



Behavioral Issues Associated With Long Duration Space Expeditions: Review and Analysis of Astronaut Journals Experiment 01-E104 (Journals) Phase 2 Final Report

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*"The human factor is three quarters of any expedition."
– Roald Amundsen*

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Dr. Claude Bachelard writing in his journal during the International Biomedical Expedition to the Antarctic (IBEA), in 1981; the electrodes on his face and chin are for monitoring EEG and EMG. From, Rivolier, J., Goldsmith, R., Lugg, D.J., and Taylor, A.J.W. *Man in the Antarctic: The Scientific Work of the International Biomedical Expedition to the Antarctic (IBEA)*, Taylor & Francis: London, 1988.

EXECUTIVE SUMMARY

This report describes a content analysis of personal journals that were maintained for this purpose by NASA astronauts during 20 expeditions to the International Space Station (ISS). Using methods developed during previous analog research, the study provides the first quantitative data derived from space operations on which to base a rank-ordering of the behavioral issues associated with long-duration isolation and confinement. The study was conducted in two phases, with ten astronauts who served as members of two- and three-person crews, and ten astronauts who served as members of six-person crews, which enabled comparisons to be made.

The first level of analysis identified the relative salience of 24 major categories of issues with behavioral implications. The top four behavioral categories during Phase 1, Work, Outside Communications, Adjustment, and Group Interaction, received 59% of all primary, secondary, and tertiary category assignments of journal statements. Adding Recreation/Leisure, Equipment, Event, Organization/Management, Sleep, and Food to form a list of the top 10 categories accounts for 88% of all category assignments. Nine of the top ten Phase 1 categories were in the top ten during Phase 2, with only a slightly different order: Adjustment, Work, Outside Communications, Group Interaction, Equipment, Recreation/Leisure, Food, Event, and Organization/Management; Exercise replaced Sleep during Phase 2. The top four categories accounted for 61% of all statements during Phase 2 and the top ten accounted for 86% of the total. The second-level of analysis identified more than 100 subcategories within the major categories and calculated their relative frequencies and temporal distributions. The third level of analysis focused on the tone of entries as an indicator of specific problems and general morale, using a metric defined as Net Positivity/Negativity (NPN); results of the NPN analysis support hypotheses concerning a third quarter phenomenon, which also is explained in the report. Responses to questions asked before, during, and after the expeditions suggest that living and working onboard the ISS is not as difficult as the astronauts anticipate before starting their six-month tours of duty. Astronauts reported that they benefited personally from writing in their journals and recommended continuation of the research.

Examples of statements from the journal entries and graphic representations of data are used to illustrate the quantitative analyses. Together, the statements and analyses provide a comprehensive description of ten person-years of ISS operations from the crew perspective. Example journal statements included in the report concern activities, events, and observations and reflect the normal ups and downs of daily life onboard an orbital space station. It is important to note that no single journal statement, nor even a subset of statements, accurately describes an entire expedition, but rather, the most salient issue at the time the entry was made. The results show that NASA's efforts concerning interpersonal issues, teamwork, psychological support, and leadership have been particularly effective. Operational implications of study results are summarized and then presented in the form of specific recommendations to facilitate living and working in space, whether onboard the ISS, a spacecraft bound for an asteroid, or an interplanetary ship.

"Truly, the whole secret lies in arranging things sensibly, and especially in being careful about the food."

- Fridtjof Nansen

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Subjects in a study of isolation and confinement prepare to enter their spacecraft simulator for a 12-day experiment in 1961. See Appendix A for more information.

INTRODUCTION

This report describes research conducted under Cooperative Agreement NNX11AG22A for the Behavioral Health and Performance Element, Human Performance Program, NASA's Johnson Space Center. The study described in this report is a continuation of work performed between 2003 and 2010 that analyzed the personal journals of astronauts who were members of two and three-person crews onboard the International Space Station (ISS); the current study was conducted between 2011 and 2016 and analyzed the journals of astronauts who were members of six-person crews. Both phases of the study are based on the premise that the introspective accounts of individuals who are living and working in stressful or unusual environments can provide useful information about the factors that affect individual and group performance under those conditions. The study uses methods developed during space analog research and refined during the first phase of the project. The report is presented in four sections. This introduction describes why the study was conducted and provides background information and the historical context of the research. The introduction is followed by a description of the research tasks performed to collect and analyze the data and, in turn, is followed by a section devoted to study results. The report concludes with a discussion of operational implications and recommendations based on those results.

BACKGROUND

The previous report in this series described how mission planners have asked flight surgeons, psychologists, and psychiatrists since the earliest days of NASA about the importance of behavioral issues that must be considered when planning space expeditions. The response always was that interpersonal relations among crew members is the most important issue, a belief shared by many non-scientists. However, it was impossible to defend "getting along with each other" empirically, because there was no systematic method for calculating the importance of any issue. Planners and equipment designers are data-driven and need a metric to guide the allocation of scarce resources, but laboratory and space analog studies usually focus on a specific issue (e.g., sleep, teamwork), which makes it impossible to place the various influences on human behavior in order of importance to space crews.¹

A content analysis of journals that were written by leaders and physicians at French remote duty stations on Earth in 1993-1994 provided the first quantitative data on which to base a rank-ordering of behavioral issues in terms of importance.² That study identified 22 major categories of behavioral issues associated with living and working in isolation and confinement and placed the categories and themes in order of priority based on the relative frequency of category assignments; information about the French Diaries study is presented in Appendix B. Research opportunities on the ISS made it possible, beginning in 2003, to study the issues under operational conditions with the participation of space crews. The flight experiment documented in this report, and the previous report in this series, was the logical next step beyond analog studies and addresses the behavioral and human factors questions of highest priority in NASA's Critical Path Roadmap, risk assessments, and mitigations.³

¹ For more information about space analog research see, Suedfeld, P., and Steel, G.D. The environmental psychology of capsule habitats. *Annual Review of Psychology*, 51, 227-253, 2000.

² Stuster, J., Bachelard, C. and Suedfeld, P. The Relative Importance of Behavioral Issues During Long-Duration I.C.E. Missions. *Aviation, Space, and Environmental Medicine* (71) 9, 2000 (September). Stuster, J., Bachelard, C. and Suedfeld, P. *In the Wake of the Astrolabe: Review and Analysis of Diaries Maintained by the Leaders and Physicians at French Remote Duty Stations*. Technical Report to the National Aeronautics and Space Administration, 1999 (February). <http://www.anacapasciences.com/publications/Astrolabe.pdf>

³ Stuster, Jack. *Behavioral Issues Associated with Long-Duration Space Expeditions: Review and Analysis of Astronaut Journals, Experiment 01-E104 (Journals): Final Report*. NASA/TM-2010-216130, July 2010.

OBJECTIVE

The objective of the Journals Flight Experiment is to identify relevant behavioral factors and obtain data to inform decisions concerning the various behavioral issues when planning and managing future space expeditions. Study results can be applied to the full range of preparations, including personnel selection, training, support, scheduling, and the design of equipment, habitats, and procedures for the ISS and expeditions to asteroids, the Moon, and Mars.



"Exploring Mars," by Chesley Bonestell, 1956, (oil on board, 14.25 x 28.5 in; 37 x 72 cm; in the permanent collection of the National Air & Space Museum) illustrating Werner von Braun's concept of winged space craft from *Das Marsprojekt: Studie einer interplanetarischen Expedition*, 1952, which was published as *The Mars Project* in 1953.⁴ *The Mars Project* attracted the attention of author, Cornelius Ryan, who served on the editorial staff of *Collier's*, a weekly magazine with nearly three-million subscribers and a tradition of shaping public opinion and government policy. Ryan commissioned von Braun and other leading space scientists, writers, and astronomical artists of the period to prepare a series of articles based on *The Mars Project*. The series, titled "Man Will Conquer Space Soon!" was published in eight, beautifully-illustrated installments between March 1952 and April 1954. The primary difference between von Braun's original plan and the one described in the magazine series was the addition of a toroidal space station in Earth orbit to facilitate assembly of the ten interplanetary ships. The donut-shaped structure became the archetypal space station form in popular culture and the articles propelled von Braun to national prominence. The articles also fueled the imagination of far-sighted Americans, including Walt Disney and producer Ward Kimball who hired von Braun and others to help develop three episodes for the Disneyland television program. "Man in Space" was broadcast in March 1955 to an audience of more than 40 million viewers, including President Dwight Eisenhower who called Walt Disney the next day to request a copy of the program that could be shown to key Pentagon officials. "Man and the Moon" aired in December 1955 and, like the previous episode, used documentary footage, on-screen appearances by von Braun and others, and narrated animation to provide remarkably accurate predictions of future events; the programs described the likely effects of weightlessness on humans and introduced the public to a new field of study, called Space Medicine. The third episode in the series, "Mars and Beyond," featured ships with solar-powered ion engines suggested by another German scientist, Ernst Stuhlinger, rather than von Braun's chemical rockets; the program was broadcast on 4 December 1957, two months after the Soviet Union shocked the world with the launch of Sputnik, the first artificial satellite. Von Braun's ideas, Bonestell's illustrations, and Sputnik led directly to the creation of the National Aeronautics and Space Administration (NASA) in 1958.⁵ Image reproduced courtesy of Bonestell, LLC.

⁴ von Braun, Wernher (Translated by Henry J. White). *The Mars Project*. Urbana: University of Illinois Press, 1953.

⁵ Stuster, Jack. Acceptable Risk: The Human Mission to Mars. *Journal of Cosmology*, 12, pp. 3566-3577, 2010.

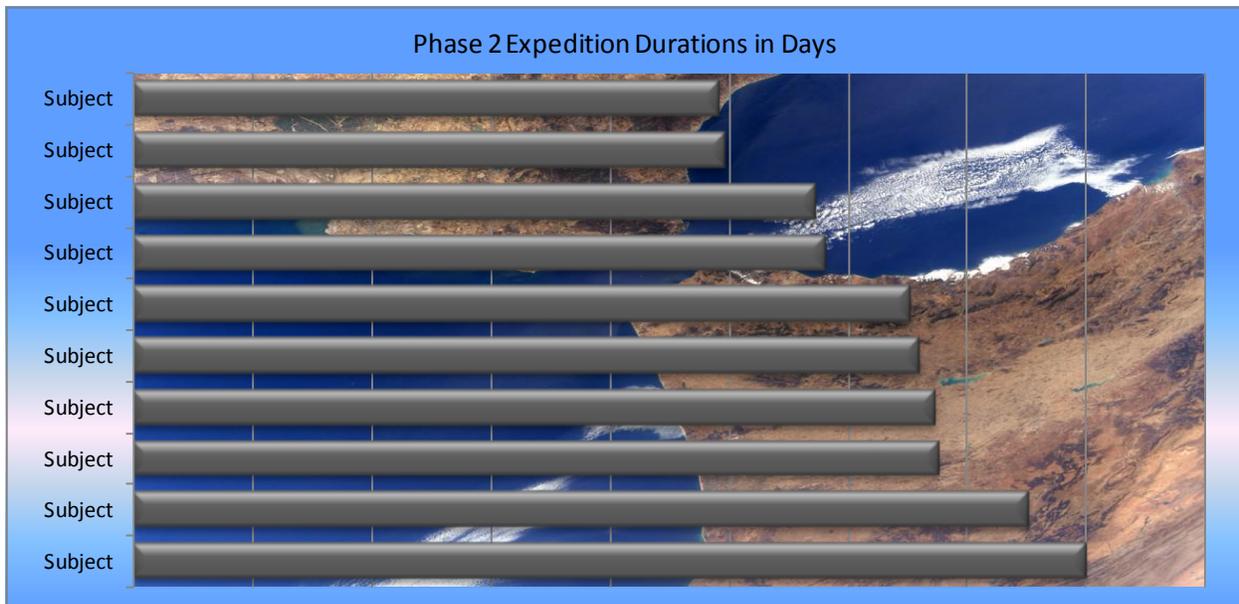
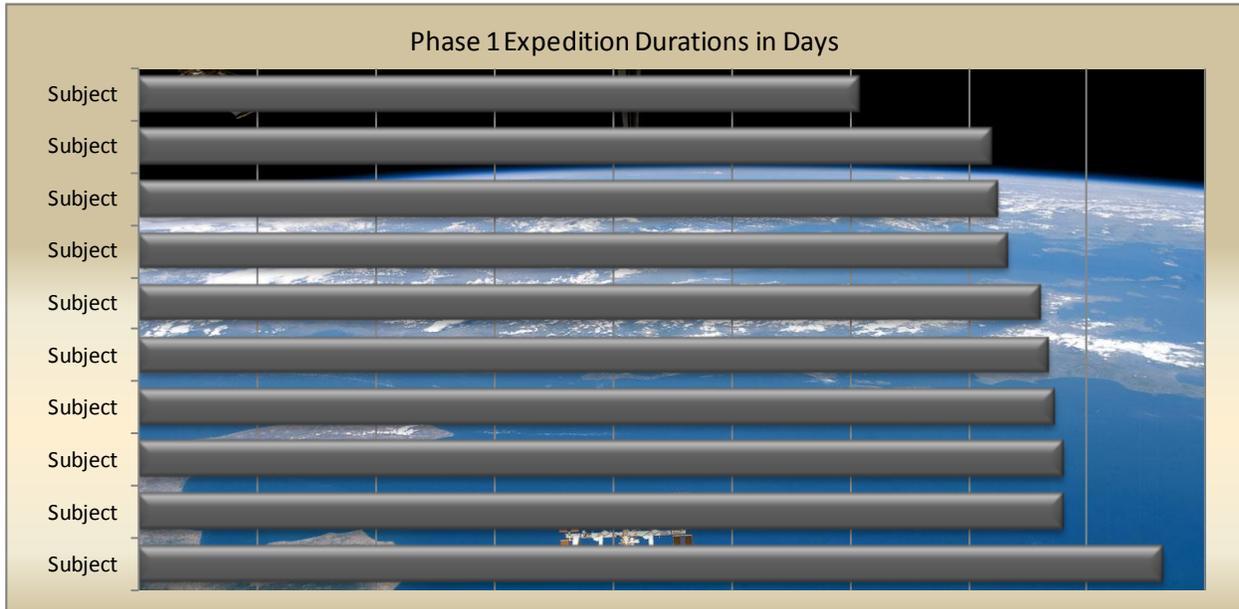
THE RESEARCH

Ten subjects normally would be considered insufficient for statistical analysis in studies of human behavior. However, each subject in the current project generated a large volume of data in the form of multiple journal entries during a prolonged period under operational conditions. The large volume of data per subject compensates for the relatively small sample if the astronauts who participated in the study represent the population from which the crews of future space missions would be selected. The ten participants in the first phase of the research (members of two- and three-person crews) and the ten participants in the second phase (members of six-person crews) are representative of the Expedition Corps, the cadre of astronauts preparing for long duration tours of duty onboard the ISS and beyond; the sample includes men and women; scientists, physicians, engineers, and pilots; and civilian and military personnel.⁶

Both phases of the Journals Flight Experiment are based on the assumption that the more a person writes about a topic in a personal journal, the more important that topic is to the person at that time. It is a reasonable assumption, but maintaining a continuous written record for a period of six months requires sustained commitments of time and effort. Participants were asked to make journal entries at least three times per week while on the ISS using a laptop computer and MSWord template. Three subjects during the second phase asked to record audio files, instead of typing their entries, a request that was accommodated by narrating PowerPoint files. Journaling sessions usually appeared on the ISS timeline, but were moved to the optional task list during periods of high-tempo activity. Participants were encouraged to address whatever topics were most salient to them and to write candidly about their experiences, but they were cautioned to avoid focusing exclusively on negative issues. Crews were promised during Informed Consent Briefings (ICBs) that no one other than the astronaut and principal investigator would have access to the original journals and that all identifying information would be removed from any excerpts used in reports, articles, or presentations. The journals were protected by passwords and encrypted during downlink and transfer to the investigator, a process that further ensured the security of data. The encrypted files were deleted from the NASA server immediately after the transfers were completed, usually within 15 minutes of the monthly, then weekly, downlinks. It is believed that the assurances of confidentiality and methods developed to preserve anonymity of participants contributed to astronauts' motivation to write (and for three, to speak) candidly in their personal journals.

⁶ In the first report in this series, the principal investigator wrote that calculating the number of cases, observations, or subjects required for an experiment to have meaningful results is a concern of all scientists and usually involves a compromise between the ideal research design and what is practical to achieve. For example, public opinion surveys are administered to samples of at least 2,000 carefully-selected individuals in order to obtain sufficient confidence that results accurately reflect the beliefs of a larger segment of the population. In contrast, the designers of more intrusive experiments, such as those requiring painful muscle biopsies, are content with as few as five subjects. The current study was confronted with an unusual variation of the sample size dilemma: How many subjects would be necessary to produce meaningful results if the subjects were to participate one at a time for periods of approximately six months each? The inclination to maximize statistical power with a large sample was tempered by the recognition that the ideal study could take so long to complete that it would be both too expensive and too late to be of use to the sponsoring agency. Many medical and physiological experiments rely on only ten subjects, so ten was the number specified by the PI during the planning phase of the experiment. It would take a minimum of five years to obtain the criterion number of subjects during Phase 1—longer if any astronauts declined the invitation to participate in the study or agreed to participate and then did not produce an acceptable journal. It took six years to collect the ten journals for analysis in the first phase of the study and only four years to collect ten journals in the second phase, due to larger crew sizes.

The durations covered by the first ten journals obtained during the study (members of two- and three-person crews) ranged from approximately 150 to more than 200 days, with an average of 187.7 days on board the ISS. The durations covered by the second set of ten journals (members of six-person crews) ranged from approximately 120 days to 200 days, with an average of 158.8 days. The durations of the Phase 1 and Phase 2 expeditions are illustrated in the following figures⁷



⁷ No numbers are used in the two figures on this page and the orders of the expeditions have been altered to prevent the identification of individual participants in the study. Actual durations have been deleted from the X axes to further hinder efforts to deduce participants. Also, excerpts from astronauts' journals included in this report have been edited to remove names and other information that might permit attribution to specific individuals or expeditions.

CODING THE DATA

The investigator read all journals entries immediately after they were retrieved from the ISS; downlinks were performed monthly during Phase 1 and weekly during Phase 2 of the study. Each journal was read again following completion of the expedition and converted to a database format using a spreadsheet configured for this purpose. Each journal session was dated, either automatically by the MSWord template or by the astronaut, to enable coding of data by expedition day. The coding process began by parsing journal text into statements concerning a topic and then pasting the statements into the appropriate cells of the spreadsheet; these "statements" ranged in length from a single sentence to a complete paragraph. All statements parsed from journal entries were assigned to a primary topical category and most also were assigned to a secondary category; about half of the entries also were coded for a third category, a procedure intended to provide a comprehensive accounting of topics mentioned in the journals. Two categories emerged almost immediately during the Phase 1 coding process that were not among the 22 identified during the analog study (i.e., the analysis of French diaries mentioned previously); Logistics/Storage and Procedures/Rituals were added to the list for a total of 24 major categories. No new major categories emerged during the Phase 2 coding and analysis of astronaut journals. Sub-categories (clusters of statements on similar topics) were then identified from the statements within each major category of issues. The process is described below using two examples; the results of this and other analyses are presented in the following section of the report.

"We got together for some food and music and it was a nice celebration."

Primary Category: Group Interaction

Secondary Category: Food

Tertiary Category: Recreation/Leisure

Subcategory of Group Interaction: Celebrations / Tone: Positive

"Today was non-stop from start to finish. It started slow with some prep work and then working out broken in the middle by a HAM radio pass with a school."

Primary Category: Work

Secondary Category: Exercise

Tertiary Category: Outside Communication

Subcategory of Work: High Workload / Tone: Neutral

The first example was assigned to Group Interaction as the primary category because the sentence began with a reference to the crew (i.e., "We") getting together. Food was the secondary category assigned, because the word "food" appears next in the statement, followed by the word "music," which is a recreation/leisure activity and evoked the third-level category assignment. The statement was grouped with other similar statements in a subcategory, labeled "Celebrations." The second example, above, describes a high-tempo day of Work (Primary Category) that included the usual two-plus hours of Exercise (Secondary Category) that was interrupted by a public affairs event that required Outside Communications (Tertiary Category) with a school via HAM radio; the statement was grouped with other statements that described periods of High Workload (Subcategory of Work statements). The semantic rules described here were applied systematically to the data during the coding process.

Parsed journal statements also were coded as positive, negative, or neutral in tone, to permit analyses using the Net Positivity/Negativity (NPN) metric suggested by Peter Suedfeld during the French Diaries Study. That is, each journal was divided into chronological quarters and then the proportions of positive, negative, and neutral statements were calculated by quarter; the proportion of negative statements was subtracted from the proportion of positive statements to derive the single metric, NPN. Proportions were used in these calculations, rather than actual numbers, to control for differential volumes of journal activity among the participants. The journal statements and associated data were entered into spreadsheets with each row, or record, composed of the following fields.

Subject Number (Coded)

Role (C for commander, FE for flight engineer, SO for science officer)

Mission Day (1 – 200+)

Category 1 (The primary category of behavioral issues to which the entry was assigned.)

Category 2 (The secondary category of behavioral issues to which the entry was assigned.)

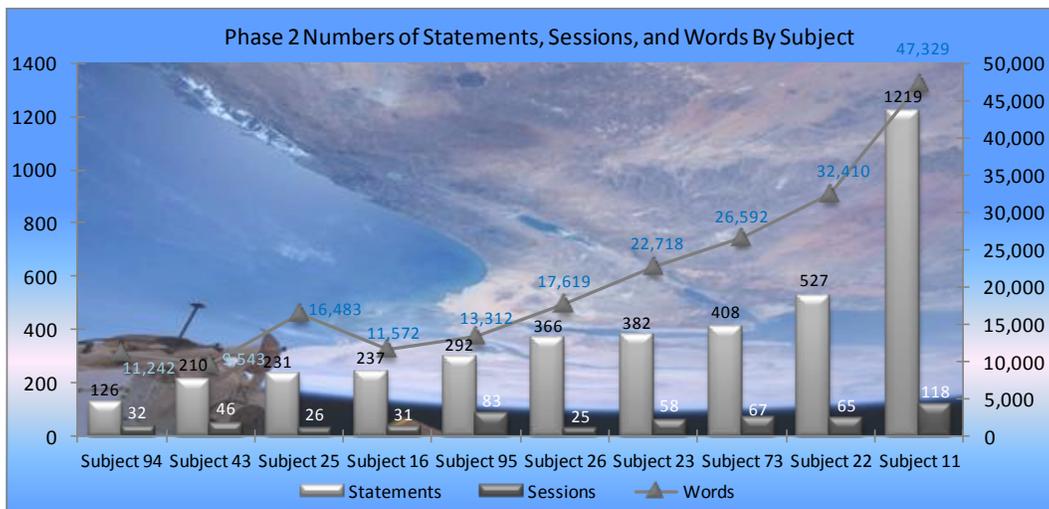
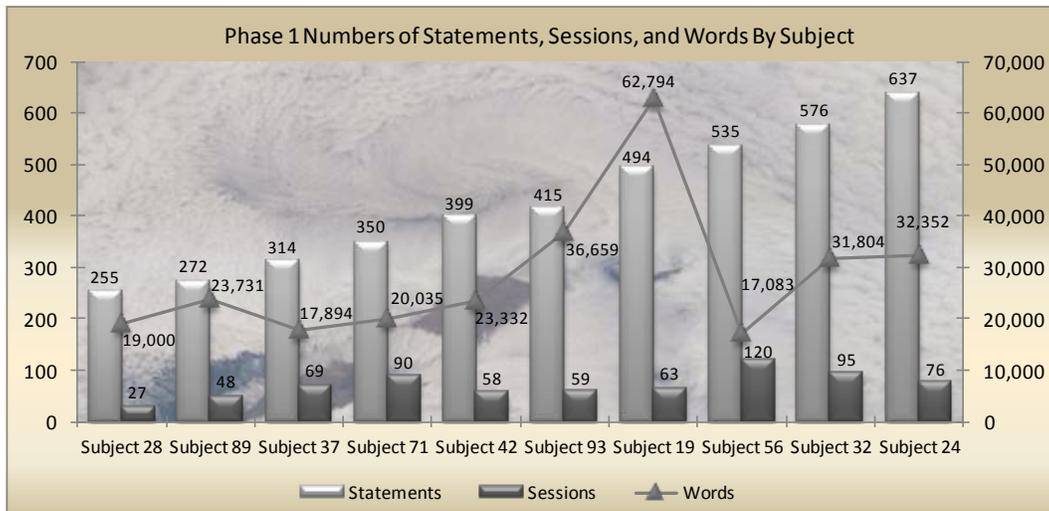
Category 3 (The tertiary category of behavioral issues to which the entry was assigned.)

Page (The page number of the original journal on which the entry can be found.)

Tone (Whether the entry is positive, negative, or neutral in tone.)

Statement (Text of the parsed journal entry.)

Nearly all of the participants exceeded the minimum commitments, writing more frequently and candidly than expected and producing detailed, personal accounts of life onboard the ISS. The first ten participating astronauts devoted a total of 705 sessions to the Journals Experiment and produced 4,247 separate parsed statements composed of nearly 285,000 words; the second ten participating astronauts devoted 551 sessions and produced 3,998 statements in 208,820 words—together it is the equivalent of two, 1,000-page books. The following figures illustrate the numbers of sessions, statements, and words contributed by Phase 1 and Phase 2 participants to the Journals database.⁸



⁸ At a minimum of 15 minutes per session, the crew time devoted to the two phases of the journals study exceeded 300 hours, which is believed to be more than any other experiment conducted in space.

sample was prepared for analysis. That sample received reliability scores of 94% for tone and 89% for category, both of which are within the acceptable range for content analysis. Further adjustments to the coding rules were applied to the entire database to increase reliability prior to data analysis and additional errors were detected and corrected during subsequent analytical tasks. The effects of those improvements to reliability have not been estimated. The coding rules and protocols developed during Phase 1 were applied systematically to Phase 2 data to maximize consistency of methods and comparability of analytical results.

