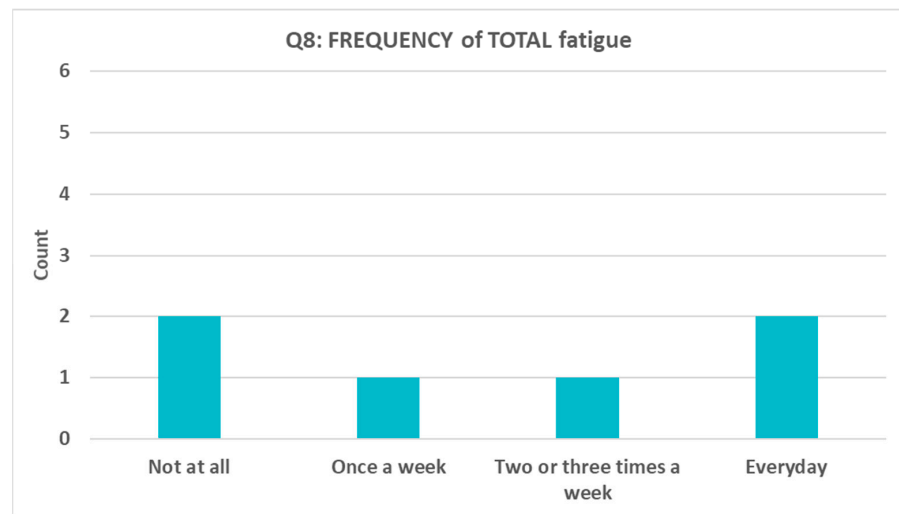


Figure 11. Frequency of overall fatigue before isolation.

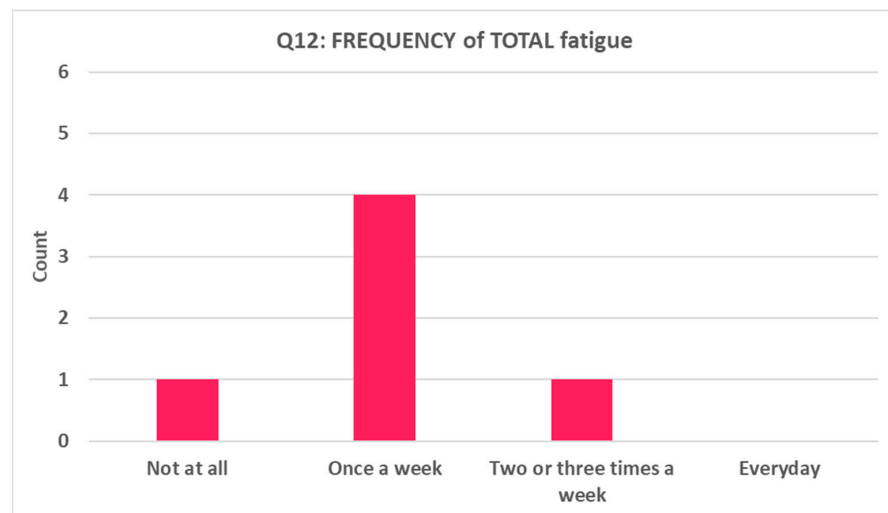


Figure 12. Frequency of overall fatigue halfway through isolation.

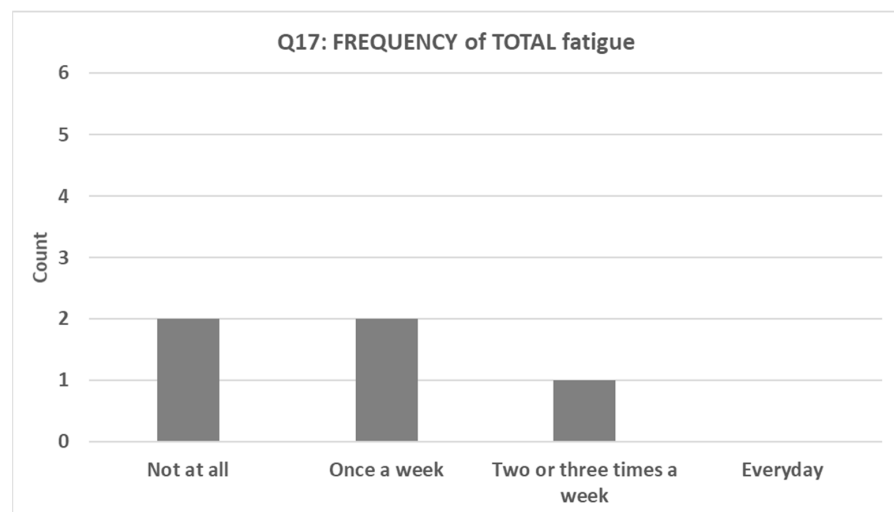


Figure 13. Frequency of overall fatigue after isolation.