OTHER POTENTIAL THREATS TO THE VALIDITY OF STUDY RESULTS

Potential threats to the internal validity of the study include variance among the participants in journal activity, volume, net-positivity/negativity, or candor. The figures on page 6 showed the distributions of journal sessions, statements, and words by the 20 study participants: sessions ranged from 25 to 120; statements from 126 to 1,219; and, words from 9,543 to 62,794. The number of sessions had the greatest variance, with participants' contributing between 0.3 and 9.6% of the 1,256 sessions recorded in the journals. The numbers of words written by the astronauts also varied, representing between 2 and 12.8% of the total volume. The number of statements showed the least variance of the three quantitative measures of journal productivity, ranging from 1.6 to 7.7% of the 8,245 parsed statements by Phase 1 and Phase 2 astronauts combined. The data show that some participants wrote more frequently than others; some wrote (or spoke) more words per session; and some addressed more issues and events in their journals, but the range of variation for the third measure, which is the primary unit of analysis in the study, was less than for the other two.

Statements are the primary units of the content analysis as they are the data that are categorized and counted and from which all study results are derived. It is reasonable to question whether differences in the numbers of statements extracted from the journals might enable individual participants to dominate the analysis and thereby distort results. It was to control this variable that frequencies of category assignments were converted to percentages within each journal (calculated by quarter) to equalize the contributions of all participants to the temporal and overall analyses of NPN. The effects of this procedure were to normalize the data and allow meaningful comparisons among the participants. However, the tallies of entries on which the category and subcategory analyses are based involved combining data from all journals and, for this reason, the process reflects the differential production of the participants. This approach is consistent with the fundamental premise of the method, which assumes that the frequency a topic is mentioned in a journal is a measure of the topic's salience to the author. If a procedure were to be performed that equalized the contributions of the participants to the category and subcategory analyses, it would diminish the study's sensitivity to differences in the astronauts' experiences on the ISS. Concern about this potential threat to validity is further obviated by the near absence of variance in the categories of issues the astronauts considered to be important; for example, the same four categories (Work, Outside Communication, Adjustment, and Group Interaction) appear in the top five of all study participants, and in the top four categories of the astronauts who generated the fewest and the most entries. The overall rank-ordering of categories represents the combined values of the participants, presented as Phases 1 and 2.

Candor is the least quantifiable of the process variables and is most appropriately assessed in binary terms, that is, astronauts were either candid or they were not. It is impossible to determine if the participants were candid in their journals at all times, but it is sufficient to report that all 20 journals included entries concerning personal matters and all included statements that the authors would not want to be attributed. The participants' willingness to write candidly about their experiences contributed to the utility and validity of study results. I have done my best to ensure the anonymity of their contributions.

It was judged to be inappropriate to subject the data to inferential tests of significance, because of the large number of behavioral categories, the relatively small number of study participants, and the individual differences among them.



"Space Station, Ferry Rocket, and Space Telescope 1,075 Miles Above Central America," 1952 (oil on board, 28.5 x 23 in; 72 x 58 cm), by Chesley Bonestell, for *Across the Space Frontier*, illustrating Wernher Von Braun's plan for assembling ships in orbit in preparation for an expedition to Mars. Von Braun's plan involved 70 crewmembers and ten 4,000-ton ships that would be assembled in low-Earth orbit from parts launched by three-stage winged ferry rockets; a staggering 950 launches would be required to lift the components, supplies, and fuel out of Earth's gravity well and to support assembly of the fleet in orbit. Seven of the ten interplanetary ships would resemble tinker toys made of girders and spheres and lack the streamlining necessary for a planetary landing, but three would have bullet-shaped fuselages equipped with wings to glide through the thin atmosphere of Mars. Rocket engines would propel the fleet on a minimum-energy Earth-to-Mars trajectory with crews discarding the empty fuel tanks during the eight-month weightless cruise phase. Rockets would be fired again to slow the fleet for insertion into Mars orbit. After surveying the planet for suitable sites, one of the winged ships would land on skids (or skis) at the north polar ice cap. The crew would then make a 4,000-mile (6,437 km) mechanized traverse to build a landing strip near the equator for the two remaining winged spacecraft to land on wheels. The wings would be removed and the fuselages elevated to a vertical position in preparation for launch, rendezvous, and return to Earth with the ships remaining in orbit, many months in the future (see image on page 2). Von Braun's plan, which is called a conjunction class mission due to the relative positions of the planets at launch, required the least energy (mass and cost) of all launch options, but would subject the crews and equipment to eight-month transits and 16 months on the surface, for a mission duration of nearly three years. Current design reference plans use essentially the same calculations for getting to Mars, but lack redundant space craft, a safety feature since the earliest recorded examples of exploration. Von Braun believed the journey to Mars would be possible by the mid-point of the 21st Century. Readers are referred to John C. Niehoff and Stephen J. Hoffman (1996), Malcolm LeCompte and Julie Stets (1996), and Ernst Stuhlinger (1996) for discussions of the possible pathways to Mars. Image reproduced courtesy of Bonestell, LLC.



The International Space Station is silhouetted against the Moon in this image taken on 4 July 2015.

RESULTS

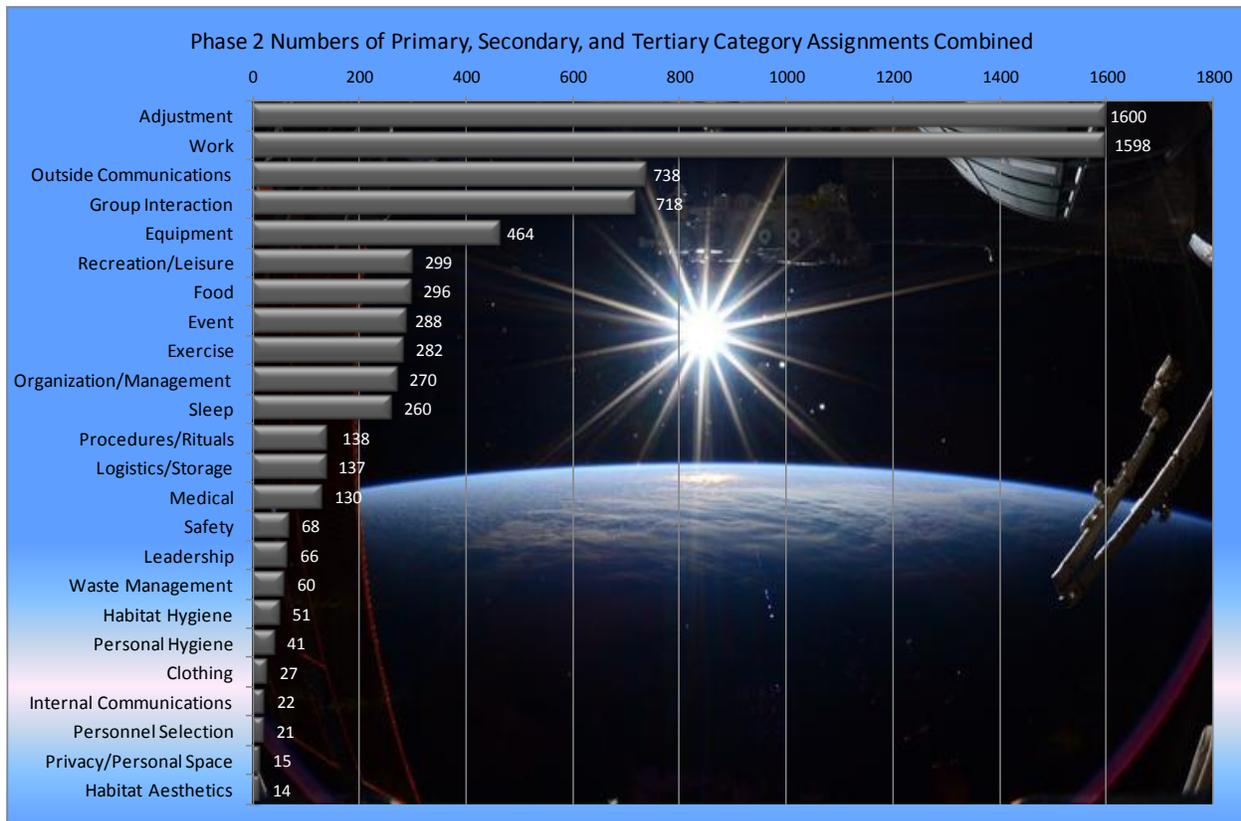
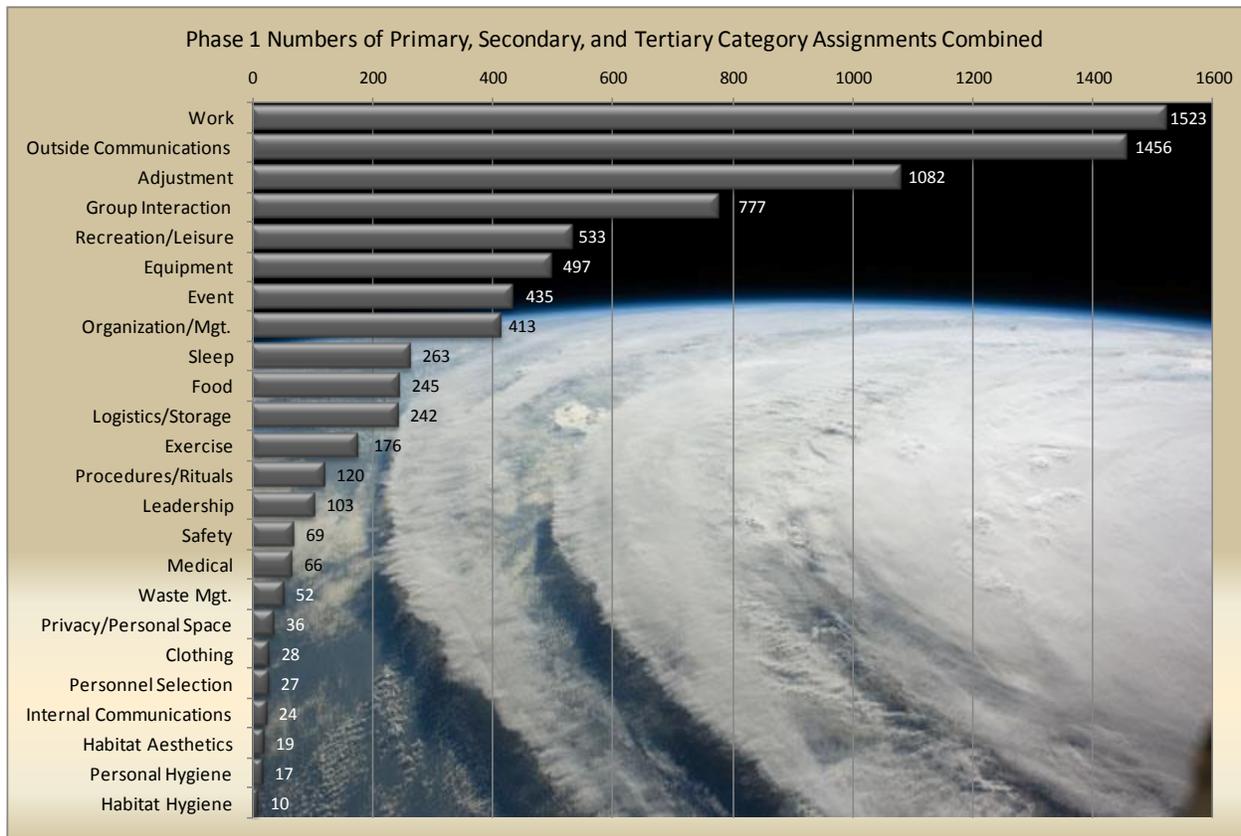
Study results are presented in sections addressing the major categories of behavioral issues; subcategories, or themes, within the major categories; Net Positivity/Negativity; and the pre-, mid-, and post-expedition questionnaires. Data for both Phase 1 (two- and three-person crews) and Phase 2 (six-person crews) are presented and compared.

CATEGORY ANALYSIS

The numbers of parsed journal statements assigned to the 24 major topical categories were tabulated for each astronaut's journal and then combined to calculate the overall total for each category. The Phase 1 and Phase 2 rankings are remarkably similar, with the same categories appearing in the top six for both phases of the study. The top ten most-frequently assigned categories were the same in both phases, with only one exception: Exercise replaced Sleep in Phase 2. Similarly, the eight least-frequently assigned categories were the same in both phases. Nearly all categories during Phase 2 were within two ordinal positions of Phase 1; exceptions include the rise of Food from 10th in Phase 1 to 7th in Phase 2 and the rise of Habitat Hygiene from 24th to 18th. The results of the category ranking procedure are summarized, below, and presented in the figures on the following page for Phase 1 and Phase 2; those figures list the categories in descending order of frequency (i.e., numbers of major category assignments) and include category tallies to enable comparisons.

ORDERS OF MAJOR CATEGORIES IN PHASE 1 AND PHASE 2 OF THE JOURNALS EXPERIMENT

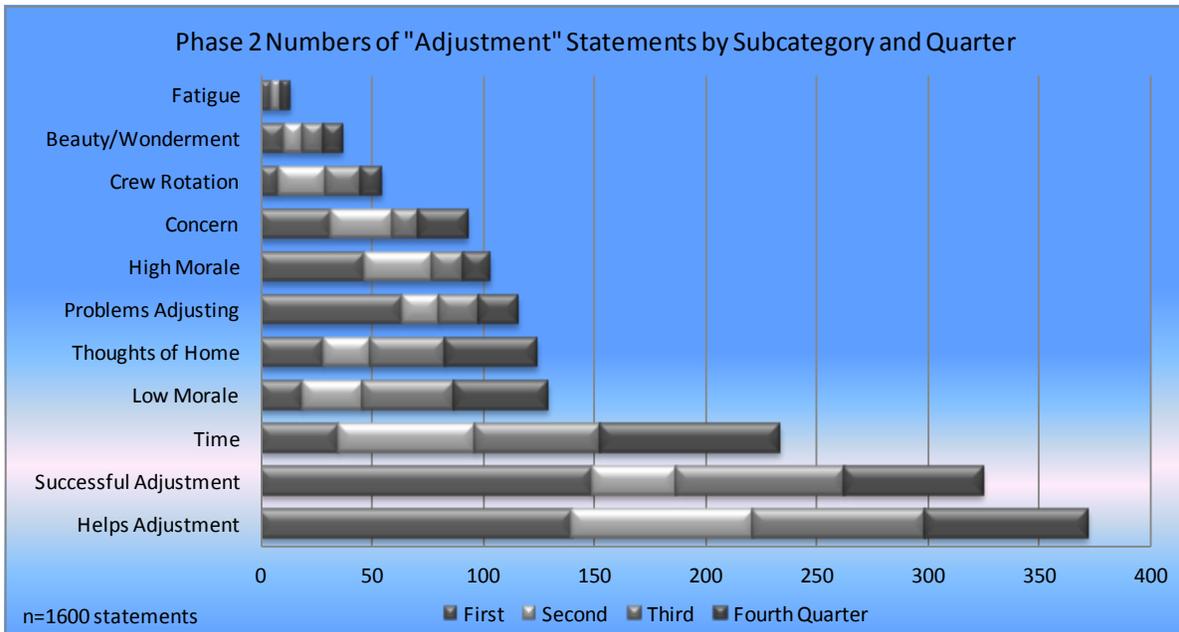
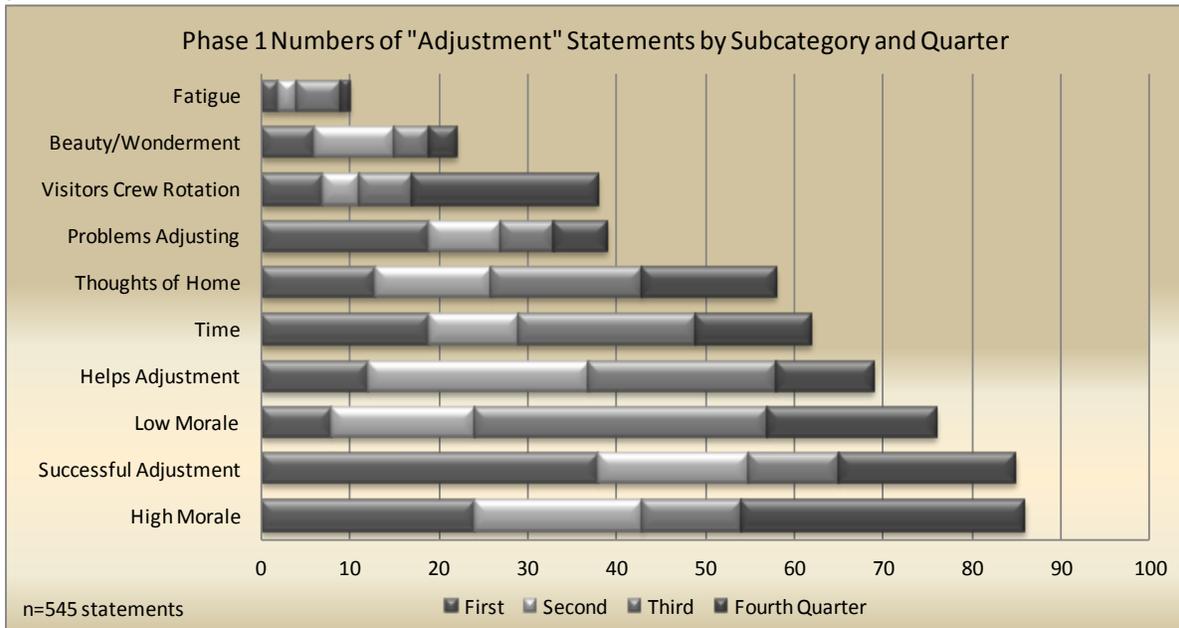
<u>Phase 1</u>	<u>Phase 2</u>
Work	Adjustment
Outside Communications	Work
Adjustment	Outside Communications
Group Interaction	Group Interaction
Recreation/Leisure	Equipment
Equipment	Recreation/Leisure
Event	Food
Organization/Management	Event
Sleep	Exercise
Food	Organization/Management
Logistics/Storage	Sleep
Exercise	Procedures/Rituals
Procedures/Rituals	Logistics/Storage
Leadership	Medical
Safety	Safety
Medical	Leadership
Waste Management	Waste Management
Privacy/Personal Space	Habitat Hygiene
Clothing	Personal Hygiene
Personnel Selection	Clothing
Internal Communications	Internal Communications
Habitat Aesthetics	Personnel Selection
Personal Hygiene	Privacy/Personal Space
Habitat Hygiene	Habitat Aesthetics



SUBCATEGORY ANALYSIS

Statements extracted from the Phase 1 and 2 journals were assembled according to their category assignments and the mission quarter during which they were written (or recorded); primary assignments were included in Phase 1, while primary, secondary, and tertiary assignments were included in Phase 2. Each category was reviewed in turn and the constituent statements were assigned to sub-categories, or themes, based on similar content. The results of this procedure are presented below in sections devoted to the 14 most-frequently-assigned major categories. Figures list the subcategories within each category and illustrate the numbers of assignments to each subcategory by mission quarter; numbers are presented for Phase 1 (tan backgrounds) and Phase 2 (blue backgrounds) separately. Discussion and representative examples of Phase 2 journal statements follow the figures. Readers are directed to the previous report in the series for excerpts from Phase 1 journals.

Adjustment



Journal statements assigned to the Adjustment category range from references to the factors that contribute to successful adaptation to the conditions onboard the ISS, to descriptions of physical and cognitive problems, fatigue, and reflections of both high and low morale. Examples from these and other subcategories are presented below. Appendix C presents results of additional analyses.

Helps Adjustment / Successful Adjustment

Luckily my day ended with my workouts, which is a nice way to end the day.

We get movies, TV shows, and radio programs--the psychological support we receive is amazing.

The other guys are coming along fine. A few idiosyncrasies as always, but we are working through everything, nothing major at all.

Looking forward to another slow day tomorrow. I know once I get going next week, it is going to be non-stop, which will be good. Can't wait to start working out next week.

Brand new procedures still slow me down, but I know my limits now, and am happy to cry uncle and ask the ground a question without fear of just having missed something obvious.

After the cleaning [a Saturday chore] I did ARED and then CEVIS [exercise devices]. The ability to work out is a life saver for me. To have those couple of hours every day is good for my body and mind.

It's Sunday and I didn't even work out, which is nice for a change; it gives you so much more free time. I got through most of my emails and made phone calls, so I'm feeling caught up in that area, which is nice. Overall, it was a nice easy day.

With email, phone calls, communications with mission control and occasional video with family, much of the burden of isolation is reduced. Exciting, productive work keeping the ISS healthy and the science return flowing is a big factor--not to mention the view.

Living and working here is now 100% routine. I am getting good enough at floating around that it is second nature. It took longer than I thought to get good at that. My body is clearly still adapting. Calluses are starting to shed off the bottoms of my feet. I love it--fun to pull skin off even if it is gross.

Having work-specific meaningful mission goals, availability of the i-phone, videoconferencing, email, the view of the Earth, and the ability to broadcast our thoughts and experiences through social media has largely solved the major behavioral health issues for long-duration spaceflight of 6 months or less.

The best part of exercise is that, aside from sleep, it's the only time the brain gets to take a break. We listen to music, watch movies, and sometimes review procedures while we exercise. But the time is accounted for already – it's been given to exercise time, and so we feel we can mentally do what we want.

We're getting better at working quickly, efficiently, and accurately through all the activities of the day. But each day still surprises us with new things we've been missing all along, old habits or reflexes that we've lost and have to recover, and new ways we can miss details and make mistakes. The good thing is, each day is a new schedule, so the opportunity is always there to capture the mistakes.

Another phase of the mission has started. The first, lasting around two weeks, was mostly about getting the body in tune with functioning normally in 0-g. A good day was having an appetite and being able to go to the bathroom. The second lasted about a month, maybe a little more – trying to master an efficient means of getting work done, with concentration on homework and prep time. This phase was associated with a fair amount keeping emotions in check – I could tell other new arrivals, despite being experienced space flyers, were having the same challenges. And now the third phase, after feeling good about the work and not being concerned about getting things done during the day: I think about being back in 1-g with my family.

Dinner in Node 1. A good time like always. We are lucky to be here and we know it.

What a day. The Station threw all kinds of things at us, but we survived and did so on time.

Downright nice weekend. We are in high beta, so the view isn't great, but otherwise it was a good relaxing time.

I have hit sort of a baseline mental state. Things that had been bothering me really aren't anymore. I have full understanding of the world around me and it is a nice feeling.

I know now how to work with ground personnel. I know now what my limitations are. I understand how to work in zero g. It is a scattered picture that has come completely into focus.

I read some news about our mission that my wife sent up. It is a good idea to look at that once in a while. As long as it's good news, it is invigorating to know that many people are interested and counting on our work.

I'm learning how to put things "down" in space. For a while after arriving we spend a lot of time "temp-stowing" items we'll be needing again in just a moment. But now, without even thinking about it, I've found that I place things in the air beside me so they're easily available right away.

There is something psychologically soothing about a day in which you have absolutely no obligations. I know that I occasionally enjoy such a day on Earth – no alarm to set, no care in the world about the clock. I think we need that once in a while. Today was originally scheduled with a few light activities, but when I asked to do them another time, MCC Ops Planners were very happy to take care of us.

It is going to be a much, much, much different crew experience when you don't have a space ship sufficiently large to ever get away from each other during the day.

Problems Adjusting

I must concentrate harder up here than on Earth to avoid mistakes. I think my short term memory is reduced.

Little details that seem so trivial bite me all the time here. I hope it will go away soon. I need to pay better attention to the lessons that I must keep relearning.

I'm amazed at how slow the mind is up here when processing details. I have made calls to ground trying to figure something out and 9 times out of 10, I see my mistake in the middle of my call; the microphone is a last resort after I have looked at a procedure several times. I have started talking to myself and if I float there and talk through what is tough to figure out I often can get to the right answer. It is weird.

The biggest challenge up here is exercising every day. It is tough physically and mentally to maintain a pace of lifting and running/cycling everyday without a break. I am told I can take a day off once a week, but I'd rather not unless we are very busy.

It's interesting how small things can be annoying after a while. I find myself a little bit irritated and it's kind of interesting how it builds. It is not that difficult to deal with and I will be home soon, so that's fine.

It is getting old being up here. The excitement has worn off after 2.5 months, but I still enjoy working here. It is the living up here that is old. It would be great to eat, sleep, shower, etc., at home and then go to work on the station.



Low Morale

It's like a continuous battle against time up here... There is a lot of stress with that. It's just a continuous time battle.

It's still busy. It's like there's no free time to do what you want to do. There is occasional free time here and there, but for the most part there is always something looming in the next few minutes that you need to do.

Today is a rare day. All three of us are in bad moods. It is one of those days where every single task for all three of us has had little problems that have set us way behind the timeline. Normally it happens to one of us each day, but today it is all three at once.

Getting a picture wrong or ruining data is something that weighs heavily on my mind. I hate it when I think I can do a better job and then sometimes just have to go with it.

We had a big week of "science," which was kind of a joke because some of the science we are doing doesn't seem like real science. But, at least we got a bunch of stuff knocked out. [This comment and several others like it refer to Congressionally-mandated technology demonstration work that consumes half of all crew "science" time on the schedule.]

Called FD, surgeon and CB management to say we were running on empty after the weekend's activities. Basically worked full day on Sat and most of day on Sun and had a major sleep shift thrown in. Didn't look like we had any compensation time for those hours on this week's plan.

I am definitely getting to the point where I could easily get annoyed. I have to work on not letting that come across. But, it is just interesting how it happens. I have about two months to go and will start getting the upslope of getting ready to come home.

I strongly feel that we are here to support the Program. Photos and work should NOT be ascribed and credited to individuals, but to members of the expedition as a whole. I don't think we should say that "X accomplished some great science up there," but rather, "the crew of Expedition Y accomplished some great science."

I actually got completely upset over a 100% trivial thing yesterday. I needed to record an experiment using a [specific] card in a camera. I had a bit of a headache [probably from high CO2 level] and we were really short of those cards. I was pissed because I saw zero reason to record me [doing nothing]. Not even moving, just standing. Plus, there was Ku coverage so the ground could have recorded it. Anyway, I wanted to call down and ask why. Cardinal error for a crew, and luckily both my crew mates jumped on me and talked me out of it. I was mad at them for a bit because they didn't see my point of view.

I've been avoiding the journal. Our EVAs got cancelled, which is a bit of a dagger in the heart. Sure, we're all safe, healthy, families are good... Lots to be thankful for and that is why I am upset with myself that I am as disappointed as I am about this. Our office puts a high premium on EVA experienced crew members and to be so close and have it get cancelled hurt pretty bad. We had the tools ready, suits clean and built up, heck even the patches and stripes were on. We have spent the last two days tearing everything back down and re-stowing all the hardware. Let me tell you, that sucked. Plain and simple.

What a day it has been. Nothing is easy and nothing is routine. Today started with urinating in the bag so that set the tone for everything.

I think I do need to get out of here. Living in close quarters with people over a long period of time, definitely even things that normally wouldn't bother you much at all can bother you after a while... that can drive anybody crazy.

High Morale

Another good day.

The crew is having a great time.

Everything OK. Feel good. Happy to be here.

Lots of cargo ops today, but that is just fun. I love it.

It was another great week. They just keep getting better.

I am going to miss working with this crew and just being here in general. It has been a good ride.

Spirits are very high thanks to our ability to joke around and see the good side of any situation. Love working with these guys.

I laughed so hard I cried today recording PAO stuff with X. Those two events made it a great day. Morale is good at the moment.

The bathroom is located in Node 3 and that is where we wash up. Connected to Node 3 is the cupola, which opens to the world below. X was in there stripping down to wash and the cupola windows were open. He mentioned that he is mooning the world. We had a good laugh.

We had a blast last night, the Russians came over to Node 1 and we had floating competitions to see who could do the funniest tricks. I realized if you tear up from laughter in space the tears don't roll down your cheeks, rather they just well up in your eyes. It is a weird feeling.

Top ten indications you have been on Station too long. Number 10: When you say, " Hey, I can hear the ocean by holding a running shoe to my ear" (this was actually said)... Number 2:When you say, "I might install a funnel in my bathroom at home. I love this thing" (this was said too)... And the Number 1 indication.... When you do "Rock, Paper, Scissors" to determine who gets to push the fire alarm button this time.

Thoughts of Home

I do crave my family. I'd love to give my children a big bear-hug.

Tough to be away on holidays especially when there is not much to do here.

I watched the family on my video camera installed in my living room. It was nice to see them and difficult at the same time.

All is well at home. I think I will send [my wife] an email every morning after I wake up so that she gets it when *she* wakes up.

I definitely feel very good about the time onboard, and think that I have a lot of constructive things to say at home about how to work and live up here.

Life continues to be grand here – no mistake about that. But, after a couple of months, when one feels they are in charge of their environment, thoughts of home and family rise to the surface.

I miss the family more than ever. As the days become easier, I dwell more on home. We are a gregarious species and at some point any human here will feel the instinct of getting back to Earth and their fellow humans. Now the challenge is to prepare myself mentally for the possibility of a landing slip.

My father is pretty sick and it will be tough if he's struggling while I'm here. But, we did have the conversation when I saw him last and there is the possibility he might not last until my return. [Several astronauts have endured news about the loss of loved ones while on the ISS; all have continued to perform admirably.]

Riding on the CEVIS (bike) today listening to my music when a Moody Blues song began to play. It was on my play list from many years before I was selected as an astronaut. I would ride my bike for exercise and that was one of the songs I would play. The song reminded me of the days when I dreamed of being an astronaut. Now I am living in space and preparing for a spacewalk. Wow!

For now, I am looking forward to getting home and just being a father for a couple years. I fully expect to be back here... My life has been a hell of an adventure up until now and I really have no idea what is coming down the road.

I miss my family so much... I know I need to go home. I looked at a couple pictures of my children playing last night and it made me cry. I never get nostalgic to the point of becoming emotional, but those kids have grown a lot and I don't want to miss any more of their young lives.

The separation might be harder for my family at home than for me, because I have interesting things to do up here, even though I would really like to have real food, etc. [This is very similar to an entry written by Fridtjof Nansen during his attempt to reach the North Pole in 1893-1896.]

I miss [my wife and children] so insanely much it is hard to grasp. That is what I think about the most... If it is 5-10 years before I fly again, I will be OK with that mainly because I need some time to be a dad. A normal dad. Not a dad always in Russia or Japan or Germany, but a regular old boring type of dad.

My list of things I miss the most has grown. Family first, then a shower, then a latte, then rain. Really miss the sound of rain and the cool air and fresh grass smells that come with it. I miss being under a blanket of clouds and guess I'll always be a child of the Earth.

Things at home have been stressful. [Conditions at home can affect astronaut performance in space, whether it is an interpersonal issue or recognition that one is missing out on key events.]

Getting back to the family is going to be tough. I hope I can reintegrate, but I've been gone for so long it is going to be weird... It is going to be awkward and in some ways I am just not looking forward to it. Life is simple here and it is going to get complicated.

I had my last PPC [private psychological conference]. I guess I am sane enough to come home. [Note: A good sense of humor contributes immensely to successful adaptation to the conditions of isolation and confinement.]

Beauty / Wonderment

Floating is awesome and the view is amazing. Can't believe we are here. [Day 1.]

I love looking at the Earth and taking pictures. I love doing effortless and pointless somersaults.

Had some good quality time in the Cupola. Words cannot describe the view and the feeling of looking back on Earth. I am definitely one lucky person to have this opportunity.

I just saw the most amazing, most beautiful thing I have ever seen in space: Sun setting and throwing enormous golden rays of light across the entire planet. I am speechless.

The reality of geopolitical and geographical differences among nations on the ground begins to fade as the greater reality of one species eking out a short life on this one sphere while nestled at the far edge of an ocean of stars with their own planets and vast, glowing, eternally changing galaxies becomes the greater reality. It was just a few minutes, but I'll never forget it.

I've fallen in love with the Earth, perhaps just as we appreciate our parents after we separate from them. She has so many personalities, has taken care of us, nurtured us, challenged us. I only wish humankind could be better, when I look down and know what is happening on our planet. We are in our "terrible twos" as a species.

Time

Several examples of statements that refer to the passage of time are listed below, perhaps more than warranted by the number assigned to this subcategory. However, these statements speak to an essential aspect of adaptation to the special conditions of life onboard a space craft. In particular, it appears that the transition from counting up to counting down occurs at about the four-month point (the same during Phase 1 of the study); time passes quickly when one is busy with meaningful work, but is unbearably slow when one is not fully-engaged (the polar explorers recognized boredom as their worst enemy); and there is general agreement that six months is a long time to be away from home.

Time is going crazy fast.

The work is very fulfilling, and the days fly by.

It has been 3 weeks since I arrived — a good 3 weeks. I am feeling like I am in the groove now.

Time is flying by. It's as good as I expected, and I'm happy to be here with many weeks to go.

Sundays on the ISS are very nice and just like at home; the next thing you know the day is over.

Can't believe I've been here over a month and I swear it feels like less than one workday.

The days are developing a sameness that will make them meld into a single impression as time progresses.

It never ceases to amaze me how quickly the time passes, whether it is a working day or a holiday. To me, that is a good thing.

I was thinking while working out about people saying how busy they were or how late they stayed up. The answer is simple. There is time to do anything you want up here but not everything.

Simply cannot believe another week has gone by. I have never had days fly so fast as they do on ISS. It must be being engrossed in work that does it. There are almost no tedious tasks. We don't commute anywhere, and even when relaxing, we're busy: taking pictures, cleaning, stocking the pantry, getting ready for the next day, etc.

Sometimes it's a little bit like *Groundhog Day*. You wake up at the same time every day. You look at the schedule and figure out what you're going to do. Even though the tasks are different, it feels like you're doing the same thing over and over again. And that's at one week. I'll let you know how it turns out. It is not an issue at this point. I just find it interesting.

As the rush of launch, adaptation, and then learning how to work up here has abated, the calendar days tick off much more slowly. The work day goes by fast as we play "beat the clock" all day, but now I'm waiting for the GMT days to go by as fast, and they're barely moving.

Here on ISS the time and the miles flow by at breathtaking speed. We mark our accomplishments by the week of successful tasks completed, and by the number of remarkable photographs we've been able to take—maybe because we want to try to permanently brand our brains with these sights.

I've stopped counting days. Time goes by slower when I try to mark each day.

Wish I had more to say, but after 52 days in space, life is 100% routine. If I went home tomorrow I wouldn't be bummed. Likewise, I don't see the remaining time ahead as a big issue. I am pretty much in a nice balance.

We are 8 weeks in and I think the routine is clearly settling in. I don't quite feel the compulsion to head to the cupola every spare second any more. Not saying the view isn't amazing, it is, but I don't feel that curiosity quite as much.

I am not writing as much in the journal because there is not much to talk about. Most everything is the same up here. In general I am to the point where I would be happy to go home and call it a

mission. I am still fine with being here. I think today is the 1/3 point of my increment; X weeks down and Y weeks to go. I will be fine but 6 months is a long time to be here and I cannot see why anyone would want to be here for a full year. If we were going to Mars it would give us purpose and we would be willing to accept hardship and time away from home.

Sunday also means a new t-shirt. Oh the simple pleasures.

The sound of voices, especially Russian voices, coming from the speakers is really the only environmental cue that it's daytime.

With the long workdays I've lost track of time. I have trouble recalling if I called my wife today or yesterday, and events on Earth aren't anchored to a specific day. The days here are each part of a running scroll of work/rest/prep time without sufficient breaks to separate one day from the next.

I've stopped counting the days, and now am thinking of milestones. Two weeks until the Dragon arrives. And then in only two weeks X departs, leaving Y, Z and me here on station. But in another two weeks A should arrive with his crewmates. And, at that point we only have 6 weeks left.

Very slow up here this week. Slower than the usual slow days. I have 3 months left so I really think the next 2 months or so are going to be hard for me to stay focused. The last few weeks I will be so happy to be near the end that I will be fine, but it is this middle part that will be the hardest.

I still don't know where the days go. We depart 6 weeks from today as I was reminded in the weekly family conference.

Not much to write in the journal since the days are the same as they have been for the last 4 months.

Life can get into the doldrums after a while, when the station becomes a bit smaller and less exciting as familiarity with it grows, and the outside world consists of nothing but the ground control team and a few others.

Still can't believe we are 60 days from home.

Mission is winding down for me. Hard to believe we're headed home in 5 days.

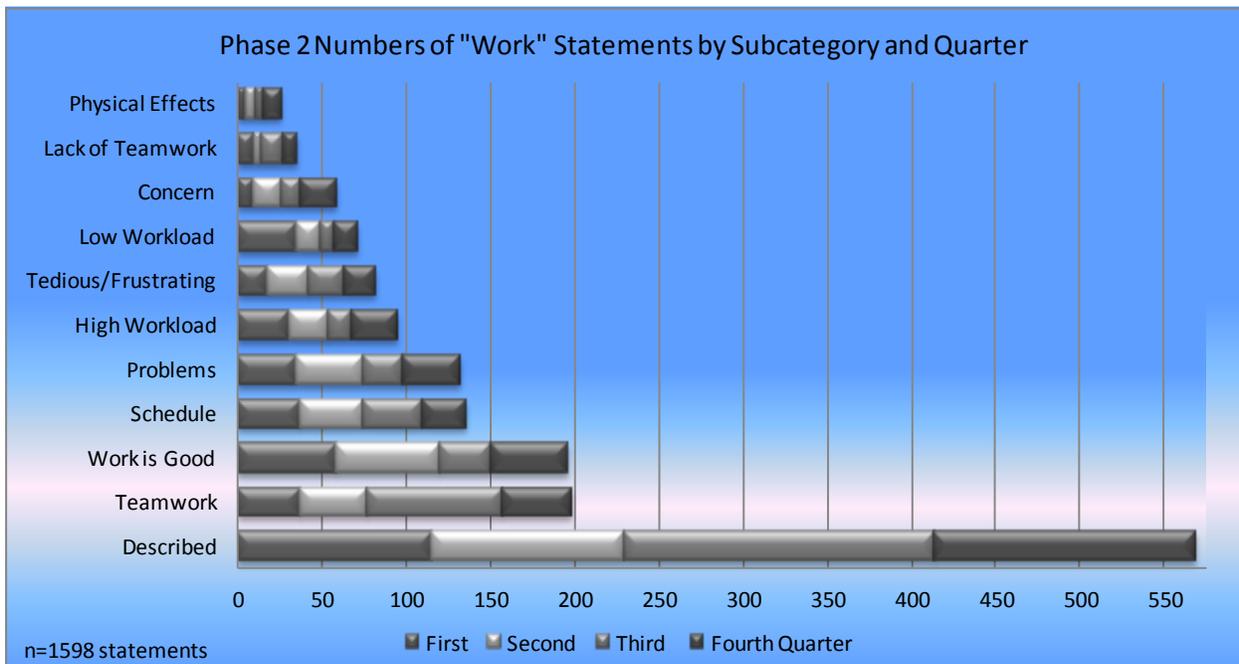
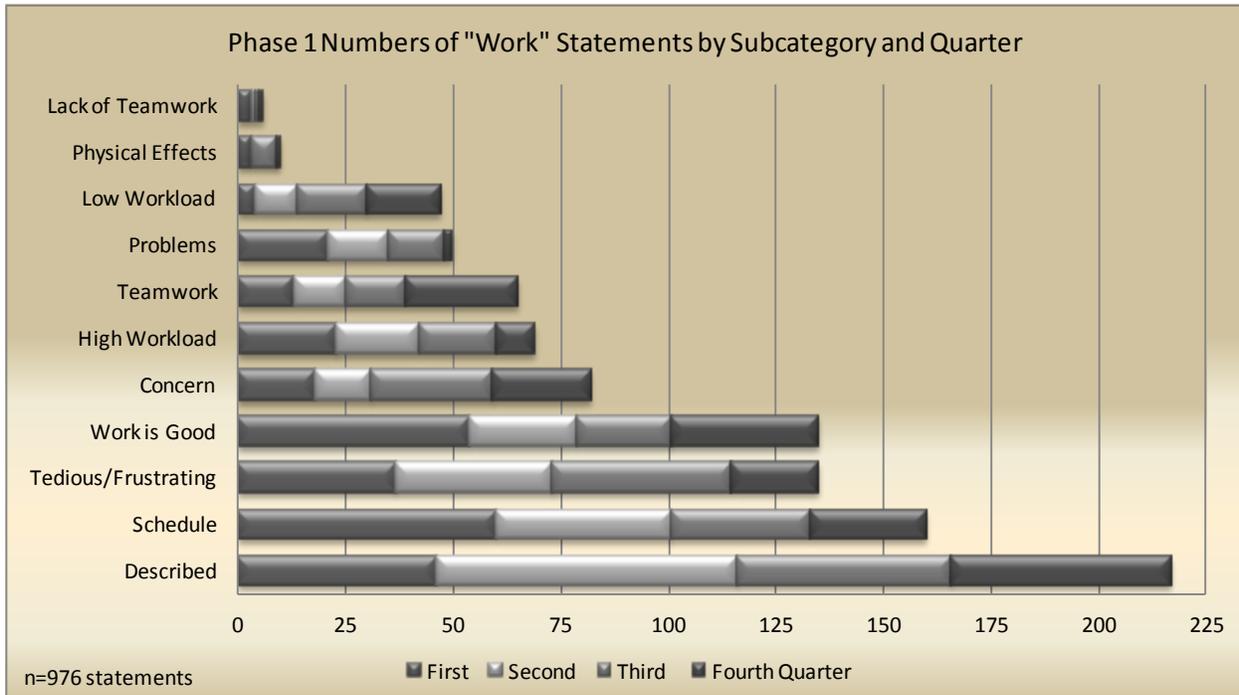
Still fascinated with the passage of time up here. Time so effortlessly glides by when we awaken and spend our entire days in the same place. If we were bored, time would crawl. But here where all movement is magical, and the work is intensely interesting, and we know we're being supported by teams all around the world, not to mention being able to see our home planet in full view out the window, we are definitely not bored.

This is my last night on orbit. It feels almost as surreal as it did the night before launch. Of course there are mixed emotions. I am proud of the work I have accomplished personally and of the work we have accomplished as a team. My main goals were to be productive and to enjoy my time. I can look back and say I have done both. While I would be happy to stay a few more months, I am now excited about the fact that I am going home. It was a good day.

Other

The process gave me a headache. So I went down to the Soyuz, which definitely has good orientation. It is very comfortable [to sit there] and I am used to the visual picture. The headache definitely abated after 20 minutes and I took a little nap because it kind of wore me out for some reason. I was fine when I woke up and there was no issue again. I [my brain] needs a visual orientation system to reference. [Much has been written about the need for a "local vertical" to facilitate adaptation to zero gravity, but the possibility of using all four bulkheads and every cubic centimeter of space has been way too attractive to station module designers.]

Work



The leading subcategory within the major topic of Work is composed of journal statements that describe tasks performed by the crews. This is followed by references to teamwork, work going well, scheduling of work, and work-related problems. Examples from these and a few less-frequently-assigned subcategories are listed below.

Work Described

A X change-out, some food stocking, MPC playbacks, and printer troubleshooting was the extent of my day.

I had a chance to enter the CIR Rack – very straightforward but good to see. Worked on a little ATV transfer ops, Quarterly maintenance on T3, X did the ICV ultrasound on me again, and then I got in my exercise.

I want to clean up the eating area – new straps for the table, new Velcro, maybe even scrub some of the stains out of the fabric lockers. There are just odds and ends everywhere, and I would like to make it a little bit more orderly. I guess it's my background!

I organized the dozens of water bags on the Node 2 ceiling so they aren't just random. I did some serious cleaning – pulling tape and Velcro off of walls, straightening up modules, throwing out anything that didn't look like it had a purpose. Some stuff has been there for years.

X is in white tornado mode, cleaning things up. In his enthusiasm, though, he threw away my two bonus food containers thinking they were trash. For the most part that was true, because they had way too much sweets and junk food. As far as I'm concerned if he's willing to work that hard he can throw away all my stuff.

I tackled the Xs in the Airlock and it was a much bigger task than advertised. Getting that large panel off and then back on was difficult, but got it all done before the DPC.

I had to make some connections this week in the CIR rack – fluid quick disconnects, that took no less than 100 pounds of force to mate. The push force was toward the floor, so I literally stood on the ceiling and pushed upward with all my might. Tricky.

The afternoon was spent working on the WHC [toilet system]. I had to change out the urine receptacle and then a bunch of hoses dealing with the separator and air filter along with a liquid sensor. The OSOs put together a great procedure. I went a little long because routing the new hoses was a challenge and there was not sufficient labeling. I used a sharpie to mark some things to help the next person.

The X experiment runs automatically, and provides video to the ground of a process through which physicists study fluid mechanics. It runs at night to minimize effects of crew movements. Problem is, the experiment starts at 9pm and runs for 9 hours. If we must move around during that time, we float slowly, using minimal fingertip pressure for control. For some reason, we also whisper, as if we are tiptoeing and afraid of waking someone up. All of us quietly and slowly swimming around reminds me of a family of dugongs. [A vivid image and terrific sense of humor.]

I ended the night by answering work emails and now this journal.

Off to the RS to try to photograph a volcano near Sicily. Stromboli. Sounds delicious.

Teamwork

What was great was that we all worked together to get it fixed.

This is a really good crew to work together and it is more fun that way. I think we all enjoy doing stuff together.

We are getting stuff done and although, sometimes it takes time, we get it all done. I love that we are always working together.

X and Y did a great job on the Progress trash gather. We've been swimming in trash for months and it will be great to have some free space again.

It is so nice working with X and Y because we just do what needs to be done without any hesitation and we don't skip a beat with the timeline.

The tools we made [for an EVA] include X, Y, and Z. It was like a mini Apollo 13 scenario. The ground team did an exceptional job.

This day stands out because we accomplished everything on the schedule, even a little early. It is pretty cool to see how well we work together as a team, not only up here but also with the ground.

It was a good handover task because it showed me tools that are not in the normal set and also taught me techniques that I would not have thought of using. I felt like a nurse handing over tools, but hey we all have to do our part.

We had 2 PAO events today, one that was supposed to be Russian only and one that was supposed to be USOS only. We decided among ourselves to have both events feature all of us – as matter of principle (one station, one crew). Both MCC's seemed to be fine with it. [This statement and others like it reflect crew solidarity and efforts to "educate" the respective management structures about appropriate team behavior.]

Normally, I'm the kind of person who would over think this tasking and be disappointed not to play a bigger role. But today, I was delighted to float around station taking photos of the grapple and bring my crew mates coffee and whatever else they needed. It was really a great feeling to know all this stuff was hashed out ahead of time and it left me in a good place. [This statement reflects the fusion of good management policy, mature crew leadership, and effective teamwork. Examples of lack of teamwork were confined during this phase of the study to instances in which individuals were engaged in a task and could not break away to help others and a few complaints that some individuals were too engaged in social media efforts to help others when needed.]

Work Is Good

I cannot ask for a better work day.

I worked on my first experiment yesterday and enjoyed it.

I performed Soyuz unpack with X today. We had a good time.

It is good to be tired and ready to fall asleep at the end of the day.

It is fun to work with the equipment that we talk so much about in training.

The science is even getting to be fun. Not my *forte* for sure, but it is pretty cool.

We all finished early so we tackled a few Task List items. Overall, a fun and productive day.

I really can't complain about anything. Life is just good. Science is fun and really rewarding.

This past week was filled with science. It has been fun, but like I was explaining about photography, we all want to do it right.

Work was good today. Got to do science, maintenance, and acted as an ultrasound tech. I loved the work even though it was simple.

Another productive day on orbit. The majority of our time was spent on unpacking and re-stowing. We knocked it all out today and finished about an hour plus early.

An enjoyable day of work today. I took apart and put back together two experiments, then I swapped out a card in a payload. Lots of work with tools, so I enjoyed it.

What was supposed to be a long relaxing weekend will probably end up being one day off and 2 days of prep. That is ok. We are here to work and there is no work better than an EVA.

I highly recommend that long-duration crewmembers do a spacewalk during their mission. It can change the way you see your entire stay up here.

A very satisfying task was setting up some Ultrasonic Background sensors today. It was a nice plan, well laid out, and I got to really build something for science. It went well.

It was fun yesterday rotating a rack down and working with lots of big clanky things and leaky fluid connectors. And the ground told me it was all working after I was done.

Workload in general throughout the mission has been good. Enough to keep us engaged, productive, and happy, but not so much we can't stop to take a moment's break.

I had a good day yesterday and was actually able to do real science for the first time. It was fun and interesting. Much of the science we do is just turning equipment on or off or cleaning out a glove box or whatever, but this was actual real science for a couple of hours. I loved it.

Glad to have the first round of blood draws, urine collections, and VO2 max complete. Now I can relax for a little bit. That stuff stresses me out. I don't like flight surgeons as a general rule because they are the ones who can keep me from flying. Not personally, they are all great friends, but as a profession... they scare the hell out of me. [This statement reflects an emotion felt by aviators on and off the planet.]

Investigators around the world have sites of interest that they'd like an astronaut to photograph, and those sites are laid out in our timeline. I set my watch to alarm when a site is coming up, and if my hands aren't full I'll blast over to the Cupola and try to get some shots. Some sites are tough to find, especially in Southern Africa or India, where cities, craters, and drying lake beds are obscured by a veil of haze. Islands and mountain ranges stand out and are easy to spot when there's no cloud cover. There's nothing like getting a great photo of an especially beautiful area.

Well, we are running through the timeline and getting stuff done. I am happy to report that things are going well and we all still like each other.

Schedule

Trouble finding jumpers which delayed me a bit.

Ground has been a huge help, but they cannot win us back time and that is what we need now.

Got to perform open heart surgery on the XYZ apparatus. Went long (2 hours over and no lunch), but really enjoyed it.

It's like a continuous battle against time up here. There is a lot of stress with that. It's just a continuous time battle.

Started Handover Ops with X. It is good to have time on our schedule to go over little items and the ground has provided a list to review.

They gave me 10 minutes to work a procedure that required me to find a specific calibration bag – that alone consumed the 10 minutes.

This is our second day of straight work with less "handover time" in the schedule for a buffer. So, I got way behind on the schedule, by about 90 minutes.

It seems that when you have a lot of different activities, and some only scheduled for 10 minutes, you tend to fall behind. If each activity runs 5 minutes over, you can be 30-60 minutes in the hole before lunch.

I suspect the reality is that few, if any, have been able to accomplish the tasks on-time, at least this early in flight before we have locations and common procedures memorized. Telling the ground that it took longer to perform a task than scheduled is an admission of lack of ability. And telling the ground a little more privately, through typing a crew note in OSTPV, well, takes even more time. It's low on my priority list when I'm pressing on to the next task.

The fatigue that develops from working here comes from the time pressure. The ground says "don't chase the red line" on OSTPV, but the fact is we crewmembers simply cannot ignore that. What is scheduled is what is expected, and another astronaut probably got all this work done and on-time on some past mission. No one wants to be seen as a slacker or as incapable [or as a complainer].

I know we're not supposed to care, but it is very difficult to ignore that clock.

Interesting that the ground assigned it as a 30-minute task – but I'm sure they know it will involve 3-5 crew hours to really get it accomplished.

I don't know if it is the new science on board or the new flight control team, but we seem to be lagging behind on everything and are unable to steal even a single moment to claw ourselves back on timeline.

The fatigue from these busy weeks comes not from physical labor but from mental strain. No matter what the ground tells us, we still feel the need to chase the red line on OSTPV. And we are constantly aware that the ground is watching and evaluating.

We are, by nature and by training, performance and goal-oriented. We tend to feel bad about ourselves if we do not complete the plan. I am aware of this and have consciously tried to get perspective on it and not feel that I must complete all tasks and in the given time. However, I think there is an underlying frustration that builds when I do not complete everything on time.

It felt like the schedule went from normal to impossible. During EX they were using about 80% of our time, which gave us some wiggle room to fix unexpected problems. In EY they have scheduled us to 120% and that causes huge problems when unexpected issues arise. And guess what, something arises almost every single day. It is very demanding and not enjoyable. No matter how much we work, we are still behind.

T2 broke, X setup took twice as long as planned, Y took 2-3 times longer than planned, Huntsville and X have called many times a day for 'favors.' All of that really eats away at your day. We had a full work day on Saturday. The place was a mess of unfinished tasks and I couldn't allow the crew to go to sleep without taking an hour to pick up and try to find a stable configuration. It was pretty stressful.

I'm feeling less time pressure – mostly due to [the realization] that the ground is actually guessing when they decide how long a task should take. I'm astounded by how much they can underestimate how long a task will take. Even if I were maximally efficient, accomplishing a task can take twice as long, or more, than the time given.

It's fun working under zero time pressure, when the threat of getting behind in your day is erased due to the ability to just get far ahead, gauge how long things are going to get, and be sufficiently confident that your call-downs and requests for help are appropriate.