| Causes of fatigue in preparatory period, BEFORE isolation |                 |  |           |
|---|-----------------|--|-----------|
| Content unit  | Total frequency | Specification                          | Frequency |
| 9. Causes of fatigue                                      | 7               | Physical activity                      | 3         |
|   |                 | Trip to and from work                  | 2         |
|   |                 | Getting up early                       | 1         |
|   |                 | Excessive intensive and diverse duties | 1         |
|   |                 | <b>TOTAL</b>                           | <b>7</b>  |

Figure 14. Causes of fatigue before isolation.

| Causes of fatigue HALFWAY through isolation |                 |  |           |
|---|-----------------|--|-----------|
| Content unit                                | Total frequency | Specification                            | Frequency |
| 14. Causes of fatigue                       | 9               | Lack of sleep                            | 3         |
|   |                 | Intensive physical strain                | 1         |
|   |                 | Excessive cognitive testing              | 1         |
| No answer 2x                                |                 | 3 days of work in a row without any rest | 1         |
|   |                 | <b>TOTAL</b>                             | <b>6</b>  |

Figure 15. Causes of fatigue halfway through the isolation.

| Causes of fatigue AFTER isolation |                 |                            |           |
|-----------------------------------|-----------------|----------------------------|-----------|
| Content unit                      | Total frequency | Specification              | Frequency |
| 19. Causes of fatigue             | 5               | Demanding physical testing | 2         |
|                                   |                 | Lack of sleep              | 1         |
|                                   |                 | Intensive work activity    | 1         |
| No answer 2x                      |                 | NO FATIGUE                 | 1         |
|                                   |                 | <b>TOTAL</b>               | <b>5</b>  |

Figure 16. Causes of fatigue after isolation.

### 5. Discussion

The Social Action Research Model presented above has already been implemented three times within the international project “SIRIUS”. The analyses so far have resulted in many interesting, valuable and useful outputs for future space expeditions which were obtained by detailed examination of areas verified for many years in normal and extreme working conditions by exposed professions, mostly Czech military professionals and military fighter pilots.

As part of the second stage of “SIRIUS 18/19”, a detailed analysis of all three areas—1. level of job satisfaction, 2. structure of relationships and ties and 3. specific factors—in the functioning of the crew during the 120 days of isolation was carried out. The outputs were divided into 11 basic areas:

1. Personal and work characteristics of crew members;
2. Attitudes of the crew towards space research:
  - (a) Attitudes of the crew towards space research generally;
  - (b) Attitudes of the crew towards the international research project “SIRIUS”.
3. Preparation for isolation;
4. Working conditions within isolation;
5. Relationships and connections, social atmosphere, communication within the crew:

- A. **Qualitative analysis of sociomap files;**
  - B. **Quantitative analysis of selected sociomap files.**
6. The current psychological state of the crew members;
  7. Crew commander;
  8. Equal opportunities, aspects of intimate life during isolation;
  9. Personal and family life of crew members;
  10. Specific areas—fatigue, sleep, work performance, intimacy;
  11. Additional areas of evaluation of the isolation experiment “SIRIUS-18/19”.

The large number of key and partial outputs goes beyond the scope of this contribution, which serves only as an example or a kind of outline of one of the possible analytical paths for investigating the functioning of small social groups in a very specific environment.

**The “foundational building block” of this analytical approach dates from the 1990s**, since when it has been possible to learn about, map and analyze the functioning of human resources for almost **30 years through two expert field research centers of the Czech army** led by Sykora and Bernardova Sykorova. The target group was soldiers from a wide range of military professions as well as civilian employees of the Ministry of Defense of the Czech Republic. Research projects in the form of **long-term comparative studies or ad hoc analyses** aimed at immediate disclosure of a given situation were implemented across the Czech army in **normal conditions** but also in **extremely demanding conditions**. Foreign **military missions** and **the peace-making, peace-keeping or combat missions** of any army in the world bring situations where people experience demanding to over-limit loads of varying intensity due to a wide range of causes.