Sunday is meant to be a day of rest, but somehow Houston managed to make it feel like Monday. [This statement was made during Phase 1, but is just too good not to reproduce in the report dedicated to Phase 2 data.]

It is a consistent workload because we all fill it in with stuff to accomplish for our busy schedule coming up. No one is working too hard, no one is slacking. Just everyone doing their work and getting it all done. For some reason this is a surprise to the folks on the ground who are amazed. It isn't rocket science. [It might be due to ground personnel learning to allocate realistic time on the schedule to complete tasks.]

The work isn't bad, it isn't unreasonable. The timeline is absolutely fine. [This relatively rare theme indicates that it is possible to schedule work appropriately, although it might be sarcasm.]

Problems

Everyone experiences problems at work, but only ISS crew must endure the special conditions of space and the constant scrutiny of minders while attempting to solve theirs. Most "problems" on the ISS are caused by either equipment malfunctions or unclear/incorrect procedures, which are addressed elsewhere in this report. However, sometimes problems are attributable to astronaut error. Causal factors include high CO2 levels, complaisance, and the constellation of conditions that result in the impaired cognition known technically as "the space stupids" (or "space fog"). The cause is unknown, but nearly all astronauts report taking about a ten-point hit to their IQ when they reach low-Earth orbit.

It seems like we are making a lot of mistakes this week.

I made a couple mistakes today by not being thorough in reading all daily summaries. I called the ground and am not worried about it, just thought I would mention that I have made mistakes already.

I still seem to not pay attention to details sometimes like I should, and then make small mistakes. I know it is a continuing issue, that I make a lot of assumptions when I read a procedure and believe I know what they want. I will work on that.

X is a bit down on himself for making little mistakes, but that stuff happens. He just needs to throttle back a little and spend more time double checking his work and these mistakes would evaporate. If only I could go back 5 months and give myself the same advice.

That makes 2 somewhat significant mistakes (at least in my eyes) yesterday. I have thought back to what could have been the cause – sleep was good the night before and I was not in a hurry – those are the usual suspects. Bottom line, I think I just lost focus in the morning.

Another challenge is the constant problem-solving. Getting to your worksite, un-stowing tools or hardware from racks that are buried under other hardware, figuring out how to restrain yourself and your tools, working with stuck bolts or confusing wiring, and especially interpreting unexpected experimental results.

I was floating back to the service module and am good enough now to make it all the way through the FGB and the PXO into the SM without touching a handrail. As I crossed into the PXO this time, I slammed HARD into something with the top of my head and stopped instantly. I quickly looked around to see what unknown obstacle I hit and there was X, also rubbing his head coming out of MRM2. We slammed into each other head-to-head – we had a mid-air collision.

I think the biggest notable event for me was urine collection. There must be a better way. My first two attempts resulted in a disaster. Got better as time went on but for a while the frustration with that terribly designed urine collection bag was high. I had pee all over my hands, wrists, a little on the wall, everywhere. But, now that is behind me for the time being.

High Workload

Space sure is a busy place.

I am sensing a common theme: non-stop days.

I have not even looked out the window in 3 or 4 days since we began this push for EVA.

The day before capture of a vehicle is always busy. Then you add some unexpected problems.

There are only two days in a week on ISS: Monday and Friday, with a couple of hours in between.

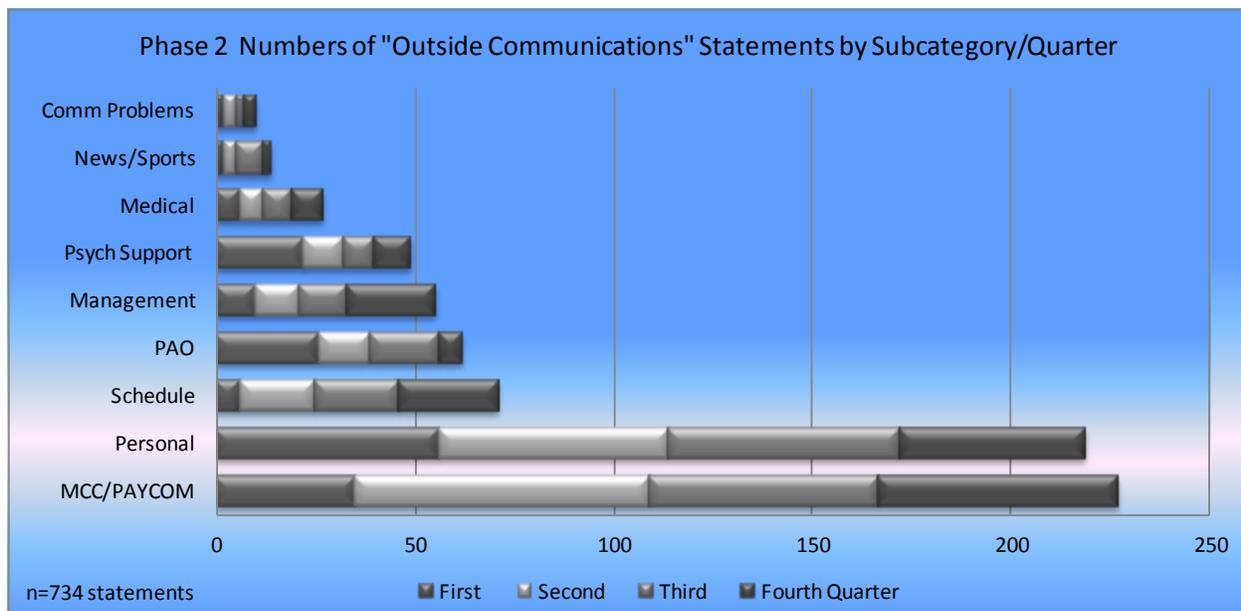
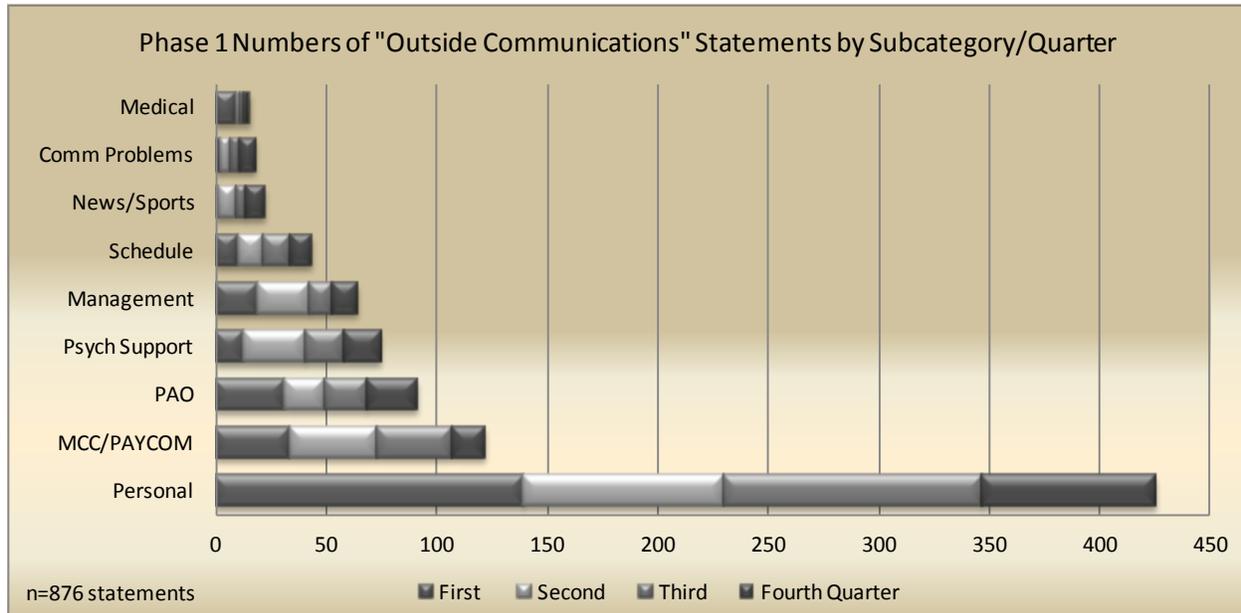
Still working feverishly! Just when I think I have this place figured out, another day comes along that seems really hard.

We had a very long day on arrival. Three of us had spent 50 hours in a Soyuz, spinning through space, eating and drinking very little, so it would have been nice to use the rest room, clean up, eat a little, and rest for about 12 hours. Not our luxury, as we worked for the next 9 hours.

Another extremely busy week, but I feel like I have the tempo under control now.



Outside Communications



Communications with friends and family was the most-frequently assigned subcategory within the major category of Outside Communications during Phase 1 of the study, followed by work-related communications. The reverse order emerged from the analysis of Phase 2 journals, fueled by a large increase in the number of statements concerning communications between ISS crew and mission and payload controllers. Examples from these and other subcategories are provided, below.



Conducting a Public Affairs Office (PAO) Event.

Mission Control Center/Payload Communicators

ISS crew members communicate daily with personnel in the Mission Control Center (MCC) at the Johnson Space Center in Houston, Texas; with payload communicators (PAYCOMs) located at the Marshall Spaceflight Center in Huntsville, Alabama; and occasionally with ground personnel from the European and Japanese space agencies. Most participants are aware that good relations between on-orbit and ground personnel can contribute to effective task performance, which fostered a tradition known as “praise inflation”—complements in both directions, even when undeserved, and a general avoidance of mentioning deficiencies, real and perceived. Praise inflation was evident during Phase 1 of the study, but there were few references to the practice during Phase 2, which suggests a maturing approach to these essential relationships.

I think the relationship with the ground has been very good. Every day there is always some problem with the stowage note and I just flow with it and deal with it.

It's important to have good communications and rapport with the ground, and I feel like I'm off to a good start. One of my goals is to have a forgiving attitude towards those supporting me on the ground. I feel good about it so far.

The ground seems more clueless, more harsh than when we first arrived. X, who's been here 2.5 months, definitely feels it. I can hear it in his voice, although he is a master at making his comments and criticisms clear, kind, and in context.

Overall the relationship is very good – but when hardware is not cooperating, or we're making mistakes, or just having a bad day overall, our impression of the ground team takes a sour turn. We know that our distance from them and our isolation contributes to that, but both we and the ground need to get better, so we have to identify weaknesses.

I will admit that there are times when Mission Control makes us roll our eyes a bit. For example, today while working on our toilet, they asked us to take some photos of fluid in a transparent hose, and to hold a piece of white paper behind it so that the color was visible. A few minutes later when we were up to our elbows, they felt obliged to call again and remind us to please not leave the paper inside the rack when we closed it up. A little bit strange. We avoided saying anything other than thanks.

Capcoms can really make your day. But there's a big difference between being upbeat and being seriously upbeat... if a capcom is always saying "great job" or "awesome work" it only goes so far. The best capcoms are the ones who are to the point, give you the info you need succinctly, and sound like they know what they're doing and sound like they know what you're doing... a sense of trust builds between the capcom and the crew and positive remarks from the capcom have more meaning. [Note: Capcom is a vestige of the earliest days of the "manned" space program and is an abbreviation of "Capsule Communicator," the person designated to perform nearly all communications with the space craft crew; capcoms are often astronauts, which helps establish rapport and fosters understanding.]

X was our capcom and it was her first day on-console. She did a great job. Upbeat and directive.

At 2300 we got a call from the ground that there was a failure in the WHC. I don't know yet what it was, but we will get more information in the morning. Depending on the failure, we could have quite a bit of work ahead.

We had our weekly flight director conference. The main topics were sleep shift (all worked out), the IMV valve in Node 1 which was blocked by food containers when we arrived; we cleared it but some people are not satisfied. I made it clear that it would be easy for me to completely fix the issue if it is a problem.

It's really a wonderful choreography of all these minds in Mission Control and from the Science Centers in Houston, Marshall SFC, Europe, and Japan, talking to us and listening to what we see, providing info and advice.

This is indeed exploration. I don't mind the trouble, just as long as Houston doesn't mind me pointing the trouble out. That's my job.

We are getting quite a bit of feedback that we are doing a good job up here but I take it all with a grain of salt, because it seems folks are quick to use that kind of talk to a crew. I think we are doing fine, so I don't worry much about it.

Loneliness – just doesn't seem to exist on ISS. While I only see five other faces every day, and two of those five all day every day, my psyche still believes there's an entire team on-board with us working. The S/Gs give that feeling. Someone to provide answers or respond to problems at any minute. When we're working with the S/G loops active with four or five control centers, I attach faces to the voices I hear on the loops and it becomes quite a crowd up here.

Personal Communications

Many of the entries concerning personal communications refer to email messages, but it is the availability of the IP phone onboard the ISS that is largely responsible for the large number of entries in this subcategory. Despite the positive tone of most of these statements, including the examples inserted below, astronauts also learned of natural disasters, car crashes, illnesses, and deaths of loved ones. The IP phone enables ISS crew to remain a part of their families' lives, but it is not a substitute for actually being there when a small child loses a first tooth or an older child graduates from high school. Astronauts and their families sacrifice greatly for participating in the exploration of space.

I talked to my sister yesterday after trying to call 3 times.

Everything is good at home. I talk to [my wife] almost every day for a few minutes.

I made phone calls and knocked out my email. It was a very productive and restful day.

We have phone calls every day with home, we have video conferences once a week. The psychological support we get on this flight is amazing.

My son actually sent me an email this morning. It was surprising. He does not communicate much.

It was cool talking to my family and hearing them sing happy birthday. I received lots of birthday emails. It is too bad there is not enough time to respond to all of them.

Called a friend and former crewmate on the IP phone today. She said "good to hear your voice with the delay." We know what that delay means: someone's in space.

Just saw a picture of the living room my wife sent me. The carpeted floor looks nice and soft. My first impression was that the carpet would be a nice place to Velcro things to keep them down.

The interaction with family and friends via email—the access we have is almost instantaneous and that has been fantastic. [The benefits of near-instantaneous communications enjoyed by ISS crew will be unavailable to the crews of planetary expeditions; emails will be the preferred medium when distances cause delays longer than a few minutes.]

Things have been really rough at home. X is having a hard time... and gets depressed. It is a struggle trying to prop things up at home from here. [Again, conditions at home can affect an astronaut's adjustment to living and working on the ISS. Military personnel are familiar with family problems associated with periodic deployments, and procedures/institutions have evolved to minimize the negative effects, but sometimes nothing can be done to resolve an issue until the family is reunited.]

The day always ends with a phone call to home. We rely on satellite coverage, operating laptops, and lack of cell phone drops to keep a conversation going. It's a delicate chain that often breaks. Rarely do we say goodbye. I just hear silence on the other end, and that's the end of the phone call.

Schedule

It was a good lesson for me to really pay attention to the look ahead schedule.

Houston told us it was a big job to replace the pump and maybe on Sunday we would do it. We said we wanted to do it now, so we were swapping out the WHC pump till 0930 last night.

I called X to ask about tomorrow's schedule and had to leave a message. With us getting ahead, I wanted to make sure they were not backfilling our schedule and that we will be smart with our time. It was a long day.

Asked them if we could get ahead on things and do activities in big blocks instead of sprinkled throughout the day. That will put some runway in front of us in case of problems. They were happy with that.

The FD conference was full of information and just as much uncertainty. The Program really wants the EVA [soon], which means the procedures must be written by tomorrow morning. That only gives the ground team one day to put together a reasonable product. For us, implementation will be easy.

X and I are at our peak, and for now at least it seems we can easily get through the day's schedule. Brand new procedures still slow me down, but I know my limits now, and am happy to cry uncle and ask the ground a question without fear of having missed something obvious.

We had a chat with X today. The main topics were the potential 7 hour work day and having payloads put on the task list and count towards utilization – again a numbers game for the people on the ground. We will continue to do high priority task list items whether they be systems or payloads.

I am not sure why, but we have a DPC scheduled for 0555 this morning, in just about 10 minutes from now. I am definitely tired and fading. I think I will go to sleep as soon as I can after the DPC. It has been a long day and morning. I don't think any of us liked the sleep shift schedule that was chosen. We will see if we can have a say for the next shift.

I had to make a quick phone call to X to make sure we are all clear and on the same page for future sleep shifts. It is a big topic on the ground and of course on that affects us. I think we look good for making some big general changes, like only having the affected/required crew actually sleep shift. Up to now, that has really never been done on ISS, or at least not recently. I think it is good for everyone. It will save time and keep us better rested.

I received an email from X about the EVA. They were looking at changing the date just so they could fit in 5.5 hours of transfer between the EVA and [cargo ship] departure. And this is 5.5 hours total between the 3 of us over a 3 day period. So we called to say we will get the transfer done, so pick the date that makes the most sense. The more I am here I can see how much things are analyzed or over analyzed and how much they are trying to protect crew time (to protect us).

I received my post flight schedule for the first week and it really makes me want to stay here even longer. It is busy and they have me doing all kinds of medical and physical tests. It is all part of the flight, but not something I am looking forward to.

Psychological Support

NASA provides "psychological support" to ISS astronauts in the forms of periodic video conferences with family members and occasional private conversations with celebrities (e.g., authors, actors, filmmakers), called Crew Discretionary Events. Other services include providing news, TV programs, and movies, on request, and maintaining web pages. The statements in this subcategory were very positive, with those few coded as negative in tone related almost exclusively to technical problems that degraded the experience. The journals convey the astronauts' sincere appreciation for the important work performed by the Psychological Support Office, as is evident in the following examples.

The psychological support that the ground provides with the crew webpage is really outstanding.

I had a nice weekly conference with the family. They are all doing well. [The majority of statements in this subcategory were similar to this example.]

X even mentioned that he had a conference with his wife yesterday, and she showed him the bag of food that is going to be on the airplane for him. He said he was just drooling, it was looking so good. I understand that.

I had my first PFC with the family. It was good. They are full of questions. It will be nice to chat with them weekly. Between email, IP Phone and the video conferences, it is very easy to stay in contact with family and friends.

PFC with wife and daughter last night. Video and comm dropped out after a minute or so, and then recovered. Fortunately I prepped my wife and daughter that this would happen a lot. My daughter was interested for about 1 minute, and then began to work on something in the background. I like it when they are just doing daily tasks and not sitting staring into the camera. There's no pressure for us to entertain each other – I mean how often does one just stare into the face of their spouse or child and just talk for 15 minutes? Anyway, IP phone is a big boost – easily controlled by the crew, works well, and so serves as an excellent backup to the video conferences.

My crew mates kept a little secret. A phone call with Giada was scheduled and they all knew but me. We were in the middle of an EMU loop scrub so I had to stay focused but then we found a break point where we could all chat with her. It was a nice surprise and added a little relaxation to a tiring day. [Note: The crew had been watching episodes of a cooking TV show hosted by the subject of the secret call while exercising individually and as a group after dinner.]

Last night I had a crew choice event with Norm Abrahm, the carpenter from "This Old House." I had the conference in the cupola and gave him a brief tour. He and his wife were very nice. [Note: This Old House meets House in Space; this and the previous statement are examples of Crew Discretionary Events successfully elevating the morale of isolated and confined space personnel.]

It started with [former astronaut] Mike Massimino and then the cast of "The Big Bang Theory." It totally caught me by surprise. It was cool chatting with them and a nice way to end the expedition. [Yet another example of the fine work performed by the Psychological Support Office at JSC to help maintain crew behavioral health. Interactive events such as these will not be possible during a three-year expedition to Mars.]

Management

Relations between management and labor are occasionally strained under nearly all circumstances, but the dynamics of life onboard the ISS can render those relationships even more problematic than usual. The lack of proximity is largely addressed by frequent communications, but it is inevitable that management cannot fully understand what it is like to live and work in isolation and confinement. More important, ISS crews have multiple sets of managers with which to contend and often are caught in the middle of bureaucratic struggles among space agencies. Participants during Phase 1 of this study frequently served as diplomats to maintain relations; one wrote that he considered it a good day when the agencies were not angry with each other and he had not overlooked something he could do to help. Changes that accompanied the increased crew size during Phase 2 have resulted in fewer instances of this behavior; that is, astronauts and cosmonauts now work independently of each other most of the time in a larger facility, and disputes among the agencies are increasingly handled by managers on the ground without crew involvement.

We received a call from the Administrator to congratulate us; he was right on the mark and it was good for all of us to hear.

We found out that X will be stepping down as Chief of the Office. That situation is always interesting and we will see what follows.

We talked a little about the work load issue and X was totally supportive of easing up the pace. Repeatedly said he wants us to have fun and relax.

For some reason we have a 2030 meeting with the Space Station Manager. I am not sure if he has a specific topic but the late start time is not appreciated (starting one hour before the scheduled sleep period). He did not have anything specific for us. It is not that we don't appreciate him taking the time to talk to us...

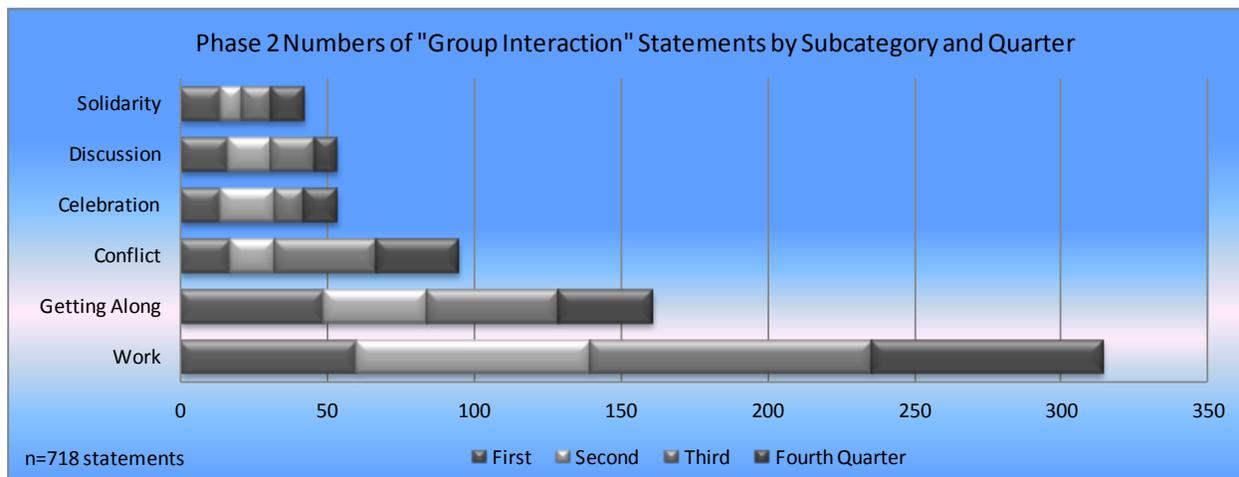
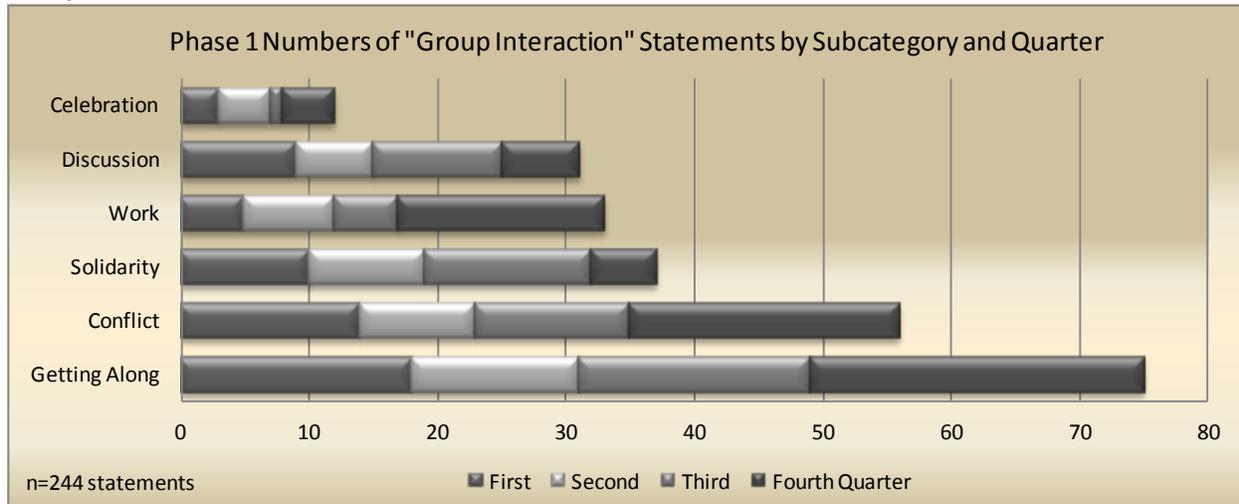
X needs to get an EVA. It is a shame that the US space program is being given to the internationals. We give up seats on vehicles, we give up EVAs, we give up everything in exchange for a few bucks here and there. Now we have no new people getting spacewalks. I think I will send a note to the office telling them they need to push for an EVA for X.

We've been lucky, no problems with management. We're not getting yelled at or anything like that. We are just enjoying ourselves and that's about it.



Interior and exterior views of the cupola (shutters open); the cupola was installed in February 2010, after Phase 1.

Group Interaction



Nearly all of the participants in this study reported prior to launch that getting along with their crewmates would be their highest priority. It is evident from the journals that astronauts shared this objective and actively worked to maintain interpersonal harmony by cooperating, avoiding certain topics in conversation, and other sincere acts of comradeship. Perhaps they were aware of what twice Hero of the Soviet Union, Cosmonaut Valery Ryumin, wrote in his journal during a particularly difficult period onboard the Salyut 6 space station: "All the conditions necessary for murder are met if you shut two men in a cabin measuring 18 feet by 20 and leave them together for two months." The Russians and Americans got along fine together nearly all of the time during Phase 1 and Phase 2 of the study and, for this reason, most of the statements concerning conflict describe disagreements between astronauts. Examples of statements concerning working together, getting along, and conflict are included below.

Work

I think the spirit of helping each other out is very good onboard.

Helped X with his ISS tour. He has a lot to do and not a whole lot of time.

We filmed us opening up the unofficial bag and eating the tortillas. They were fantastic. Maybe the best tortilla I ever ate.

We made another small dent in stowage and transfer. The PMM is looking pretty good. Our next big job will be to start the unpack.

X gave me a quick lesson on the volt meter and accessories- 10 minutes with him probably saved me close to an hour of time tomorrow.

X and I knocked out a lot of the prep for de-mate and got ahead for some of tomorrow's tasks. It should make a compressed morning a little better.