These many years of research have brought a large amount of data, insights and information, but also methodical instructions on how to investigate the functioning of people and small social groups in extremely demanding living/working conditions further, better and in more detail. They produced outputs that can be generalized to professions that have many “common denominators”—**military professionals of various specifications, military and civilian pilots, military fighter pilots, policemen, firefighters and rescuers, but also pilots—cosmonauts/astronauts.**

As part of the “SIRIUS” project, the questions were asked: What connects the professions of professional soldier and flyer—**cosmonaut/astronaut? Is there any analogy between these professions?** The answer is, thanks to the years of experience of Sykora and his team in the field of space research and Bernardova Sykorova and her team in the area of the military environment, quite clear. Both of these professions must **be prepared**. To be prepared to endure extreme conditions they must be together, they must work together, they must learn to trust, they must be able to be a proactive part of teamwork, they must be able or learn to tolerate isolated areas and exist in closed environments without problems within social groups, they must be able to carry out long-term activities, they must be able to endure monotony and stereotypical activity often, they must be ready to bear stress and extreme load and they must adapt as quickly as possible to states of psychic oversaturation. They must be prepared for eventualities: injury, own death, loss of a fellow warrior. They must quickly adapt to a new environment, must learn to work in a mixed-gender team and must be prepared for long-term separation from family. Both professions must handle all of this in either a military or space mission situation.

However, ultimately, certain differences appear within their professions. A soldier experiences war, combat, the act of killing and repeated killing, often having to deal with loss, often of his closest comrade. Due to being in a spaceship, an aviator—cosmonaut/astronaut experiences limited space, sensual deprivation and limited communication, is often lonely and also exists in a kind of “**DEEP AND UNKNOWN**”, which he can feel especially intensely in space when the planet Earth is moving further and further away from him during a space flight into near or deep space. **What both professions experience together and especially strongly is stress and extreme or even excessive load.**

On a very general level, it is possible to answer the question as to what helps these professions to bear this “weight” and the difficulty of the situation and activity; in addition

to readiness—precise professional preparation, physical preparation, good physical health, psychological and psychosocial preparation and a certain degree of own moral integrity—it is mainly these factors: mutual trust, communication, cooperation, social atmosphere in the group, composition and the functioning of the team and a strong manager/commander and leader. In conclusion, the most important and absolutely key factor—only a few factors influence the activity, the work process, the life of a person and small social groups in general as much—is interpersonal and intergroup relations and ties, their tightness and interconnectness, their structure and the dynamics subject to external and internal influences taking place in every person. **Only a team in which all members “pull together and cover each other’s back” can fulfill all the tasks set, can successfully reach the goal and can handle the most difficult life moments and tasks within the framework of personal and working life. As individuals and as a group, they can handle such extremely demanding and in every way over-the-limit situations and activities, which military and space missions undoubtedly are.**

The complex, detailed analytical process used for the researched crew of “SIRIUS-18/19” once again confirmed what has already been proven many times—the importance of a strong and charismatic leader and a highly professional commander who, within the framework of a simulated four-month flight to the moon, was able to provide his people with the conditions for creating the tightest and the most interconnected relationships and ties, to develop mutual trust between people and between himself and his people, to enable a completely comprehensible flow of highly effective and open communication, to set up a system of high-quality cooperation where one can rely on the other, to create a system of mutual support, to permanently strengthen and develop mutual respect and professional respect and other qualities and literally be a model of a professional, a true leader, who can prove to his people that the attractive visions offered, connected with the “conquest” of space, are clear, understandable and, above all, achievable, throughout the simulated four-month expedition while also being a so-called “GOOD PERSON”.

Due to the openness in expressing attitudes and reliable and constructive cooperation of all members of the “SIRIUS-18/19” crew during the collection of questionnaire data during the entire experiment and within the framework of semi-controlled interviews with the crew in the post-isolation period, it was possible to obtain new, hitherto unknown, extremely valuable and useful insights that can advance cosmic research into human functioning to the next level of knowledge. The next stage of the “SIRIUS-21” project, which is a simulation of a flight to Mars, will open another chapter of the investigation of small social groups which will not only contribute with its analytical level, but will become significantly useful in the preparation of human crews for real manned space flights into near and deep space. This is the main currency of social action research in the field of exposed professions.

## 6. Conclusions

The results of the favorable development of all investigated phenomena, **1. levels of life/work satisfaction of “SIRIUS-18/19” crew members, 2. structure and dynamics of relationships and ties** in the crew and **3. specific areas**, throughout the four-month simulated mission indicate that the vast majority of the investigated phenomena contributed very significantly to the fulfillment of the scientific and other tasks set out in the simulated flight program and, in general, to the overall successful handling of the isolation experiment.