I suggested that we have a policy to get all your stuff done and if somebody else is working after DPC it's all hands on deck to help them get through their thing.

X was all over the place helping out, we switched the order of the ultrasound to utilize the available crew members, I helped out Y with the suits and Y helped me out with the hatch ops.

X and I stayed in the SM for a while trying to reach Houston via Moscow on UHF, and Y stayed in the US segment punching off the Caution and Warning alarms that kept wailing about every 30 seconds.

First full day back with a crew of 6. We were not given scheduled handover time, so all of it will be informal whenever we get a chance and whenever the questions come up. There is a lot to learn...

We use a rotating duty officer of the day we take turns leading the DPC and turning off the lights and closing the shutters at night. Also Responsible for the Earth pictures for that day. It is not much but it spreads the work evenly.

We noticed that the CO2 level was increasing so we reported it to MCC. They told us it was normal and to continue. As the level continued to rise, we again notified MCC and they asked us to check a couple of things, which we had already done.

As part of the inspection, we secured me to the CMRS and then Moscow called him to take care of something in the SM. That left me tied up (literally!). Ground was on board via video as always, and after I freed myself, Capcom congratulated me on my Houdini escape.

X and I worked very well together... We had to reroute a lot of cables and had a lot of sticky connectors. We got everything done and I think we made it appear easy. We remained calm and professional. It was just very tiring... We were 30 minutes late getting outside and really late getting inside. There was no hurry to get us out of the suit, I will leave it at that.

Getting Along

Crew dynamics in the USOS appear to be outstanding.

X and Y [cosmonauts] came over for a little dinner and conversation.

Overall, things are going pretty well. No issues with the crew. We're all getting along fine.

Having a good crewmate show up partway through the mission is a good thing for morale.

X and Y [cosmonauts] and I are getting along great as always. Still having a lot fun doing this.

I sort of wish we did more with the Russians, but it is just great to see them every now and then.

Commander and rookie crewmates were great. We all helped each other out and made it through those 2 days.

I also think it is best to give people their space and not push the social things on people every day. We all need a break from each other at times.

Crew dynamics continue to be good. I see no issues at all among us. Humor and joking around continue to be huge assets and quickly defuse any problems.

So far the three of us have had one meal per day together, and are settling into a comfortable conversational mode, talking a little about the day, joking about what we're doing at the moment. We'll see what happens when the others arrive...

Had dinner with X and Y [cosmonauts] – missed a couple of those recently. They had a busy day today with the ground frequently calling about stowage, Elektron, and issues surrounding today's computer upgrade. Awfully nice just to hang out and chat.

Crew dynamics remain great in the USOS. Joking and gentle harassment seem to be our technique for giving and receiving feedback as well as for defusing tension. X is a master of this and he has been a huge asset for us up here. Hard to believe there hasn't been as much as a single argument on our end.

Conflict

I still feel that there is a little tension if I decide to do something a different way than the senior crew has always done it. Again, it sends the message that I don't quite approve.

X likes things done his way, Y does things another way, and I like things done a certain way. So, we were talking about that, how it's not my station, it's not anybody's station. It's been actually pretty good to have that open feedback. I think it's important to have those discussions.

Well the day has finally arrived. I am now somewhat frustrated with my crewmates. Maybe it happens to everybody, but one of them continues not to do what they are supposed to do. Small things that wind up being big things-not vacuuming the razors when it is their time to do it, leaving stuff open on the computer, changing camera settings in the cupola. [This description of grievances is familiar to anyone who has lived with roommates; only the details are unique.]

X and I just have this occasional conflict that's not good. We had one last week and I hunted him down an hour later and said, "Dude we have to talk about this," and he said I was treating him disrespectfully. So, I guess I have to be aware of my shortness when I get busy with something. I don't have the bandwidth to talk to people [when I am focused on a task] and I'm aware of that. We talked man-to-man about it afterwards and will press on. [This is an example of trivial issues exaggerated by the conditions and a mature resolution to conflict; nicely done.]

Americans [interacting] with the Russians is still sporadic. X was saying the recent trouble with the ruble and the Russian economy [might be] putting a bit of strain there. I don't know if that is true or not.

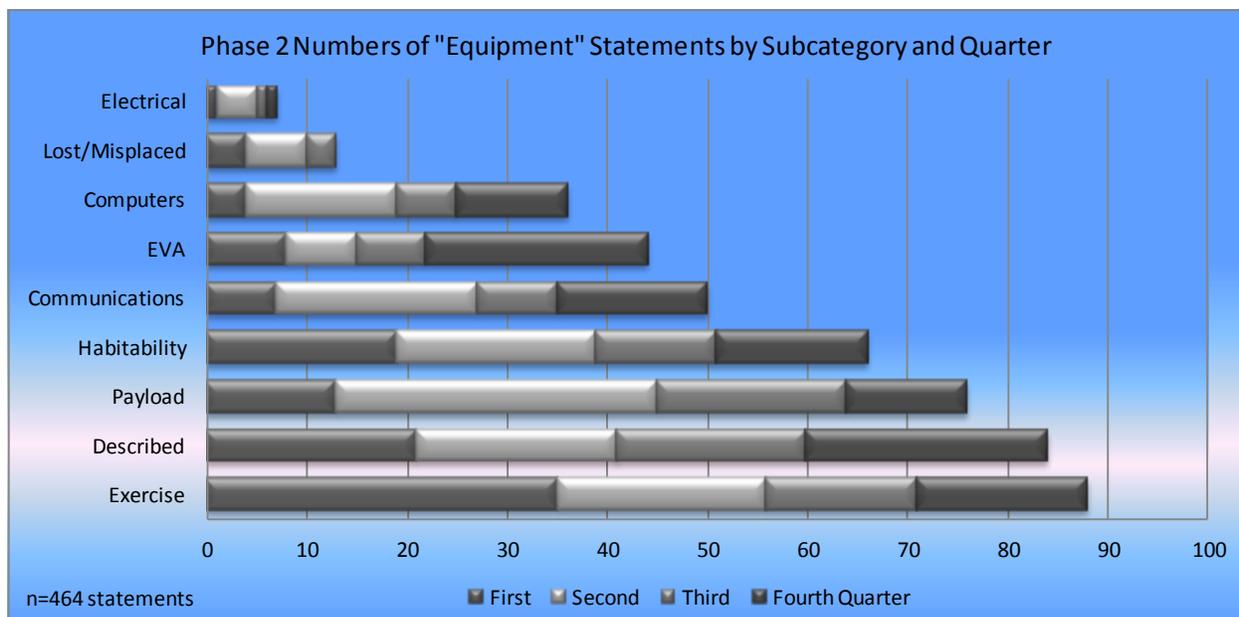
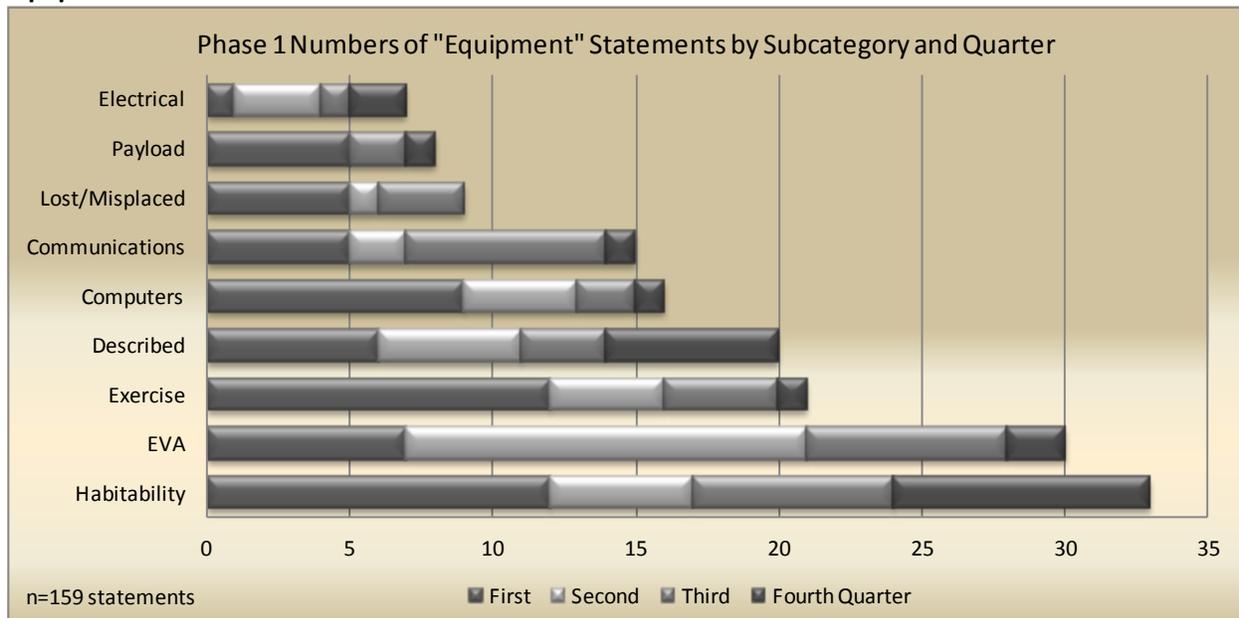
It's different of course, and I knew it would be, living with people you didn't choose. Just some basic, standard issues of life where you have a different outlook on life and the way you operate and the things you talk about. I expected that. It's been that way my whole life, so I'm fine with that.

I do notice a little rift in the Russian segment, mainly between the guys who were already up here. I can understand it. Our relations with all of them is superb but we also don't work together day in and day out. One individual has a bit of a stress level that makes him edgy and he [takes it out on his] crew mate... who is the nicest human I have ever met, but he is a bull in a china shop up here.

I could tell there was some stress in the air because there were a couple very short tempered exchanges between us this morning. I have come to recognize these moments as relating to stress and I saw them often in training too. The good thing is they don't have a lasting effect. All it takes is a little direct communication and a couple jokes to clear the air and that is exactly how the morning proceeded. [This is another example of astronauts' characteristic self-awareness, sensitivity, and use of humor as a coping strategy.]

Wow, you want to see crew dynamics, video tape taking a group photo in space. I thought we were going to lose a member of the crew during that one. Six cooks in the kitchen, all brewing up their own ideas. Several people had their own cameras and needed their own pictures. I was entirely too vocal. Some people were overly anal, myself included. Some people didn't care, which made them want to rush. Overall, that was a psych analyst's dream moment.

Equipment



The journal statements assigned to the Equipment category during both Phase 1 and Phase 2 mostly refer to problems with equipment, rather than the smooth functioning of machinery and other systems, although some describe the joy that accompanies a difficult but successful repair. The most-frequent subcategory to emerge from the data during Phase 2 concerns exercise equipment, which is essential to countering the negative effects of (simulated) microgravity on muscles and bones, and on other aspects of well-being that will be addressed later. Other subcategories include descriptions of equipment, equipment arriving on the ISS as payload, the effects of equipment on habitability and communications, and EVA-related equipment. Most of the statements about computers refer to upgrades and re-boots, of course. Examples of statements from the Equipment subcategories are provided below.

Exercise

T2 locked up on me so I used CEVIS.

I love ARED. Very cool machine and works very well.

With 6 of us, it's starting to get harder to sequence ARED exercise.

And then the ARED broke. It took part of Wednesday and part of Thursday to repair.

Unfortunately, ARED had a problem and broke in the afternoon which at this point was just par for the course

We still don't have T2 working. We lost CEVIS yesterday and stopped everything to get it R&Red. It is fixed but at a huge time hit.

The harness was hurting my shoulders. I was so happy to get off that thing. The muscle tension was building up with the tightness of the harness and really gave me one of those pounding headaches.

I am down to 4 clips (120 lbs) on T2 [treadmill]; I started with 5 clips (100 lbs). I should be able to go to 3 clips in a week or two. The goal will be to get to no clips on the bungees which is about 160 lbs, less than my weight but close enough. The harness feels ok.

The ARED is my sanctuary. I don't wear iPods or watch any movies while working out on it. Often there is a soft blue light overhead: the cupola transmitting Earth albedo. It's like lifting under a skylight during a rainy day, with occasional jabs of brilliant white and yellow as the sun sets.

The big news today is that ARED is hard down. Something is stripped out in the crank handle mechanism or the ball nuts that run on the ball screw. X was squatting 250 and it suddenly became 350. We told the ground and then gave them video of it as we cycled the load adjustment unit from low weight to high.

ARED broke again last night. Was doing my first ARED exercise in almost a week, since a minor back strain last week. When I set up for deadlifts, the load adjustment unit slipped and immediately jumped from 150 lbs to 400 lbs when I released the secondary lock. Looked like the same failure we had earlier when the key that locks the ball screw and the crank handle adapter worked. In this case one of the adapters inside the crank handle failed structurally, with the two tangs that engage the adjacent adapter's slot shearing off.

Took the initiative this morning to disassemble the ARED crank and crank mount assemblies. Would have taken too long to get the data to the engineers otherwise. Figured out that the problem was not with the ball nut (thank goodness), but with the square cross section key that fixes the ball screw relative to the adapter that interfaces it with the crank mechanism. The key had slid out entirely and was free floating within the crank handle adapter. The only thing keeping the two shafts from rotating with respect to each other was friction, and eventually they started to slip. Dangerous aspect of this is that the load will shift abruptly from low to high. [Note: It will be essential to have someone like the astronaut who wrote this statement on an expedition to Mars to repair equipment that will inevitably break.]



ISS Astronaut Using ARED.

Described

I struggled with my very first task, basically changing a light bulb (LHA), until I discovered that it wasn't me, the LHA itself was of a different shape and wouldn't fit. CDR helped me out.

SLAMMD weigh-in. Says I'm 180-186 lbs (about 10-12 lbs more than Russian scale). I trust their scale more than ours. SLAMMD varies considerably depending on how tight you hold the fixture. [Note to Other PIs: Beware of apparent weight fluctuations.]

The D3 rack is "popping a wheelie" (upper attachment fittings not engaged due to interference with a soft partition closeout bracket). We suggested just removing the bracket, but they wanted to R&R the knee braces instead. We told them it could take hours, and they didn't believe us so they gave us 30 minutes to do it.

I know a procedure will take longer than expected if Kapton tape is mentioned. Half of my effort and time will be devoted to managing the tape. You can't tear it off the roll, but it falls apart when trying to stick it to something. It rolls up on itself and once it comes off, it won't stick well to anything again, so you end up with a swarm of tiny pieces of useless tape.

It is a Russian system originally, so X has expertise, especially when it comes to those pesky Russian fluid connectors... asked him to come help and he got it done for us. He is great and always ready to help out. I feel like I can't help him much because I don't know all the peculiarities of their systems, but whenever I can I want to make sure he and the Russian segment are working well. We have a good time all working together

The freezer cannot be open for more than one minute. The ground can see when I open the door and close it, so no cheating. Once the door is open, I have to don gloves, pull out a drawer amidst a fog of sublimating dry ice and a little snowstorm of ice flakes, find my sub-compartment in the drawer, open the lid to the little metal cage in the sub-compartment, place the tubes in while making sure previously inserted tubes don't float out, close and latch the cage, check to make sure the lid doesn't bind up the drawer, slide the drawer back in, and then close the door-all in 60 seconds.

We had some unplanned Soyuz firings today that put the station out-of-control and killed my day. It was very annoying, but anyway we got it all under control. I think we ought to delay a couple of days to make sure the Russians have all their ducks in a row, but that is not going to happen. The Russians undock when it is time to undock. That is their go/no-go criteria, so we are going to undock. There is I think a small risk that we will have unplanned firings on undocking...

Habitability

The toilet is very noisy and is probably damaging our hearing

We have plastic shields over our windows to protect them from scratching, which makes the photos horrible.

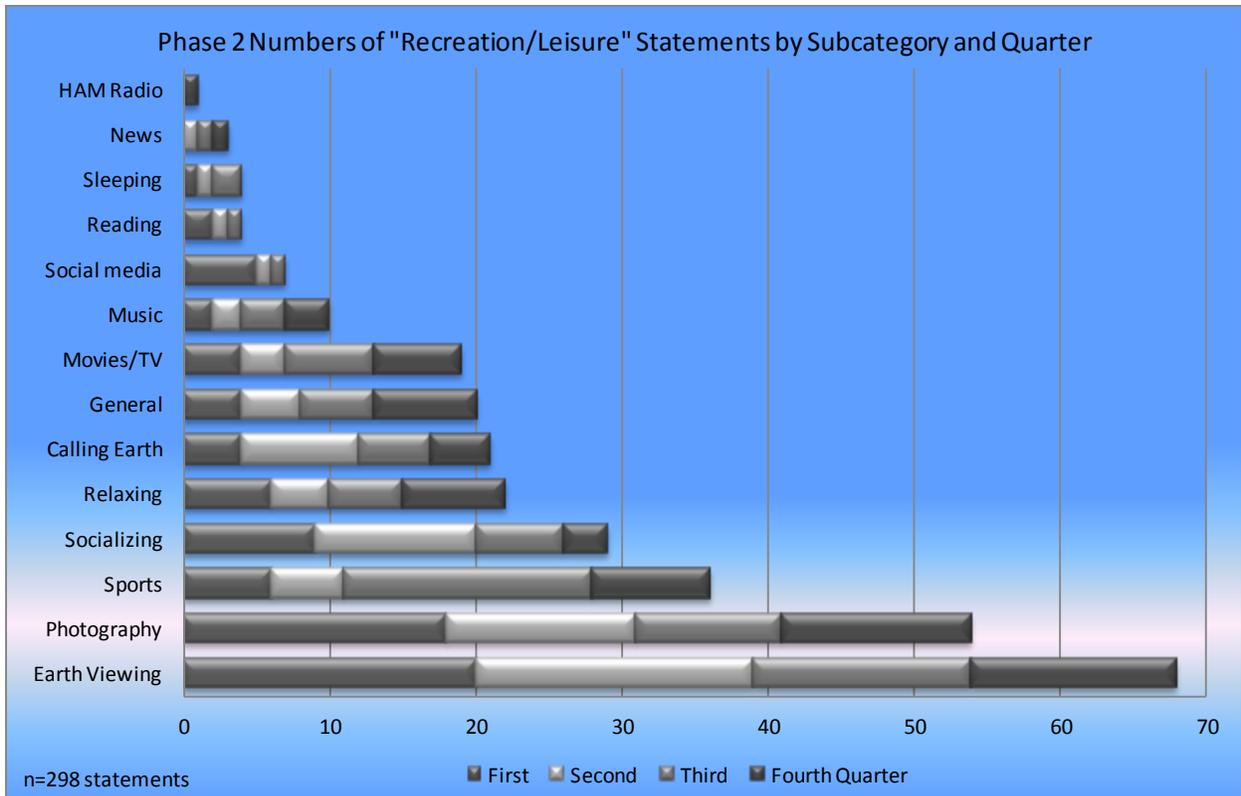
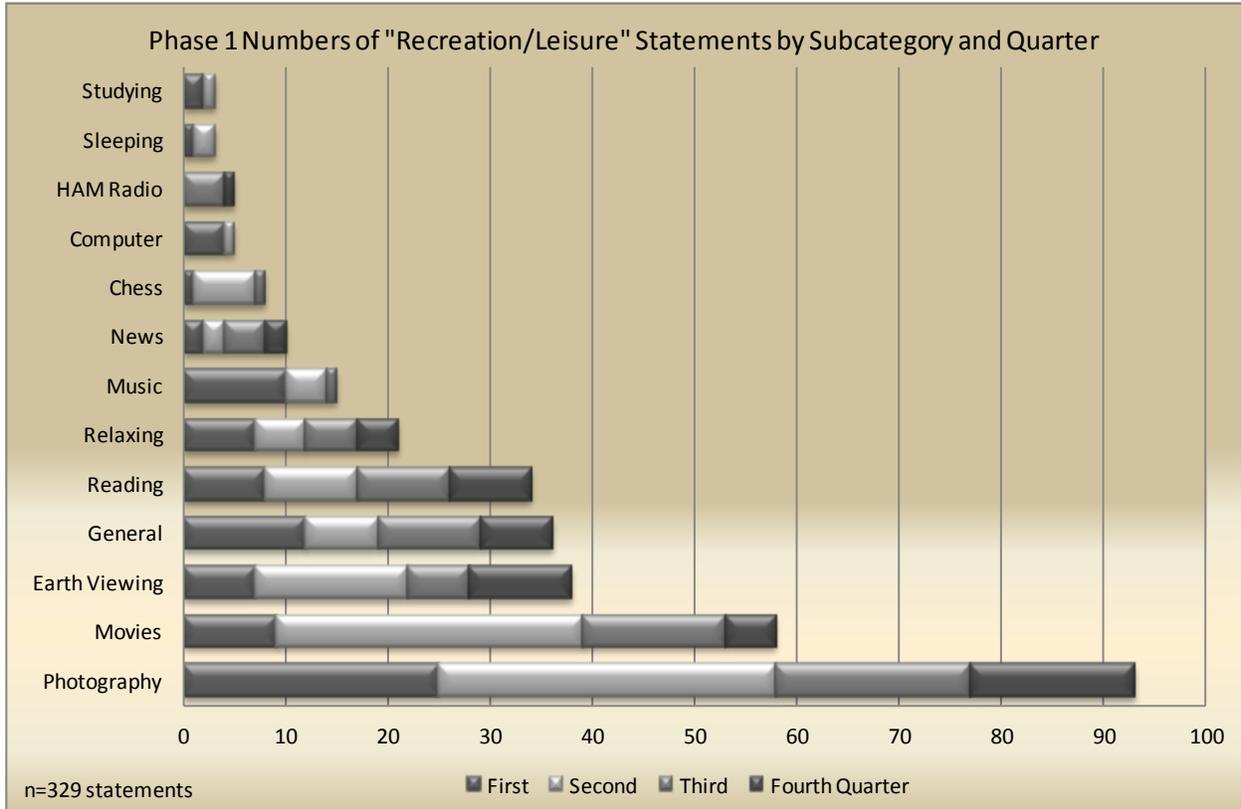
For habitability purposes we need to [remove the equipment] so we can enjoy the cupola. X agreed as he always does. I am sure it will work out fine.

Things break in space. In the three weeks since arriving, the potty has broken twice, the treadmill twice, the stationary bike once, the zero G weightlifting machine three times, as well as a few other things.

Woke with no headache today after putting a sleep bag in front of vent. Tonight I sleep in a crew quarter, which will be a great improvement in living conditions and convenience. [Note: CO2-induced headaches and other maladies are serious problems on the ISS.]

It is impossible for the ground to really understand the scenario I was in today (vacuuming the ventilation system). I really think the design would change immediately if they had the adventure themselves. But because it's different in zero gravity than on Earth, they can never see it firsthand.

Recreation and Leisure



More pages have been written about recreation in space than any other behavioral issue, most during the 1960s when it was assumed that an expedition to Mars would follow a successful Apollo Program. The emphasis on leisure activity reflected the widely-held belief that astronauts would be at psychological risk during interplanetary voyages and heeded admonitions from the past that boredom was the primary enemy of polar explorers.¹⁰

An expedition to the Moon, Mars, or an asteroid would present opportunities for unstructured time and idle hands to work their legendary mischief, especially if equipment malfunctions, atmospheric conditions, or some other factor prevented performance of scheduled tasks and resulted in prolonged periods without meaningful work. The importance of meaningful work to adjustment and morale is evident in many of the journal statements included as examples in this and the Phase 1 report. All participants complained about trivial, redundant, and tedious tasks, but few complained about the low workload periods that are typically experienced during the latter stages of transferring responsibility for the ISS to a replacement crew. The high-tempo of scheduled work usually limited the participating crews' leisure time, which was put to good use when available, as described by the statements reproduced below.

References to Earth viewing and photography accounted for 40% of all entries assigned to Recreation and Leisure as the primary category during Phase 1 and 41% during Phase 2. The preeminence of these activities was predicted by previous spacecraft and space analog experience. The *Skylab* crews spent nearly all of their free time at their window and recommended bubble-like observation domes on future stations, and the cupola that was installed on the ISS in March 2010 was inspired by the most popular design feature on NASA's 1969-1970 *Tektite* undersea habitat.

Deriving pleasure from observing nature is a uniquely human activity, which when combined with Type-A personalities, a great view, and a camera with an 800 mm lens has resulted in a zillion extraordinary images of our planet and contributed to the habitability of the ISS for many astronauts. NASA's Crew Earth Observations (CEO) program specifies targets of interest for the astronauts to photograph (e.g., Mt. Kilimanjaro without cloud cover, wildfires in California, a hurricane approaching Mexico). The target opportunities are hard-scheduled and performance of the tasks inspires most astronauts to develop skill with the powerful lens and then to capture images of their own choosing. The results have been an enormous catalog of interesting and beautiful images, and the complete elimination of boredom as an enemy for most ISS personnel. The availability of Earth photography opportunities, which are determined by orbital dynamics and weather even influences individual morale. It is important to note that this source of recreation and personal gratification will be less available to interplanetary explorers during long periods of their voyages.

Earth Viewing and Photography

Looking out the window remains the number one pastime.

But one look out the window wipes all that away... and sets a better emotional tone.

Around 60 million bucks to get me here. Hard to watch a movie or read a book in my spare time when I think about that.

We had some nice window time looking at Baja California, San Diego, LA, and the Grand Canyon. I am going to miss this place.

I tried to go back to sleep for a while and finally I went down to the cupola about 10:30 and had an unbelievably beautiful pass right over the Nile.

¹⁰ For more on this topic see Chapter 14, "Recreational Opportunities" in, Stuster, J. *Bold Endeavors: Lessons From Polar and Space Exploration*. US Naval Institute Press: Annapolis, MD, 2011.

We just watched the Progress launch from the cupola. We could see the first stage engines lighting up the clouds and a small bright dot. It only lasted a couple of minutes and then we lost sight of it.

The southern lights are back again so X and I were [experimenting] with different cameras to get some views. With the lights out in Node 3 and Node 1, the stars just jump out at you. Living here is too cool.

The one thing that is always changing and keeps me excited is the view of Earth. We are in a great phase right now coming off high-beta with a full moon. The viewing during night passes has been the best of the increment. We are even getting some northern lights as we come across the US at night. I love it, love it, love it.