The aim of presenting parts of the selected results was to demonstrate the validity, importance, usefulness and significant advantages of the above methodology. Its use in the next stage of the “SIRIUS” project confirms the above-mentioned theses and thus makes it possible to restate the following general conclusions related to the presented model of investigation for exposed professions:

1. **The Model of Social Action Research** by Bernardova Sykorova, intended for research into the functioning of human resources exposed to professions with a highly specific work environment, appears to be one of the possible avenues of research, bringing

- valuable and useful findings describing the functioning of humans and small social groups in a highly specific environment of long-term isolation with performance of a specific human activity, which the space environment undoubtedly is;
2. The model **indicates the possibility of highly effective measurement of human attitudes using** statistical operations and mathematical modeling based on the combination of **psychology, sociology and mathematics/statistics** (fuzzy logic); human attitudes are easily measurable and well represented graphically using descriptive statistics, advanced statistical operations or data visualization and are thus clear and understandable;
  3. The model emphasizes a multidisciplinary, interdisciplinary approach—psychosocial and biopsychosocial—in close and interlinked cooperation and communication with the participating research teams; it examines a person from a psychological, sociological and psychosocial point of view and examines aspects of health, physical condition and readiness for specific work performance;
  4. The model is based **on a strictly holistic principle, a comprehensive approach** to the study of a person and a small social group;
  5. Findings and outputs significantly contribute to **the preparation of groups and teams** for further simulated or real missions of exposed professions;
  6. Outputs enable project organizers to make **effective operational and strategic decisions** within ongoing or future missions or experiments;
  7. The research model is suitable **for repeated and long-term studies**, which brings the possibility of comparing the outputs at individual stages of a given isolation (**before, halfway and after isolation**), as well as of comparing the functioning of individual crews. It is also intended for individual “ad hoc” analyses, bringing immediate outputs;
  8. A set of adopted methodologies—the author’s own questionnaire techniques, adapted to the target group of cosmonauts/astronauts—is of **considerable importance in this concept** as it brings a comprehensive, **and at the same time detailed, view and insight** into the researched group and situation;
  9. The method uses sociomapping, graphically, i.e., clearly and comprehensibly, based **on data visualization using mathematical modeling** of outputs, and is a **highly suitable** and adequate technique for **uncovering the structure** and monitoring the **dynamics** of relationships and ties in the target group; its level of **diagnosis** and **intervention/development** is of incalculable value not only for project organizers, but especially for the team itself;
  10. The sociomapping method is also highly suitable in relation to the **psychosocial support** of the crew during a simulated or real mission. It makes it possible to **create expert recommendations** for the command/crew commander, who can work with graphic outputs—sociomaps—for the entire duration of the mission **in managing activities and leading people**. The method also makes it possible to **forecast the development** of relationships and ties;
  11. This model of human and group research brings, in addition to the **diagnostic/analytical approach**, the possibility of **an intervention development** level for working with teams and groups in the form of **development workshops** in the **post-isolation** or post-mission period of the target group;
  12. According to Bernardova Sykorova, the research model is of **an action nature**, i.e., it enables the creation of so-called **sociotechnical measures** that minimize or eliminate the event of “weak places” in the functioning of the group and make it possible to strengthen “strong places”;
  13. The model places emphasis on **providing feedback to project organizers**, but also to **the target group**, for which it has a significantly developmental function;
  14. The model enables the provision of **psychological and psychosocial support** during simulated or real isolation, including **crisis intervention** and other forms of accompanying crew members and the crew as a whole;



15. The model of the imaginary “**TRIPOD**” helps to identify, and then **develop, adaptation mechanisms** that ensure coping with the demands placed on a person and a small social group from the external environment and help to maintain a balance of the person’s inner integrity;
16. The above model was used, verified and developed **for 25 years in the highly specific and all-round demanding environment of the armed forces** in situations of ordinary military training but also in demanding conditions of foreign military missions of a peaceful and combat nature;
17. The mentioned Model of Social Action Research by Bernardova Sykorova **has been successfully implemented within the international research project “SIRIUS 2017–2023”** from 2016 until now, where it once again has proven its justification and its uniqueness.

#### *Proposals for Follow-Up Sociotechnical Measures*

Based on a comprehensive analysis of the functioning of the “SIRIUS-18/19” crew, according to Bernardova Sykorova’s **Model of Social Action Research**, the following proposals for sociotechnical measures are made. After their implementation, all so-called “**strong points**” would be strengthened and used, and findings intended for development, so-called “**weak points**”, would be minimized or possibly completely eliminated.

**It is recommended that the organizers of the international research project “SIRIUS 2017–2023” carry out the following:**

1. Award the crew members of “SIRIUS-18/19” for their excellent cooperation in questionnaire data collection;
2. Award the commander of crew for his excellent team leadership throughout the isolation;
3. Award all the crew members for the excellent quality of communication and cooperation throughout the isolation and for their diligent effort to maintain very close and interlinked interpersonal relationships and affiliations;
4. Revise the crew member preparation project for isolation for use in the next stage, “SIRIUS 21”;
5. Revise the crew preparation project for isolation in terms of feelings of fatigue during the preparatory period so that the crew enters the isolation at their full physical and psychological strength without feeling fatigue;
6. Revise the system of psychosocial and other support to crew members, particularly in the post-isolation phase and in the phase when crew members return to normal life. Develop a project for psychosocial and other support that participants in the next isolation experiments can perceive as an “institute” that is capable of providing the crew members with an adequate, wide range of support and services if they get, after the isolation has ended, into demanding or even difficult situations which might damage them in any way and preclude them from normal integration into normal living conditions;
7. Make maximum use of the outcomes, findings, researchers’ proposals and respondents’ comments obtained **in the “SIRIUS-18/19” project for preparation of the “SIRIUS-21” experiment;**
8. Make use of all the “strengths” and “weaknesses” identified in this analysis and apply them in preparation and programming for the next project stage, “SIRIUS 21”;
9. Endorse and enable the Czech team’s implementation of **a developmental workshop** focused on feedback notably in the area of sociomapping for the crew of “SIRIUS”;
10. **Consult the crew commander of “SIRIUS-18/19”** on options and proposals for improvements and strengthening of the organization of certain activities for use in the next stage, “SIRIUS 21”.

The leader of the “KOSMOW” team and its members are ready for questions, discussion, presentation and sharing of the results of the “SIRIUS-18/19” study, which was designed comparatively and will be followed by the next stage of the series of isolation experiments, “SIRIUS-23”, simulating a 12-month-long space flight to the Moon.

The presented model for examining the functioning of human resources enabled a detailed comparison of the outputs of four space missions, similar to the way it enabled extensive analyses of the functioning of Czech military contingents deployed in foreign military missions over the past 25 years of the operation of the expert research facilities of the Armed Forces of the Czech Republic.

**List of Publications of the Czech Research Team Sýkora J.-Šolcová I.-Dvořák J.-Drahota Z. (1970s–1990s), on Which the Contemporary Czech Research Team KOSMOW Builds Upon**

**1. Original scientific publications**

**1.1 Published abroad:**

- Sýkora J., Šolcová I., Jakoubek B., Drahota Z.: Electrophotography as a tool for evaluation of changes induced in human organism by hypergravity. *The Physiologist*, 30, 1988, 1, 150-151
- Sýkora, J., Šolcová, I., Pelčák, O., Dvořák, J.: Pilot performance is increased after alternating hypo- and hypergravity states. *The Physiologist*, 32, 1, 1989, Suppl. 92-93

**1.2 Published in CR:**

- Sýkora J., Šolcová I., Drahota Z., Dvořák J.: The underground laboratory as a model of social isolation. *Scripta medica*, 1989, 62, 5, 293-296.
- Šolcová I., Jakoubek B., Sýkora J., Hník P.: Characterisation of vertebrogenic pain by means of the short form McGill Pain Questionnaire. *Physiologia Bohemoslovaca*, 1989, 38, 572.
- Šolcová I., Sýkora J., Pauer M., Semiginovský B.: The heart-rate response to psychological challenge is higher in children displaying lower physical activity. *Act. Nerv. Sup.*, 1990, 32, 1, 40-42.
- Šolcová I., Malý O., Sýkora J., Jakoubek B.: Effect of fitness-directed physical exercise the mental state of cardiovascular patients. *Act. Nerv. Sup.* 1990, 32, 3, 189-190.
- Šolcová I., Řehulka J., Sýkora J.: Character of activity modulates an impact of group isolation on the individual. *Studia Psychologica* 1991.
- Šolcová L., Řehulka J., Sýkora J.: Character of activity modulates an impact of group isolation on the individual. *Studia Psychologica*, Praha, 1993.