I had the most incredible experience last night. About two in the morning I was down in the cupola flying over Africa watching thunderstorms, just floating there watching this incredible power. You could see how they are connected to each other. When one goes off it causes another one to go off-white grayish, bluish explosions. Giant mushroom-cloud explosions, and little small ones, and just a continuous stream for many minutes. I was listening to Enya, "Storms in Africa," as we floated over. That was truly one of the most memorable days of this expedition. Just incredible.

Tonight I was in the cupola way, way past when I should have been - two hours past when I should have been. I saw an amazing sunrise. It was just incredible, to have my brain right side up, which makes a difference in perceiving the sunrise. The colors were amazing... I put my long-distance glasses on. I don't know if that helped the colors or not, but it was really distinct. What a treat that was. I'm glad I did it.

I have been hitting the cupola and Russian windows every chance I get during the last couple days. My mind knows it is almost over up here for this mission and it wants to see more. I have been sleeping unusually well with a few hiccups here and there. I think that has added to my desire to look outside often because I haven't been tired recently.

Watching Movies, TV, and Sports

Watching movies together was the second-most frequently reported form of recreation by the astronauts during Phase 1 of the study, but the activity declined in frequency during Phase 2. For example, several Phase 1 participants mentioned watching the 1968 Stanley Kubrick/Arthur C. Clarke classic, *2001: A Space Odyssey* and the 1984 sequel *2010* together with their Russian crew mates, but there was not a single reference to those films during Phase 2 and comparatively few references to watching movies as a crew. Viewing films as a group was a traditional form of entertainment enjoyed by remote duty personnel since soon after the advent of the medium; films worn from repeated showings at Antarctic stations were creatively re-spliced with hilarious results. Videotape players eventually rendered movie-watching a solitary activity at US Antarctic stations and a similar phenomenon is apparently occurring on the ISS as astronauts increasingly watch episodes of TV shows as they exercise and before retiring for the night. Watching sporting events and the occasional new release were mentioned as a group activity during Phase 2, but far less frequently than in the smaller crews.

Another good end to the day with a nice dinner and Olympics.

Watched X [pre-release]. That was our second movie night. We need to do that more often.

I stayed up until 2300 watching some NCIS:LA. It is a good way to turn the brain off after a long week.

Men's Beach Volleyball was good. Of course we lost Ku at the end of the final match. Thank goodness for Huntsville keeping us in the loop and giving us scores.

My wife sent a short video of wind in the trees of the Astronaut Tree Grove at JSC. The wind sounded weird, and evoked a distant memory from my childhood.

We started to watch some TV, but EVA topics came up and we had some good discussions and spent a little time squaring away the Airlock. [Work-related topics dominate conversation.]

Watching a TV show or movie during a workout is a great brain drain, but only because I'm a captive audience when on the treadmill or stationary bike and otherwise would just be staring at a wall.

I'm not going to be able to watch as much TV, "24" and that kind of stuff when I get back home. Ironically I won't have as much time on Earth to do that. [Watching TV shows is a perfectly convenient activity to accompany 2.5 hours per day of required exercise and to fill the time normally spent on family when at home.]

I finished "Breaking Bad," the TV show. It was good and I was sad to see it end. I have been watching one episode a day since I arrived, so I have a lot of associations with that series up here. Now I am moving on to "Firefly." Should be much lighter. [The perfect type of programming to watch on a space craft, "Firefly" was canceled after only 11 of the 14 episodes were aired. *TV Guide* ranked the series No. 5 on their list of shows that were Canceled Too Soon.]

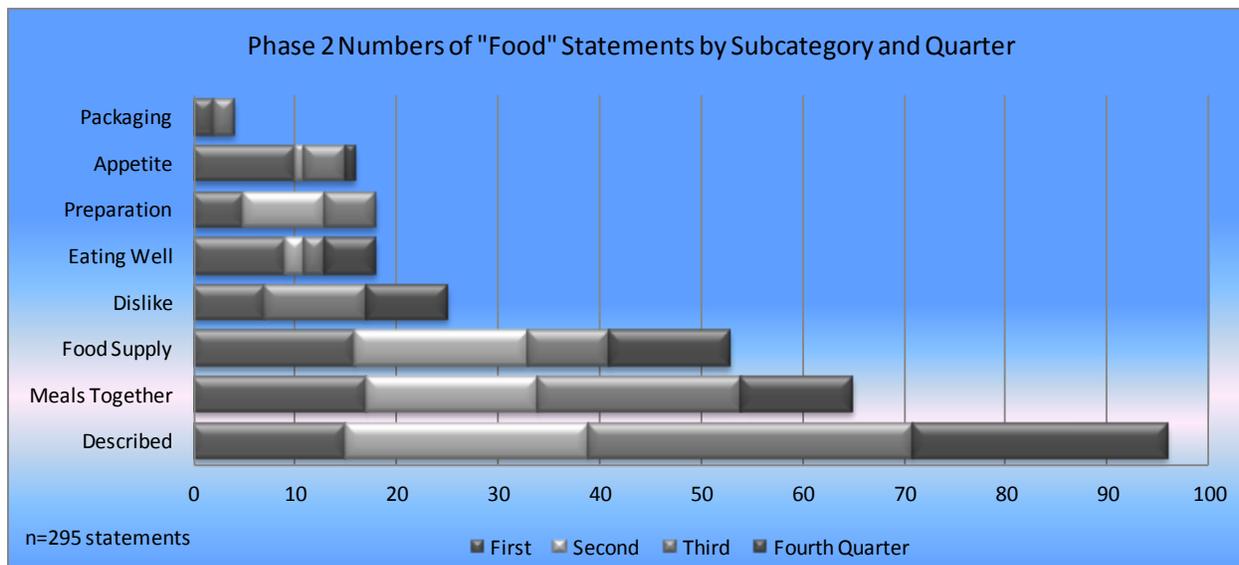
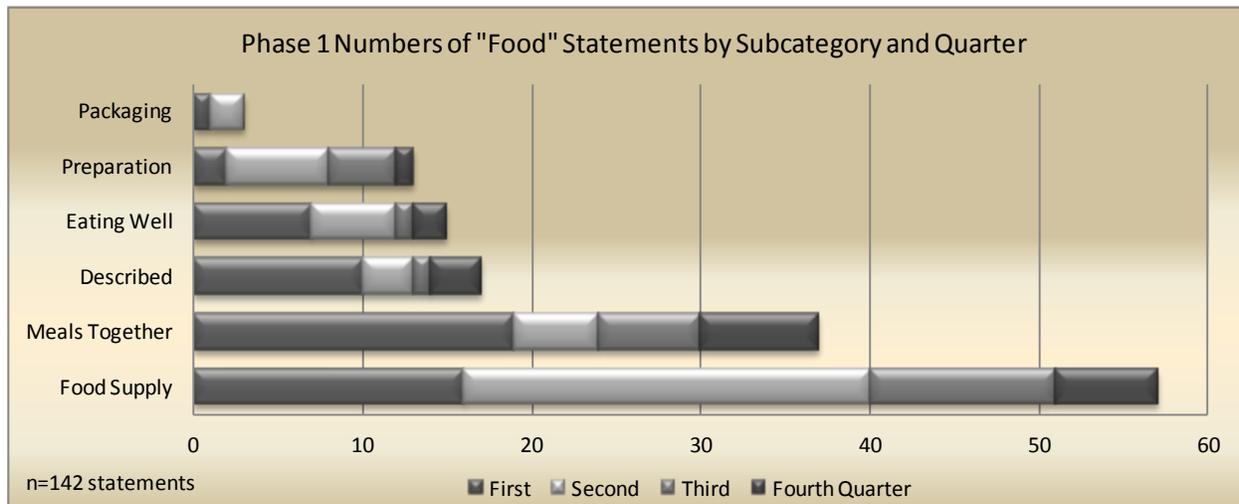
In addition to Earth viewing, photography, and watching TV, movies, and sports, the astronauts' journals contained references to reading, listening to music, and catching up on news from Earth. Some of the astronauts devised guessing games and contests to engage and entertain their ground controllers. Others spent off-duty time contacting HAM radio operators, communicating with friends and family, or preparing collections of images and video to document their expeditions. It also is apparent that several of the participants devoted considerable free time to maintaining the personal journals that are the subject of this study. A few of the participating astronauts wrote nearly every day in the manner of explorers from previous eras.¹¹



Watching *The Martian* onboard the ISS on 20 September 2015 (the day before its release on Earth).

¹¹ The only new Recreation/Leisure activity to emerge during Phase 2 of the study was "Social Media," which involved primarily the posting of photographs and videos on Twitter. The activity became the source of considerable discord among crews because, 1) individuals received disproportionate recognition at the expense of a crew as a whole; 2) engaging in the activity made some individuals less available for group tasks; and 3) NASA management encouraged astronauts to engage in social media to generate publicity and at the same time criticized individuals for the content they posted. Concerning the last reason, an astronaut wrote, "It is a tough mission – they say 'get the word out and help our program' but when we get the word out and people start to love the crew for having fun, I think management gets scared and wants to pull back. It is difficult to find the proper balance. A comment from one crewmember last night was **** this, I'm quitting with the social media stuff because I just can't win. I feel much the same way. It is fun but it is painful."

Food



Food assumes added importance when access to friends, family, leisure pursuits and other normal sources of gratification are denied. The importance of food during isolation and confinement is well-known to the managers of oil rigs, commercial ships, Antarctic research stations and nuclear submarines, all of whom serve large quantities and varieties of high-quality food daily. The polar explorers of the heroic era recognized the role that food can play in facilitating adjustment to confined and austere conditions, as did the managers of airlines until recently. Food is the quintessential habitability issue.¹²

References to the onboard supply of meal items composed the most-frequently reported subcategory of journal statements concerning food during Phase 1, due to a serious logistics problem. Most within this subcategory during Phase 2 were complaints about errors in providing preferred and bonus food items. All of the participants described disappointment concerning the depletion of favored food and drink items, and some wrote about the joy of finding an item that had been believed to be long gone, especially tortillas, which always are in short supply.

¹² For more on this topic see Chapter 10, "Food Preparation" in, Stuster, J. *Bold Endeavors: Lessons From Polar and Space Exploration*. US Naval Institute Press: Annapolis, MD, 2011.

The benefits of having a variety of preferred food options and of crews eating meals together are reflected in the astronauts' journals. A disproportionate number of statements from this major category are provided below to reinforce Fridtjof Nansen's admonitions about eating together and being especially careful about the food.

Described

I found a little time for breakfast.

Ate a quick dinner and went to bed.

Skipped both exercise sessions and ate lunch on the fly.

Have missed having meals together for a couple of days, just due to the work pace.

Funny thing, on our schedule for today, my Russian crew mates get an hour for lunch and I get nothing. It isn't easy being an astronaut.

Meals Together

Enjoyed dinner together.

Mellow dinner with US crew only [NPR's Car Talk in the background].

The Russians came over for dinner and chips and bean dip and cheese and the Olympics.

Then it was a late dinner. The Russians came over and we hung out for a while talking and watching TV.

We had a nice time at dinner and X came by to chat for a while. He is pretty darn funny. Sleep will be good tonight.

X, Y, and Z have been here for a week. We had a little dinner to celebrate down in the Russian segment. It was really good,

Dinner with USOS crew watching Olympics and X's interview on CNN. I will end up the night watching the newest Spiderman movie.

And we have been having crew dinners together pretty regularly, which has been nice, or lunch at least. We are all around the table for 15 or 20 minutes together, which is good.

We have been joining X most nights for dinner and joking around [about] training in Russia. I really like these guys and it is neat to share this little slice of the mission just with them.

Had dinner tonight on the Russian segment. It is difficult to coordinate because people get hungry at different times and everybody has different things to do in the evening. But it is nice when it works out.

So far the three of us have had one meal per day together, and are settling into a comfortable conversational mode, talking a little about the day, joking about what we're doing at the moment. We'll see what happens when the others arrive...

Had corn chips, jalapenos, salsa, and Russian cheese last night. Just the three of us on the USOS side. Was very nice to have something different. Into my third week on ISS, a small special event like that has more meaning and buoyant effect on my spirits than during the first two weeks. I suppose it's because I'm settling in.

We usually have dinner together, either in the Russian segment or around our table here in the US segment. Sometimes it's short and quiet, especially after heavy workdays or towards the end of the week, and sometimes it's lively with chatter about the day's events. One of us usually throws a few packets of meat and soup into the food warmer before dinner. Or one of us floats by the water dispenser (which is on the ceiling in the Lab), and fills packets of dehydrated vegetables or drinks, tossing them to each one of us. The throwing technique is a learned skill – slow is the ticket, and extra points if you get the packet straight down the axis of the modules without touching anything!

Food Supply

There was a meeting yesterday, where all the major players talked about the calorie shortfall.

Tortillas – I was told that there would be some in every food package and we get about 2 a week each. I want 2 a day.

If I were to do this again, I wouldn't put an ounce of meat in my bonus food. I would fill it to the brim with granola, fruit, and yogurt.

We got our bonus food and that was really nice. We've been eating fresh fruit for a while, that's great! Food is a big deal up here.

In my bonus container I asked for peanut butter in every one of the 9 cases. I received one and it is low fat. I did not ask for low fat, so why would they give it to me?

The 9-day cycle of our current menu should be extended. We see too much of the same thing, which would be tedious if we didn't have our bonus food packs to mix things up a bit.

I have opened my Russian Bonus food and it is a nice change of pace. It is very tasty, but I hear the salt content is high so I will eat it in moderation. I am trying to stay under 3 grams per day.

I had the usual breakfast of oatmeal and fruit and coffee. If I ever do return, my bonus food would have a lot of oatmeals for breakfast. There are definitely not enough of those onboard. Breakfast is one of the meals that you eat almost the same thing everyday.

Many [former ISS] crew members recommend thinking about your bonus food and other food before you launch because it is very important on orbit. So I did that but the food folks don't come through on what they say. My 3 drinks a day were 1 coffee, 1 protein drink, and 1 metamucil. The only thing onboard when I arrived were 14 metamucils to last me 2 months.

I found out, talking to these guys that have been here for five months, the food is going to be interesting. I can't wait to see how that is going to work out. Because you're eating the same food variety for every seven days we get the same batch of food and it's also the same thing for lunch and dinner and so it gets pretty repetitive. They're not great. They're okay but they're not great, so I will try to figure out how to make it interesting and new. I know these guys are kind of struggling with that right now. I imagine I will too.

Making the Russian food available to us is a huge addition. The difference in prep techniques and of course recipes between the US and Russia increases our variety immensely. For deep space missions, I would recommend more than one vendor supply the food. The food coming from one vendor is bound to be similar in texture and taste, even across different dishes. [Excellent suggestion! The crew of the Belgica Expedition, the first to winter-over in Antarctica in 1898-99, complained that although their food was the best Europe had to offer, it all had the same taste and texture; they dreamed of eating something crunchy.]

Food is still a pain... we get 2 or 3 day's worth of actual sides out of the 7 days we have to eat them. Breakfast lasts about five days for us; we all eat the same [items] and don't like the other stuff, so those are the two issues we cannot get around and just kind of make do... Our food system is definitely broken. We'll see if we can fix it or at least try to make it better. But, it's another reason to look forward to getting home.

What do I miss most besides family so far? I'm surprised. It's a hot latte in a cup - with a scone. Fresh fruit or salads, anything that doesn't come in a pouch or a can. But, that latte sure sounds good. Maybe because it also comes with a chance to sit and relax and read a newspaper.



Cinco de Mayo Space Taco.

Dislike

The food doesn't bother me too much anymore. [Now, there is a backhanded complement.]

I'm doing an experiment that has a diet restriction on what I can eat (not how much). That contributes to the feeling that I'm "sick."

Food is still just okay... There is definitely a difference in quality. I don't know really why that is. Maybe manufacturing or just age of it in the package. But that is something that needs work.

Being on the Pro-K diet for four days is always inconvenient and the amount of food is an issue. There is a lot of food today so I have to plan it out to make sure I can get it all down before sleep. [Many of the complaints about food assigned to this subcategory concerned this experiment that required astronauts to eat large quantities of food.]

You just eat what is there and make it somewhat decent to get down. But it is tough to get enough food in your belly, I think, because it doesn't taste good like it does at home, where you get some food that tastes good and you just want to keep eating it. You never have that issue up here. So once you get full enough you just stop.

Eating Well

Feel good today, eating well.

I enjoyed a nice breakfast of Granola, Seasoned Scrambled Eggs, Sausage Pattie, and a couple of bags of coffee.

After a light breakfast, some work, and an exercise session, I was hungry for lunch; it tasted normal and I enjoyed it!

We filmed us opening up the unofficial bag and eating the tortillas. They were fantastic. Maybe the best tortilla I ever ate.

Shrimp cocktail, minestrone soup, lasagna, vanilla pudding and a yogurt bar – a very nice dinner while watching a pre season game.

I received a crew care package with salsa and tostada shells; it was so tasty it was amazing! Having real salsa flavor on a chip! I don't know why, but it just hit the spot. It was delicious. It was nothing special, just salsa out of a can, but it was good.

We even received apples [in the resupply]. They are crunchy and awesome! No expense spared. We also got vanilla/chocolate ice cream. That was a really nice treat.

X harvested some romaine lettuce and put a little of it in his pocket to give to Y and me. It was unreal to taste something so fresh and delicious in this sterile environment.

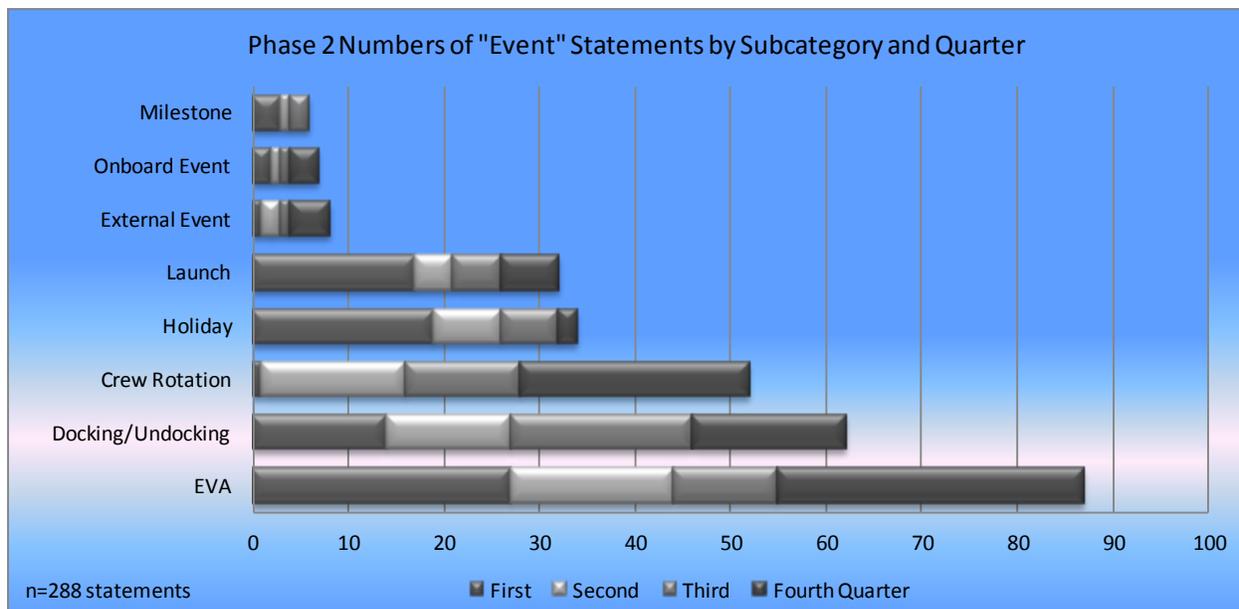
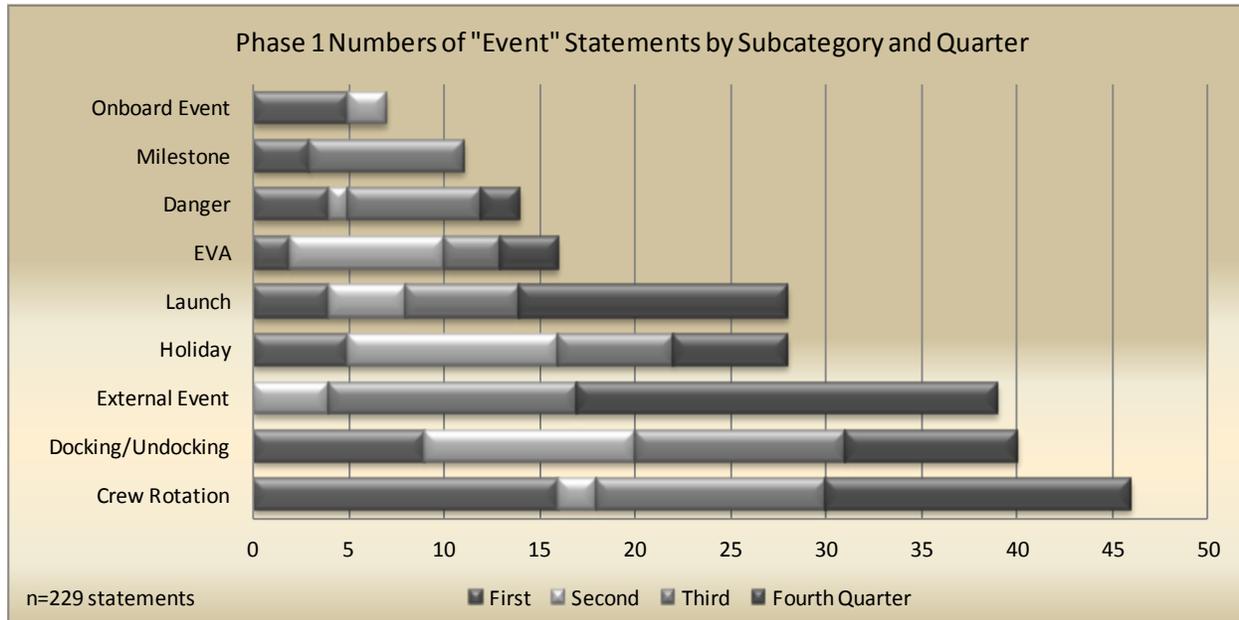


Eating dinner on *Skylab I* (1973).



Eating dinner on the *ISS* (2015).

Event



Event emerged as a category to accommodate periodic external and internal influences on crew behavior during the French Diaries study. Some events that influence ISS crews are reasonably predictable, such as resupply launches; docking/undocking; crew rotations; and holidays, while others are not, such as onboard emergencies, increased solar activity, and hurricanes and other phenomena on Earth that threaten friends and family (and/or affect station operations). The disproportionate numbers of statements concerning EVAs during Phase 2 of the study, illustrated in the figure, reflect primarily unscheduled requirements to make repairs outside the station and the many days of work necessary to prepare the EVA suits and other equipment for venturing outside. The preparation can be tedious and the EVAs are always exhausting, but no one complains, because EVA is the most-desirable task performed by space crews. A few examples from the sub-categories follow.

EVA

So, getting ready for EVA. I am psyched about it. It should really be interesting.

EVA Day. What a day it was. It is late now and I am tired. I got up at 0520 and it is now 2320. Suiting up and getting them out the door went well.

The spacewalk itself was amazing. The scenery was phenomenal. I almost didn't see it because I was so busy. The entire time I shot [only] one minute of video, and took 20 pictures. That was the entire sum of my rest time. Other than that I was working.

I think the next 2 weeks are going to be very busy getting ready for EVA. Wow here is yet another case of be careful what you wish for because you might just get it.

Our next EVA is tomorrow and the goal is to get the new X installed. I think we have a good shot at getting it done in a reasonable time, but we will see. I am worried that I will have additional discomfort, but am hoping for the best. [EVA in a gas-pressurized suit causes pain where the suit rubs against the astronaut's body, and the gloves are especially tough on finger tips.]

It has been a gigantic relief having the EVAs done. Those spacewalks were very stressful. They were a huge amount of work and it was such a great feeling to have them over and behind us. X and I did really well. We got everything done on time or ahead of time and it was just a very good feeling. [Astronauts love conducting EVAs and are greatly relieved when they perform well.]

It's amazing how much prep we have to do to spend 1.5 hours out the door: 4.5 hours yesterday just to get ready to go out the door, then 1.5 hours out the door, and then another hour or two afterwards - more than that really, maybe three hours when you're through cleaning up. It's a lot of work. And, considering all the work we did prior to yesterday to get ready, it's definitely a lot of work for just that brief time outside.

Docking/Undocking

Long day today waiting for Soyuz to dock.

I'm definitely looking forward to [the docking] for the food. Bonus containers are onboard.

Saturday will be capture day so we may relax and celebrate a little tonight and then it will be all about getting prepared.

Tomorrow is undock. I'll let you know how that feels after it happens. We should have a nice opportunity to see them fly into the atmosphere, glowing all the way home.

It was a good day. We successfully captured [the cargo ship], berthed it, and connected power and data. It was not without some issues, but everyone did their jobs and it worked out as well as we could have hoped. There is definitely a drop in the intensity level onboard. It was a big deal. There is still lots to do and we have not lost sight of that.

X grabbed it with his golden hands and I got to berth it. All went very well and we got to hatch opening with no problem that same day. It seemed like all went well because we sweated all the things that could have gone wrong. So, all in all, a good day... we both felt great that day and even stayed up a little later with Y to check it all out. Very fun day.



Capturing a Dragon cargo space craft using the Canadarm2 Mobile Servicing System.

Crew Rotation

They will be here before I know it. I can't believe another week is in the books.

Our next crew arrives in a little over a week. Will be great to have new faces around although I'll certainly miss these quiet days.

We did the official recording of the crew departure and hatch closing. They were all ready to go on time and actually started the process a little early, which is a good thing. You don't want to be rushing when it is time to get to work and go home.

X, Y, and Z are strapping into their Soyuz right now. It was a real up and down day because the weather at the landing site is not good for the helicopters. They were unsure if they were leaving until about 20 minutes before hatch closure.

Holiday

Today is Fathers Day.

NASA does a good job of making special days special.

Pretty much an off day today. It's Cosmonautics Day, so we get the day off.

We are getting ready for Christmas. I've got Christmas presents for everybody, basically just giving them food from my bonus container and I have an astronaut pin for X.

Thanksgiving day – not really a special day. We have some work but not much. We will eat together in the US Node1 (all 6 of us), but the food is from the standard menu.

We had a good Christmas yesterday. It wasn't like Christmas, really, but it was definitely one to remember. It was a day off so there was no work, which was nice. I didn't really do any exercise; I did a couple of squats and that was about it. And I slept in and woke up about 9:00 and then laid around and went back to sleep until 10:30.

Launch

It is definitely tough to watch your cargo ship blow up on liftoff. This is a high stakes game and the results of problems are usually grotesque to watch.

External Event

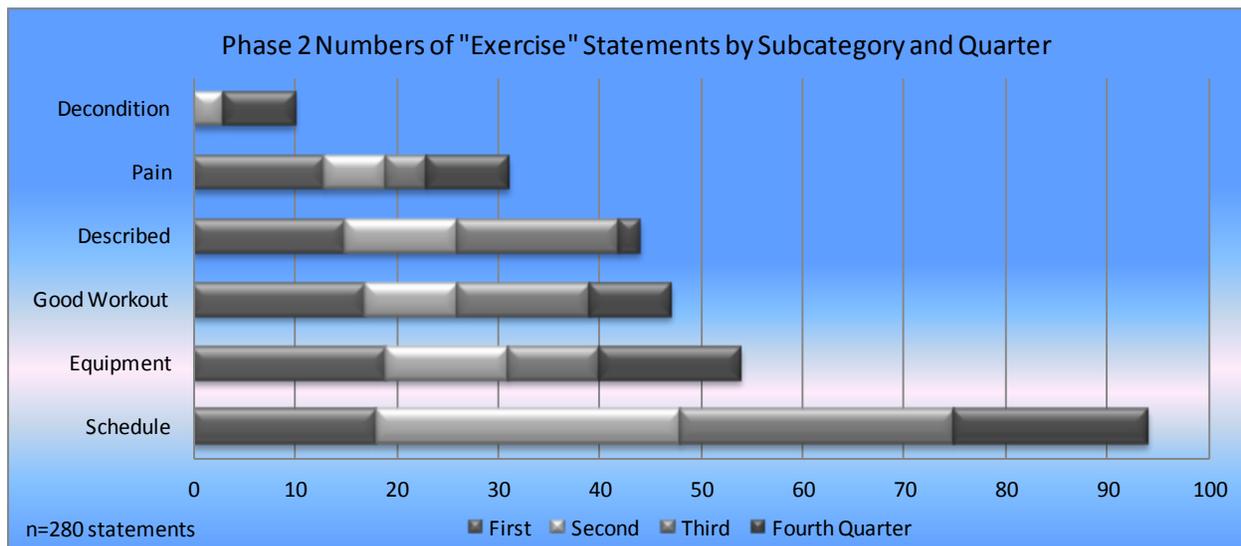
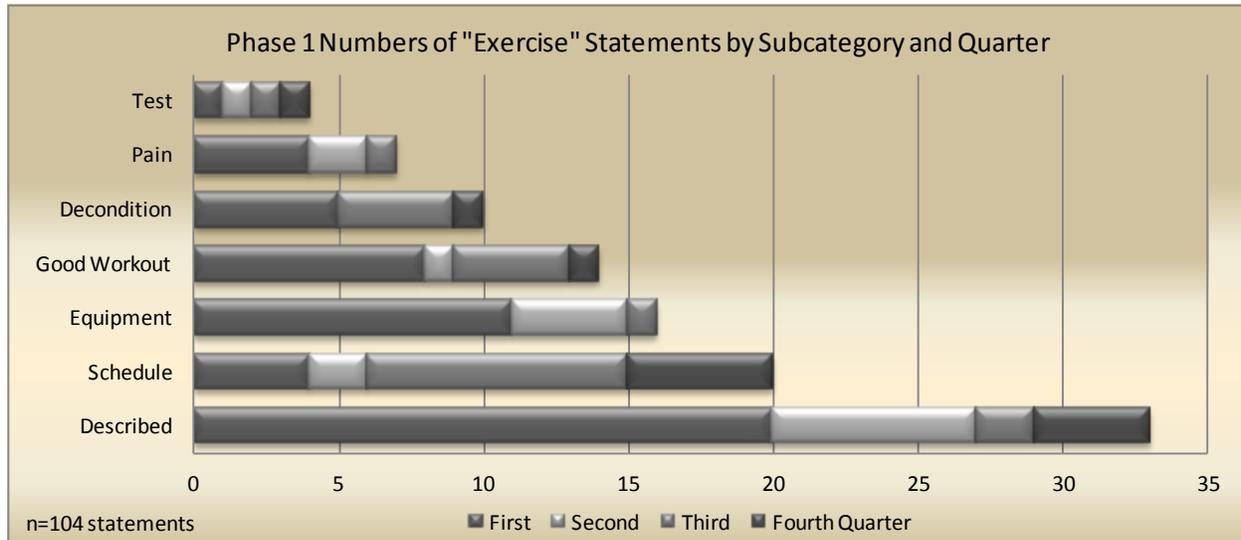
A Malaysian airliner was shot down by what appears to be a Russian weapon system. It is interesting to see the two sides of the story. Our Russian crewmates get their news from Russia. We get our news from Europe and the US. We are positive Russian backed fighters shot it down. Our crew mates are positive Ukrainian fighters with the help of westerners shot it down thinking it was Putin's airplane. We are all good friends so this doesn't cause us tension, but I think I can see in their faces that they are worried it was their countrymen's fault.

General

An event every two weeks makes the time go faster and the prospect of how much time I have left on-board seem shorter. X docked this weekend, in two weekends Y will be gone, and then two weeks after that Z arrives. And then, just 6 weeks left. An exploration mission out of LEO will need to have special events around every two weeks. Events provide stimulation for the crew and a means to mark the passage of time. [This is an astute observation and a recommendation that has been made previously based on space analog experience.]



Exercise



The most-frequently assigned subcategory of journal statements concerning exercise is composed of statements about the scheduling of exercise, followed by references to exercise equipment; many of the latter concern equipment malfunctions. There also are many references to enjoying a workout or benefitting from exercise, in general. And, there are statements that describe pain resulting from exercise and deconditioning, despite having devoted many hours to exercise countermeasures to the effects of simulated microgravity. A few examples are provided below.

Schedule

I got in ARED and CEVIS sessions, barely.

Skipped meals and both exercise sessions.

I've missed 5 out of 6 exercise session in the past 3 days.

With 6, it's starting to get harder to sequence ARED exercise.

I was able to get both of my workouts in before my weekly PFC.

I got on the bike around 1730 and finished up with ARED around 1940.

Luckily, my day ended up with my workouts. That is a nice way to end the day.

They had me scheduled to do ARED at 0330. I don't know who thought that was a good idea.

My work out time is always first on Sunday (0900) so I might as well get up and get the day started.

Around 1115 I rode on CEVIS. I have been in the habit lately of not lifting weights on Sundays. My body needs the rest and I think that is the way to go.

Workouts are going pretty well. I'm trying to work on a pattern of hard days and easy days. We'll see how that works out. I'm trying to give my body a little rest by still getting on the machine, but not working that hard on it.

The biggest challenge up here is the exercising every day. It is tough physically and mentally to maintain a pace of lifting and running/cycling everyday without a break. I am told I can take a day off once a week, but I would rather not unless we are very busy.

Equipment

ARED broke again last night.

Due to T2 being down, it is on my schedule to use TEVIS today. I have never used it so I am looking forward to trying it out.

I worked out this morning on both CEVIS and ARED. I felt tired but went up in weight. I just need to watch out for my back. T2 is down because of power consumption.

So I ran my first TEVIS session today. I started off in passive mode just to get the hang of it. The tread is much narrower than T2 and it is a lot less stable. It took a few minutes to get the hang of it but then it felt alright. I did not like that my view was looking out the CM hatch – its moving up and down while I ran did not make me feel good.

T2 is still not working and the troubleshooting we did this morning did not work. We really need to get away from those [extremely long] passwords, especially when dealing with touch screens. Just to get the virtual keyboard to work took longer than the amount of time they had scheduled for the entire task (10 minutes). So we are still without T2.

Good Workout

Good workout on treadmill and ARED today.

It felt good to run and turn my brain off for a few.

An ARED workout to end the week is the way to go.

Workout was good and I have a long afternoon ahead.

I really like the opportunity to get good athletic training every single day.

Workouts were great. I did a 30 minute CEVIS and then cranked up the tunes and got in a nice ARED session.

I was not too motivated to run and lift, but now that I am done I am glad that I did. I always feel good after a workout.

I had a good workout. I'm starting to feel a little better. My leg was better today, so that was good. My back is definitely getting better. So I'm feeling good.

After the cleaning I did ARED and then CEVIS. Having the ability to work out is a life saver for me. To have those couple of hours every day is good for my body and mind.

ARED and T2 workouts were good. It really took about 5-6 sessions on T2 to get the harness just right. It was killing my shoulders before, but now it fits well. I may need to tweak it a little more.

Maybe I exercise pretty hard... speaking of which, these sprints are tough. I like it though. Really gets my heart rate up there and I am tired afterward. I love ARED. Very cool machine.

Pain

My back feels good when I lift but I still need to be careful not to pull a muscle.

Still recovering from a lower back strain from ARED. Laying off the strength training.

I am having a little problem with my harness and right hip. I couldn't complete my run today.

My biggest concern is hurting something by pushing too hard (on ARED), specifically my back. I never really had back problems but some of these weights may get very high.

It's interesting how you are always on the edge of hurting yourself (with exercise). I think if you work hard on it, you never get a recovery time. So, I'm still trying to work on recovery.

I hurt my lower back again. It was getting better, then a few days ago I was starting to work my weights back up again, doing some RDLs, and I just over did it, even though I was really light and just doing a lot of reps.

Also lifted on ARED. That thing feels like it is trying to pull my arms off. It is strange that dead lifting half the weight I do on the ground feels very hard on the forearms but the legs feel fine. Obviously there is something different.

Notes on T2, treadmill – If you put too much weight on legs it makes it very hard on the thighs so I keep some pressure on shoulders and usually adjust it every once in awhile. I notice if I shrug my shoulders up I can relieve the legs a little.

My legs are almost always tired. Working out twice a day without a break had fatigued them. I finally took a day off yesterday from running. I need to take a day off every week or two from at least running or lifting just to give the legs a break and mentally recharge.

Knee still hurting. Perhaps a little better today, so I tried very light weights on ARED, and just put pressure on the knee, just standing there. No harm done as far as I can tell. I'll try a little ambulation on T2 tomorrow to see how it goes. A knee injury wipes out much of the exercise capability up here, it seems. I'll recover, but if this had happened early in the mission, I'd be quite atrophied by the time I got home.

Deconditioning

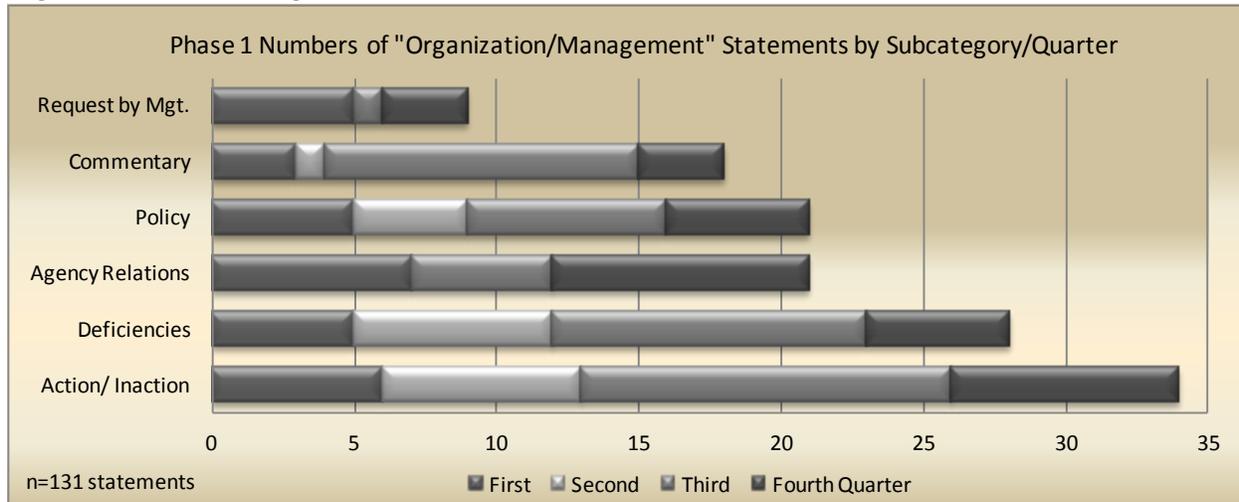
Worked out on treadmill and really felt it in my calves. It seems like missing 1 or 2 days [up here] is like missing 1 or 2 weeks on Earth.

Exercise is such a psychological boost up here. Without it, one can feel the lack of activity. Not exercising can definitely hurt your mood, particularly if your crewmates are doing their standard exercise regimen. I see it and I want to participate.



CEVIS - Cycle Ergometer with Vibration Isolation and Stabilization System (left);
T2 - Combined Operational Load Bearing External Resistance Treadmill, or Colbert (right).

Organization and Management



Communicating with management was addressed in the discussion of Outside Communications. In contrast, the major category labeled Organization/Management is composed of journal statements concerning management actions, policies, and relations between the space agencies. Examples follow.

Commentary

The Program seems happy with our work up to now.

So, I think my only complaint about this mission is that it seems everyone wants to make something out of nothing. That is probably a good sign, since really, there isn't anything to complain about.

We decided we would rather have X delayed a day so we could get the EVA over with. But of course, it seems like whenever we decide what would be best, it doesn't happen that way. Which is okay, it's just kind of interesting.

I've been having some nice philosophical discussions with X lately. Being out here on the frontier gives you a perspective on how best to get some work done, and make advances, and not get clobbered with the enthusiastic ideas from the ground on how to spend all of your time.

I do give honest feedback on the comm loops, and in the crew notes, but I appreciate that the ground is not necessarily trying to make our lives hard, they're just doing it because they don't understand the place very well.

Unfortunately the rumors are still out there that we are burning the midnight oil and working all weekend. All of that is false and it is not the perception that we want or one that is good for future crews. X was even told today that the ground was concerned because he sounded tired on the loops. Our every actions are scrutinized... We took a picture of ourselves watching [TV] to send down to the big bosses to let them know that we really do relax here.

I think when I get home, I'll look for ways to try to help people understand the difficulties of working up here, and perhaps how they could do things different to make us more operationally effective. Astronauts really have little tolerance for silly or unnecessary activity.

Action/Inaction

I saw the schedule for next week and they have it set up like I had requested it NOT to be done.

MCC has moved [the journals] project to the task list because I am "out of crew time." I hope it doesn't greatly impact my ability to continue to write things down.

The living conditions up here are not bad, but it seems they are getting worse. We could not open the cupola windows for 10 days or so and it will continue until the ground folks move the arm.

We were told that [the resupply ship] will have a bag of fresh fruit and vegetables for the past few months and now we are told that it has been replaced by EVA hardware. That is not a good way to treat a crew.

EVA tool lists still come up wrong. Years ago I asked them to send up a list so I don't have to go into the same bag multiple times. Tell me what to get from a bag all at one time. Obviously they did not listen because they still use the same format.

I continue to be frustrated, a little bit, with the ground over some issues. Not Mission Control, but more our office. Some of the things continuing from training, just seems like a lack of support at times. I'm not letting it get to me. I'm just sharing it because this is what I'm supposed to do.

Media attention. I don't care for it, I don't like it, I don't want it. I have been doing Twitter and it has exploded beyond my wildest imagination. That has caused tension for the three USOS crew. I got invited to do [a TV] show and it was clear from the jokes my crew mates made that it was BS that I did it alone. I desperately wanted them with me, but NASA PAO made it that way. I talked to NASA PAO and hope to do very few solo PAOs in the future. Not where I want to be.

Deficiencies

It is interesting the response we get to comments. The ground folks response is basically to tell us why they won't change it.

In anticipation, they gave us a relatively light day today to make up for Saturday. It may work mathematically, but it is not the same in terms of rest.

Most of [the problems] have to do with working in a bureaucracy that can only move very slowly, and with understanding how different performing a task in space is compared to doing the same thing on the ground.

[It bothers] me how the ground treats the crew. We work trivial and mundane tasks for weeks and even still they do not trust us to do the simplest of things. Then, when we get frustrated we are labeled as hard to work with.

Yesterday, I had a HAM pass in my post-sleep, a PAO event during the day, and then another event in the evening hours with a school. That really keeps you hopping. I suppose on the

ground, they think that we can just show up for those things, but the truth is that there's a lot of preparation to get ready. Some thought needs to go into it, or the [events] will be mediocre.

One of the biggest problems with operations is the understanding of how we must operate onboard, versus their imagination on the ground. This may be one of the biggest challenges in spaceflight, since it's just impossible to understand without the experience. Some of the disconnect is gravity related, and others are the assumption that things work as designed or planned, and that is rarely the case.

As an example of the gravity phenomenon – if you gave somebody a bag of M&M's and 6 baggies, and asked them to sort them into the baggies by color, they would dump them in a bowl, and just start sorting. It would take maybe 5 minutes, but the same task would consume a full hour in space. I had much the same task for matching up hardware to install some brackets a few weeks back.

My blood is boiling right now and again, it is over social media and CB counseling me. I made a cute little video... and they said it [could not be released] because it didn't put the crew in the best light.

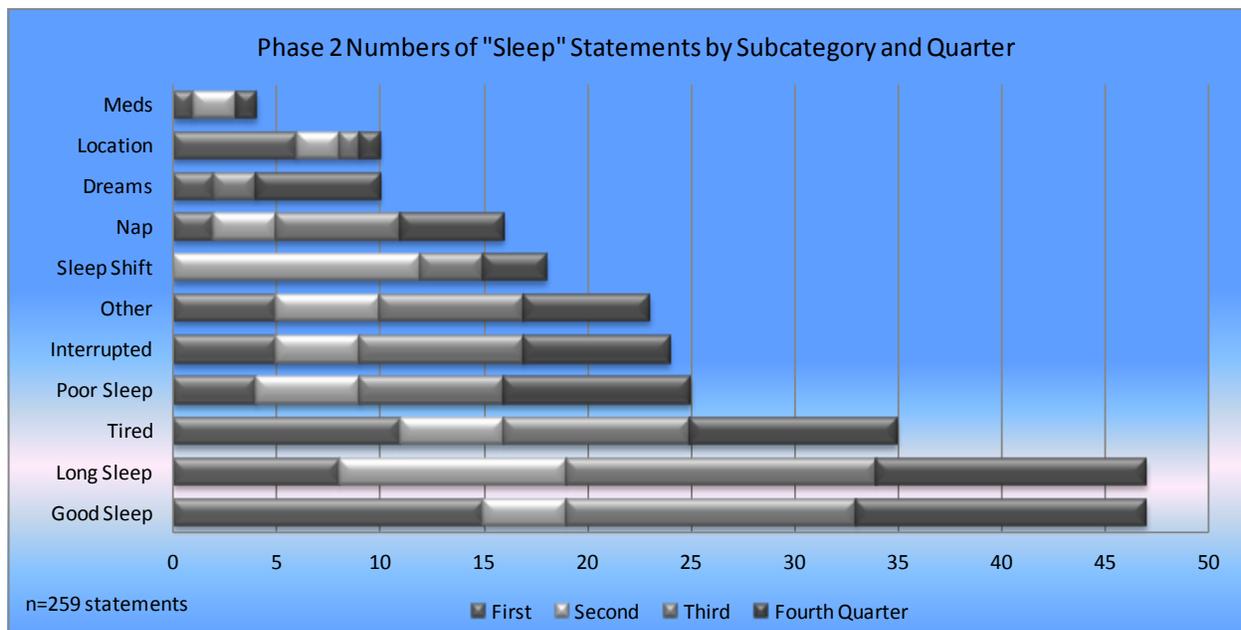
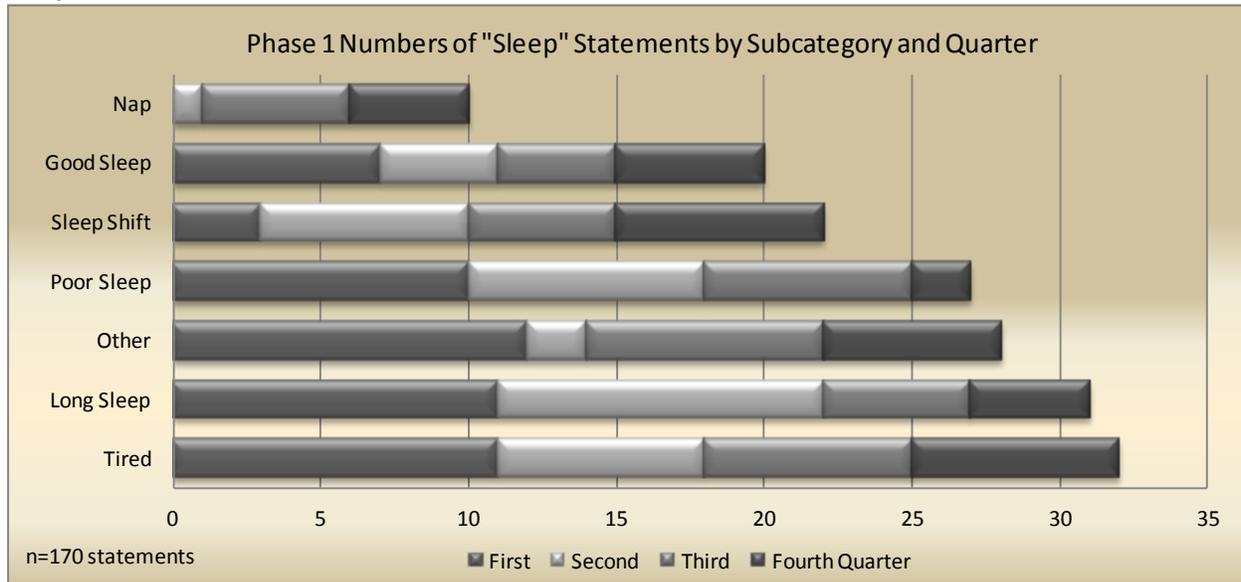
The final statement in this subcategory has been edited and does not reflect the full intensity of the astronaut's emotions. I have refrained from including other journal excerpts concerning agency managers and attorneys negatively affecting crew behavioral health to protect the individual astronauts involved from identification. However, imagine for a moment how it might feel to plan an event to increase public awareness of a serious problem on Earth, have that plan approved before launch, and then be informed it cannot proceed shortly before the event (because it might be perceived as using NASA to benefit afflicted individuals). Now imagine being instructed on the same day to send a public message promoting an entertainer's career, because it might increase public awareness of NASA. It was the single most upsetting incident to occur during the 13 years of the Journals Flight Experiment. The astronaut recovered promptly and continued to perform admirably, but NASA might not be so lucky in the future. Living and working in isolation and confinement for long durations is sufficiently stressful to tax the limits of human endurance. Astronauts on the ISS and the crews of future space craft should be insulated from the actions and opinions of attorneys and others who are unfamiliar with operational conditions and the principles that influence adaptation to, and performance in, isolation and confinement.

Agency Relations

Our management looks at Russian segment EVAs as something for Moscow to work, and not a big concern for us. From the crew perspective, I see us as one station, one crew, and fundamentally disagree with segmented ops on principle. We should be engaged, each side with the other, every time there's a critical operation going on.



Sleep



Few people know what it is really like to live and work in space, but we all are familiar with the performance-degrading effects of poor or insufficient sleep. Humans can endure many forms of deprivation and motivation can even counter the effects of fatigue, but only temporarily because the requirement is finite and deficits are cumulative. We all eventually succumb to the need for sleep. Differences in the numbers of journal statements between Phase 1 and Phase 2 suggest that astronauts are learning from their colleagues' experiences and are receiving better sleep throughout their expeditions. Under-reported use of sleep medication probably is a factor in any improvements in hastening the onset of sleep. Examples from the subcategories follow.

Good Sleep

Sleep will be good tonight.

I slept in until 0800. It was good sleep.

Got a whole 5.5 hours without waking up! Woo hoo.

I slept great last night, much better than I thought I would.

Slept fairly well. About 6 hours. I will be happy when I can get that to a steady 7.

I did get to bed relatively early and got some good sleep. I woke up feeling good and refreshed.

Always something to do here on ISS. Sleep is most important though, so I am finishing up now. Good night.

After several nights of 4-5.5 hours of sleep, I'll get one great night of sleep for 6-7 hours. And I feel wonderfully refreshed after that.

Had a great night of sleep last night. Very nice. Just like on Earth, good sleep is a great thing. I feel like I could tackle the world right now.

I have been sleeping really well lately. I have been going to bed on time and not taking a long time to go to sleep. So that is helping out. I am feeling a lot better actually. I don't realize sometimes how tired I am. It is nice to feel well rested. Overall everything is going well.

Long Sleep

We all slept in to catch up on some much needed sleep.

So far it has been a relaxing holiday. I slept in until about 0800.

It's a Saturday morning I slept in about 8-1/2 hours [and] actually got good sleep.

Finally after the [docking] I went back to bed and was able to sleep in, and I feel better now than I have in weeks.

I slept in until 10:30 today. That was great. I needed it. I missed last weekend of sleeping in, so this was really huge.

By the time I sleep in for maybe an hour or two, eat breakfast/drink coffee, read the Daily Summary, do housecleaning, workout, and then have the Weekly Planning Conference, it is already 1330.

I slept in until about 0730 so I got about 9 hours of good sleep. I am very glad that during the week I have managed to get between 6.5-8 hours of sleep every day. That is about what I need and had been shooting for. It does not leave a lot of time at the end of the day, but sleep is a high priority.

Tired

I will be ready for bed tonight.

I am tired and will get to bed early.

It is going to be an early night for me.

We are all tired and a good night's rest and a day off will be welcomed.

It is 2100 and I am tired. I could fall asleep right now. Good thing tomorrow is Friday.

I am still not getting enough sleep. Every night I say I am going to go to bed early, and it just never happens.

It's after 0100 again and I need to get some sleep. Been averaging 4-5 hours a night since we arrived. Would be much nicer to get 6-7!

I am not sure why, but we have a DPC scheduled for 0555 this morning, in just about 10 minutes from now. I am definitely tired and fading. I think I will get to sleep as soon as I can after the DPC. It has been a long day. I don't think any of us liked the sleep shift schedule that was chosen. We will see if we can have a say for the next shift.

I'm really just tired today [six weeks remaining], I don't really know why. I slept pretty well last night. Of course the night before that, I didn't sleep well, and usually for me it is the day after that I have more trouble. So, I was definitely tired today. But it wasn't like a bad day. I just had to do some tedious tasks, and that makes it worse.