**2. Presented Papers on Conferences Published:**

**2.1 In Czech Republic:**

- Sýkora, J., Knotek, P., Jakoubek, B., Šolcová, I. aj: Group isolation study: An interdisciplinary approach. In: Bod'a, K., ed.: *Current trends in cosmic biology and medicine, Vol biochemistry and medicine. Vol. I*, str. 103-108. *Ivanka pri Dunaji*, Institute of animal genetics SAV, 1990

**2.2 Abroad:**

- Sýkora J.: Social'no-psychologičeskije faktora v issledovanii problem mašinstroitel'nogo predprijatija. *Mezinár.porada specialistů NIIIOM, Sofia/Praha* 1979
- Šolcová I., Sýkora J., Drahota Z., Kaspar I., Janák Z., Kozerenko O.I., Nečajev A.P. Ševčenko O.I: Vlijanie kratkoročnoj gruppy voj izoljacii na psichičeskoje sostojanie i psichičeskij rezultat ispytujemych. In: *XX. sovelčanija postojanno dejstvujulčej rabo čej gruppy socialističeskich stran po kosmičeskoj biologii i medicine Interkosmos*. Berlin, Interkosmos 1987.
- Sýkora J., Šolcová I., Jakoubek B.: Ocenka urovnja stresa vyzvannogo sostojanijem. In: *XXII. sov.post.dejstv.rab.gr.soc.stran po kosm.biol. i med. Interkosmos, gipergravitacii* Berlin, 1987
- Sýkora J., Šolcová I., Jakoubek B.: Ispolzovanije elektrofotografii na bazi Kirliana kak neinvazivnogo diagnostičeskogo metoda. In: *XXII. sov.post.dej.rab.gr.soc stran po kosm. biol i med. Interkosmos*, Berlin, 1987
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**Funding:** This research was funded by the Technology Agency of the Czech Republic, grant number: TL03000257.

**Acknowledgments:** At this point, I would like to thank respectfully the organizers of the research project “SIRIUS 2017–2023”—the management of IBMP RAS, RF and the management of HR NASA, USA, who enabled the Czech research team “KOSMOW” to participate in the project in its three stages. Heartfelt thanks go to the director of the IBMP RAS, Oleg Orlov, for his immense support of the Czech team “KOSMOW” in its work and his support of the cooperation with important Russian scientists from the IBMP RAS. Many thanks to Alla Vinokhodova (IBMP RAS) for excellent cooperation, for her significant long-term support of the Czech team, for her apt advice and recommendations, for her significant help, together with Polina Kuznetsova (IBMP RAS) and for her dedicated support in the collection of research data in place of the experiment. I respectfully thank Sergey Ponomarev for all the support and help in the field of organization of the research project of the Czech team. Conceptualization: Katerina Bernardova Sykorova, Col.Ret.; Methodology: Katerina Bernardova Sykorova, Col.Ret.; Software: Cyril Höschl, FRCPsych. (sociomapping software); Validation: Katerina Bernardova Sykorova, Col.Ret., Pavla Tefelnerova and Eva Chroustova under the guidance of Eva Höschlova; Formal analysis: Pavla Tefelnerova and Eva Chroustova under the guidance of Eva Höschlova; Investigation: Katerina Bernardova Sykorova, Col.Ret., Jitka Lastovkova, Daniel Strobl; Data curation: Jitka Lastovkova, Katerina Bernardova Sykorova, Col.Ret. and Pavla Tefelnerova and Eva Chroustova under the guidance of Eva Höschlova; Writing: Katerina Bernardova Sykorova, Col.Ret.; Writing—review and editing: Katerina Bernardova Sykorova, Col.Ret.; Visualization: Katerina Bernardova Sykorova, Col.Ret., Pavla Tefelnerova and Eva Chroustova and Bc. et. Bc. Matylda Klosova—technical support; Supervision: Katerina Bernardova Sykorova, Col.Ret. and Jaroslav Sykora, Col.Ret., IAAM; Project administration: Katerina Bernardova Sykorova, Col.Ret.; Consulting: Jitka Lastovkova, Jaroslav Sykora, Col.Ret., IAAM, Ing. Jaroslav Klacek, Lt.Col.Ret., Ing. Oldrich Pelcák, Col.Ret., Zdenek Drahota, Radvan Bahbouh; Funding acquisition: Katerina Bernardova Sykorova, Col.Ret., Jitka Lastovkova, Jaroslav Sykora, Col.Ret. and Pavla Tefelnerova.

**Conflicts of Interest:** The authors declare no conflict of interest.

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