Poor Sleep

I tried going back to sleep but no luck.

Woke up about an hour ago but couldn't sleep.

We are not sleeping much, since we're working into our pre-sleep and sleep [periods].

I did not sleep great last night. I fell asleep no problem, but then woke up around 0130 and had a hard time getting back to sleep.

I have been reading a really good book at night before bed, and it usually gets me sleepy enough to nod right off. Not so lately. Interesting.

I still awaken early quite often, before I've had sufficient sleep, just like on Earth when I was very busy in training or had multiple exams or evaluations pending.

Didn't have a great night's sleep, not sure why. I woke up around 0030 to use the restroom and then couldn't fall back to sleep. Knowing today was busy, I took a Sonata.

Morning of EVA and of course as expected I woke up too early. I got about 5 hours of sleep. I will be tired at the end of this day but will be fine during the EVA.

Sleep is OK, but not great. The last two nights I have had trouble falling asleep. Once asleep, I'm sleeping great. Hopefully as I start the workweek I will regain my good sleeping habits. Sleep for me is a must so that is a stressor.

I have not been sleeping enough these past few days so that might be related to my difficulty on T2. The last 3 nights I have not fallen asleep until 2 am or so. I have not taken Ambien. I took it last week and I am [avoiding] it now. I feel fine in the day, but just T2 runs seem harder.

The only notable thing for me right now is I have had 3 bad nights of sleep in a row. I am having trouble all of a sudden falling asleep. This happens from time to time on the ground so it doesn't worry me, but until now I have not had this problem up here. I have tried to analyze what is going on. It doesn't appear to be stress because this is the lightest time yet schedule and pressure-wise. The only thing that seems to be happening is as I try to go to sleep, I am thinking of all these great things that make me happy and then I can't stop it. I have thought about my family, how my kids are growing up, what I'm going to do after I get home, long term plans, etc. All of it is so fun to think about, once I get on those topics I can't seem to turn them off.

Interrupted

I want to get to bed early because I know this [device] is going to wake me up.

Two false fire alarms last night – so we've been a little grumpy today after less sleep.

I think everyone was planning to sleep in, but unfortunately the vehicle had other plans.

The Russians had three fire alarms, all false, and then we had a caution at five in the morning.

Woke up this morning to a Caution tone at 0700. The Russian telemetry system is still acting up. It is not the way you want to wake up, especially when you can sleep in. The tone is very subtle and it is pretty quiet in our crew quarters.

Sleep Shift

I got about 4 ½ hours of sleep yesterday. You can never win on a sleep shift.

Woke up at 5:30 and couldn't get back to sleep. Residual effect from slam shift we did for X docking.

It is a little after 1500 and time to start winding down and trying to get some sleep. Wake up time is midnight.

I have heard that [sleep shifts] can be painful and the scheduling is not always the best. It is now 2130 and just now getting to my quarters.

Protocols for changing sleep and awoken times seem to make fatigue accumulate, rather than prevent fatigue. I'd perform much better if I simply got up early one day to do an important task, then went back to sleep after the task is done, than to slowly shift in the hope of fooling my body into not knowing that it's shifted. The most sleep deprived I've been on the mission has been during sleep shifting.

Dreams

The only difference between sleep in space and on Earth is that I sleep without dreams here. I simply close my eyes and then awaken the next day as if no time has passed.

I remember lots of vivid dreams. Last night I had CRAZY dreams involving lots of old friends all the way back to elementary school. Very strange. I still wake up pretty disoriented too, which seems to be a standard thing up here. I always wake up feeling upside down in my crew quarters. It is funny actually, I should video tape me waking up and trying to find my watch to turn the alarm off. I usually don't succeed until the alarm stops.

I had an interesting dream last night, that we came back down to earth for two days. We landed and then two days later launched back to the station. And we were talking about how they should have given that flight to one of the new classmates, but anyway we did it. It was a weird and kind of a cool dream. We went back to the office and it was a different building than it normally is, but the same meetings, the same people. It was interesting.

I've had a lot of dreams recently, and I just can't remember them. This is why I need to write them down immediately in the morning. I'm thinking here, what dreams have I had? Yeah, I need to do this as soon as I wake up in the morning.

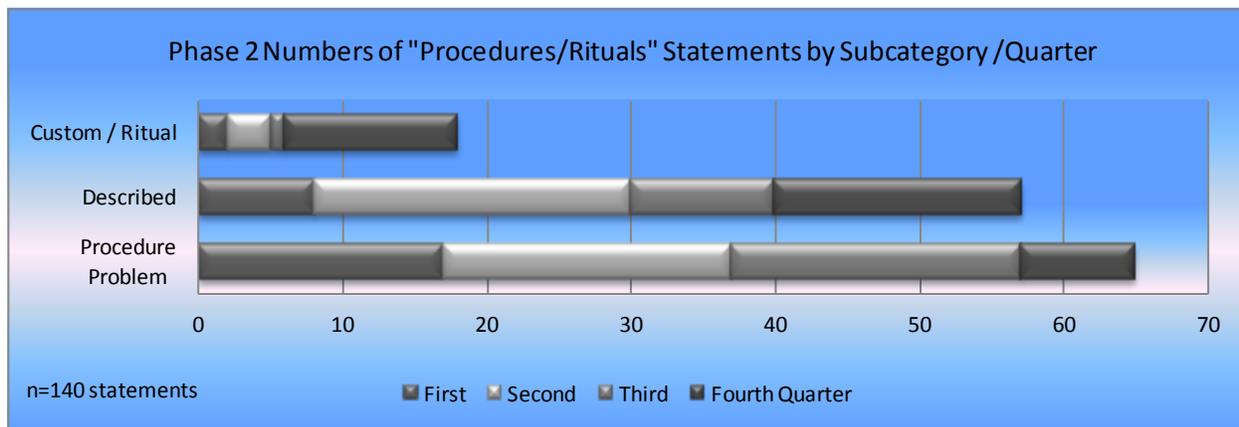
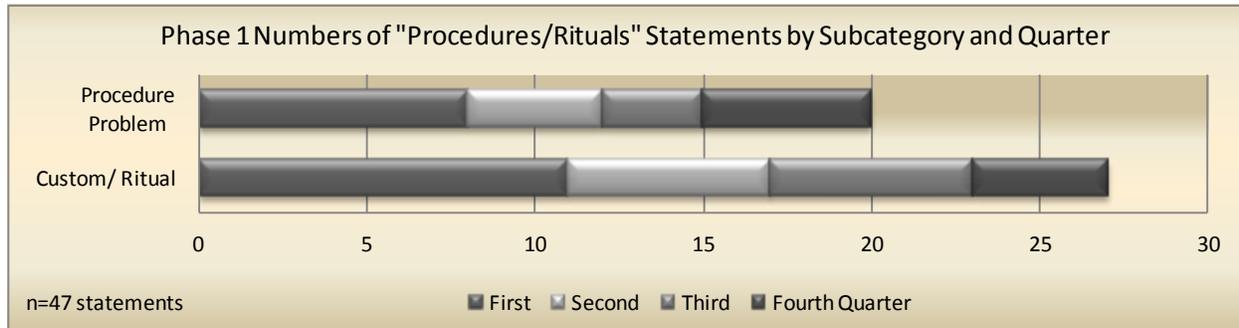


Skylab sleep chamber, 1973.



ISS sleep chamber, 2012.

Procedures and Rituals



This category consists of statements that describe procedures, problems with procedures, and rituals that have evolved to enrich the experience onboard the ISS. Examples from the journals follow.

Procedure Problems

I spent 5.5 hours changing out the mass spec in the N3 MCA (with only 2-1/2 hours allocated).

The last step of the procedure to configure the transceiver was incorrect. So I had about 3 minutes to figure it out, and got it to work.

A complex procedure had a step that was completely wrong: It told X to turn a knob CW when it had to be CCW for the task to be successful.

The procedure is missing a couple of things and they did not send up a great note for X practice. We were not too pleased with the products.

The cleanup and RWS checkout went a little long. The procedure was very unclear and I don't remember ever seeing it. With the help of the ground I got through it.

As we plan on saying to procedure writers: "Yes, the procedure is technically correct. You'll have 85% success with the procedure. If you want 95% success, you should address the human factors issues." [A human factors specialist could not have made this point more clearly.]

Some frustrating times today for my fellow crewmembers. I've settled in to a happy place where I don't get too frustrated by the procedures and workload. I suppose it's because I know I only have to tolerate it for another few days.

I had perhaps the most terribly written task yesterday and we all worked our way through it. I said a few bad words off camera just to get the frustration out. It helped. [And then the astronaut wrote about it in his journal, which also helped.]

The procedures are not very clear nor written in an order that makes sense for the work we are doing. They also have outdated pictures for equipment we are no longer using. In addition, they do not clearly state which steps in the procedures we will be running.

This [error] could have been [avoided] had the procedure developer recognized that it was asking a bit much of one person... it's something that is difficult even on the ground. Now [with] the equipment being in different orientations, it is easy to lose your place in a procedure.

I definitely get frustrated with the Payload folks and their procedures sometimes. They just don't seem to understand the consequences of their statements, or what they really mean. We must try to enlighten them. I'll send an email to X, who will be a good person to work on that.

This procedure was awful. Steps were missing, the stowage note was wrong in multiple places, nothing made sense. I remarked to X that if this is how things used to be every day on ISS, I can definitely understand why people get fed up with ops here. It was a disaster. And it went about 2 hours over the allocated time, which made it even worse.

The last skill acquired up here, and maybe it's never perfectly acquired, is procedure interpretation. That continues to occasionally stump all of us. The current form of procedure writing and presentation simply has too many human factors flaws. [Note: Astronauts develop an appreciation for the work of human factors specialists during training and from previous aviation experience; they then expect all aspects of their work - equipment and procedures, in particular - to have benefitted from the application of human factors methods and principles. It is not an unreasonable expectation and will be essential for planetary missions during which real-time support from the ground will not be available.]

Described

The procedure was clear and there was space for me to insert 2 battery numbers, so there is no one to blame but myself.

The robotics procedures seem pretty good and will only get better. I will now have more time to review and be better prepared. Zero mistakes is my goal.

I did a fairly thorough cleaning. I pulled up the housekeeping procedure for the first time to see if we were missing anything. Nope. The new cue card/procedure will be good for handover purposes.

Got to see our first full blown emergency with a very small fire in the Russian segment. Very cool to see our crew absolutely dive straight into emergency procedures and do a great job handling the emergency. I was super impressed with everyone.

Custom / Ritual

We are getting ready to join the plaque hanging in MCC. It should be fun.

After dinner, we went over to the Russian segment with gifts, per tradition, and had some chocolate pudding cake.

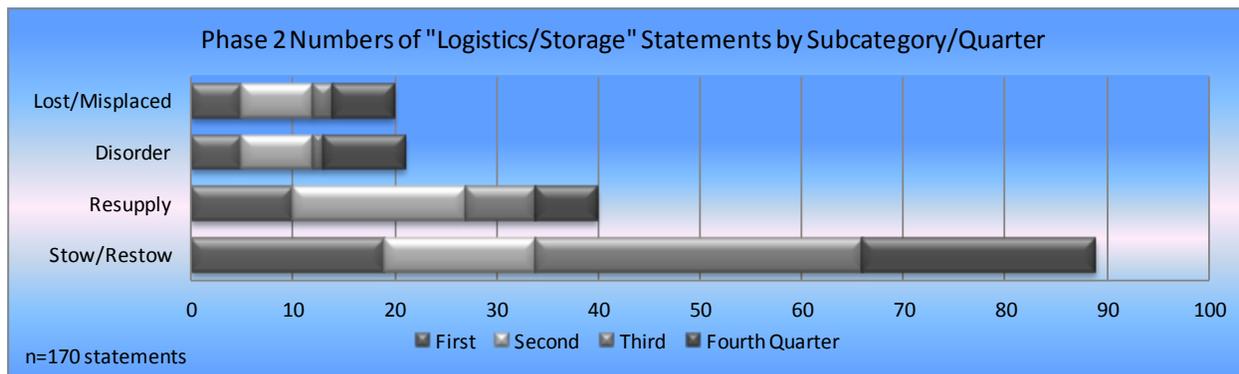
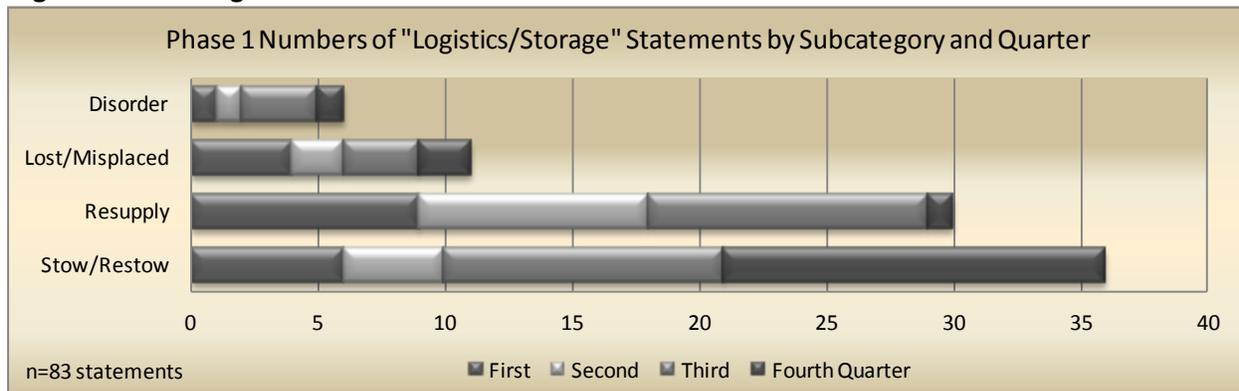
Last night we did the sticker ceremonies, attaching [our] patch to the N1 bay 2 area and the Soyuz patch on the FGB gold panel.

Change of command ceremony today. X said some very nice words about the progress of mankind and how far we've come in the last 100 years.

We had a very brief Change of Command ceremony. We are now officially the prime crew. With that, the sound has been piped into my crew quarters.

The party was very nice. There was a good showing and it was nice to see people having a good time. X and the BHP folks do a great job supporting us.

Logistics and Storage



Logistics and Storage emerged as a major category during Phase 1 of the study in response to the large numbers of entries referring to the tasks and problems associated with supplies. The inverse relationship during fourth quarters between resupply concerns and stowing items in preparation for crew rotations is evident in the figures. Examples of journal statements concerning logistics and storage issues follow.

Stow / Restow

Even learning things like where to find food... takes time.

Good organization of items frequently accessed, such as trash receptacles, food, dry goods, tools, etc., is essential and allows you to feel in control of your environment.

Biggest impact of X operations was the unstow and restow... Don't think they understood how much overhead was involved. Gave them lots of pictures and movies, before, during, and after to help them get an idea.

I remember locations better, probably because when I read a location in a stowage list, I can visualize it in my mind. So, stowing and unstowing tools and equipment according to a stowage note is easier than it used to be.

I had a stowage task scheduled for 45 minutes and it ended up taking an hour and a half to two hours - in part because we had a false smoke alarm in the Russian segment, but in part because that stuff just takes forever.

Today I broke out a new pair of pants; not too bad after 2 months. I could definitely have made it for the duration, but when we do that we contribute to the stowage issues. We have an overabundance of cargo pants and shorts.

I look up the location of the next bag of breads available, hunt it down in another module, bring it back to our "table," bar code it, bar code the pantry location where it's going, separate out the

breads which for some reason are packaged with "rehydratable meats," get those corralled into separate bags and stowed away in the pantry, and then eat.

Opinions vary, but we've adopted a "vending" machine approach. If a crewmember wants a specific item, such as soup, they should be able to access a container easily and find a container of soup. Current delivery options for the ground teams limit the granularity of packing, so crews currently get a bag of "soups and cereals" and have to separate the contents.

The only major frustration in the last few days was for X pre-pack. They want almost everything wrapped in bubble wrap. But, we don't have rolls of bubble wrap, so we end up cutting apart old bubble wrap bags and stitching them together with duct tape to make a tapestry that will cover the item. It is by far the dumbest thing I have done on orbit and after 2 hours of pre-pack you seriously want to punch something or someone out of frustration.

The only difficult part was packing the vehicle. [There are] a lot of little things to take into account that aren't in the procedures, and you just have to figure it out. You will start packing one area, get done with that, you think, and put stuff in the next area, which you find out doesn't match up - there is either a buckle in the way or something is too big, so you have to pull that out, redo the one below or next to it and repack it again, and keep working like that as you keep putting things back together. It took a lot longer than it would have if we had a Big Picture of how things were [supposed to fit].

Stowage is one area that deserves some attention, because ground doesn't really understand the problems of gathering equipment from multiple locations and tying it down for use at a work site. Walls are already cluttered, and it's hard to organize a location nearby. Most items are buried deep in bags, sometimes three or four deep. Inside a locker, there is a CTB, inside of which is a kit, which has a Ziploc with a tool inside. This can really add to the cost of doing business.

Resupply

I received another bonus food container this week [which contained] lots of chocolate so I am happy.

I spent about an hour and half restocking the food, WHC, shirts and washcloths. We are all set for the upcoming week.

Shirts we do change out about every 10 days – t-shirts that is. Polo shirts we just wear and enjoy off and on during the months.

It appears that the vehicle is proceeding fine... I am looking forward to getting it here for, again, a change of pace - to do some cargo ops, get some new stuff, just do all that, it's a good change. It will help with the monotony of operations.

I do hope [the cargo ship] launches. Besides having a lot of good science onboard, it has our bonus food. It would be nice to get a little different food. I'm definitely looking forward to that, but hope I remembered to put something good in there.

I spent some time stocking up and cleaning out the WHC. It had been neglected over the past few days with all of the concentration being on the EVA. I changed out the KTO (maybe my last one) and restocked the local pantry. I gave X one last run down as [he/she] will be taking over that stuff.

Disorder

The biggest thing you have to worry about getting under control is organization.

I still have some more organization to do. I have too much crap in my little cubicle here.

The station is a bit of a mess since we have not cleaned in 3 weeks and there is stuff laying around all over the place. [After a period of high-tempo operations.]

I feel like the place is a little bit in shambles right now. There is stuff out of place all over the ISS. I don't think my crewmates are as concerned about keeping order as I tend to be.

I pick up a little after them but I am at the point now where I am leaving soon and it is easier to let it go and let someone else worry about it. X leaves tools out and cables dangling in the middle of a module. Nothing big, but these little things are the difference between making work easy or hard. [Messy roommates are annoying on Earth and even more so in space.]

We have a lot of junk up here that just needs to be thrown away, but everyone is very hesitant to do that and it all involves paperwork. You need to stock pile up to a point, but we have stuff up here we will never use. If we had infinite space, we would keep it just in case. However space is a limited resource. [Hmm. There is infinite space just outside the hatch; maybe bags of stuff that is too good to throw away could be secured there, like Grandpa's cans of rusty screws in the shed.]

Lost / Misplaced

It is very important to put things away up here and keep things as neat as you can. This makes future tasks easier and less frustrating.

Today there were problems finding things in the expected stowage locations. If it's not there, time is up [for the task] before you even track down the hardware.

A few items were not where they should have been, but the ground gave me alternate locations and those were good. I got into places I had not been before and some are very poorly organized. I am very glad the ground keeps a pretty good tab on most things. We may complain at times about the organization of this facility, but overall it is ok.

One of the guys was asked to retrieve a specific serial number USB stick for downloading, and after an extensive search for that particular one, he gave up and called them. They said that the serial number wasn't important – that he could use any one. Couldn't help but smile when he wondered out loud why they specified a serial number if they didn't care.

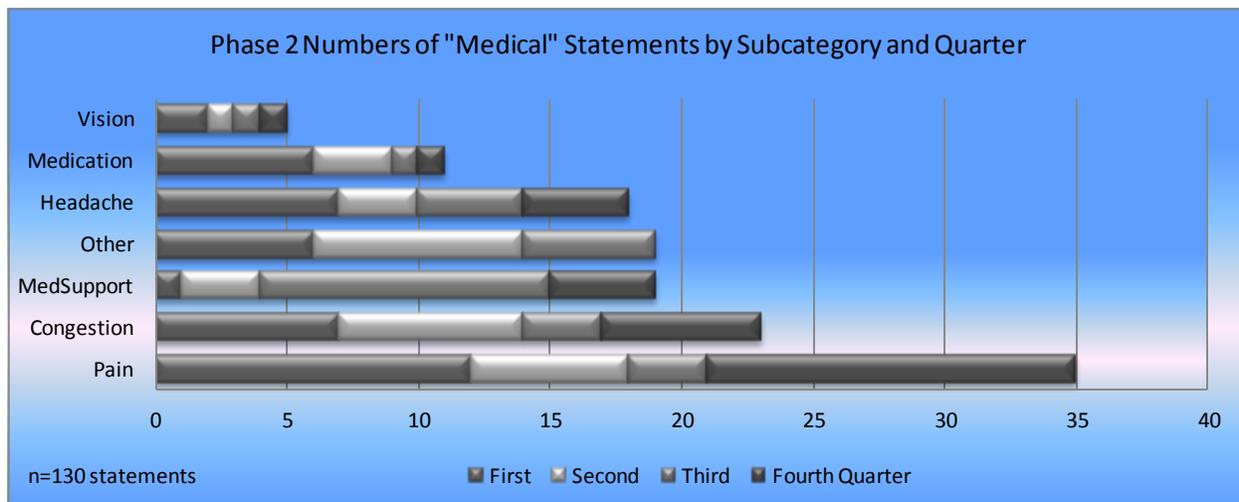
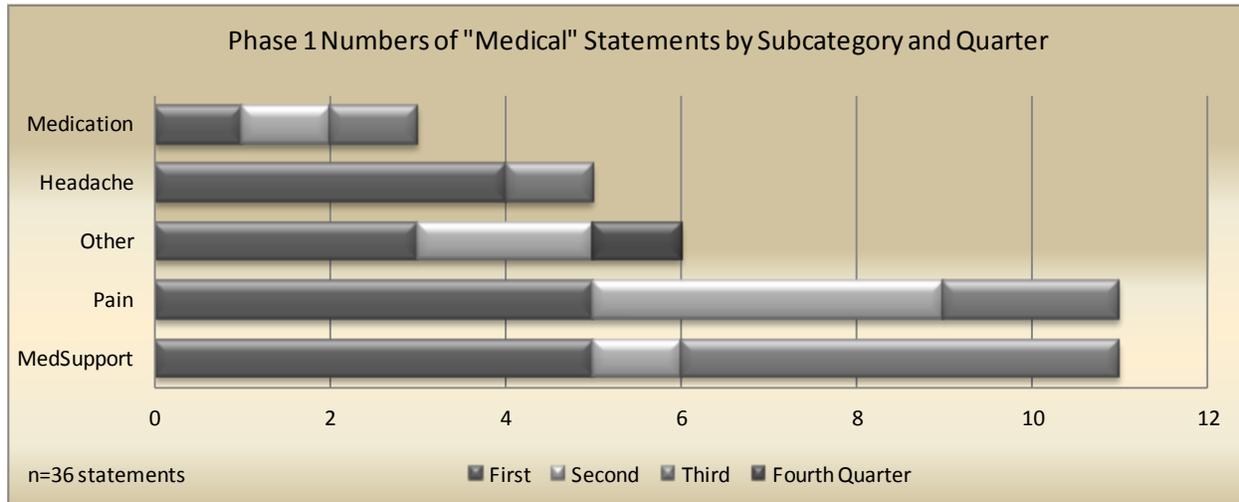
The one downer today – X and Y were looking for some kind of [device] stowed in Node 2 by a previous crewmember. I'm pretty sure I threw something like that away during my days trying to clear 10 years of trash out of the ISS. Because I suspected it was in the Node 2 trash, and that trash is generally pretty clean, I went looking - spent about two hours, but never came up with it. Seems to me it wasn't the best piece of equipment, but they sure wanted that thing.

You can easily lose items up here and they are difficult to find if you put them down someplace that is not the usual spot. [I was tasked with finding] a foam box with a couple of pieces of hardware in it. They had several locations where it could possibly be and other ones where there were things similar to that, so I looked and didn't find it. I was ready to give up and then happened to see multiples of the same size box bungeed to one of the walls and found the one! It had been sitting in that spot [lost] for over a year.



The Leonardo Permanent Multipurpose Module (PMM), installed in March 2011, is used for storage. Take a guided tour of the ISS: http://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html

Medical



The statements assigned to the medical category are primarily descriptions of the normal aches and pains that result from heavy exercise, but also include the effects of micro-gravity, such as headaches (from the lack of convection and/or insufficient CO₂ scrubbing) and skin and nerve irritation from working in EVA suits. A few examples are provided below.

Pain

Knee is improving. It's amazing how health effects the mood here.

Back is a little sore but not too bad. Ran on T2 today and it seemed to help.

In other news I tweaked my back a little on ARED so I will take Friday off from lifting to let it rest.

I hurt my back with heavy loads on the ARED yesterday, and I'm hoping that it will recover so I can get back to a nice healthy exercise routine.

My legs are almost always tired. Working out twice a day without a break had fatigued them. I finally took a day off yesterday from running. I need to take a day off every week or two from at least running or lifting. Just to give the legs a break and mentally recharge.

After the EVA it is normal to have several sore spots. My shoulders are sore. My neck always gets a lump from the chin strap. On my back the two points of my shoulder blade have a sore spot and on my left ribs it is sore from the snorkel hose pushing up against me. No arm or hand fatigue since this was a short EVA, but that is normal to have.

Congestion

Things have been going really well on the stuffiness, but today it is just terrible! I'm getting through it.

Nose is stuffy and started Nasonex today and will see if that works over time. Sudafed did the trick for a quick fix.

In the morning it seems I will get a stuffy nose for a short time but then it clears up and I am fine all day. Ears are clearing fine.

Body hasn't adjusted just yet. I still feel the pressure in my head of body fluids pressurized by my cardiovascular system still being shoved cephalad like on Earth. Lower GI system hasn't adapted yet either – all moving very slowly, which kills my appetite.

Everyone is getting pretty spooled up about dust in the atmosphere potentially being the source of near universal hay fever-like symptoms. Other competing theory is that it's CO2 levels (about 20X higher than on the ground and right at the red line for NAVY submarine ops, BTW).

Medical Support

The day started off OK with the monthly physical fitness exam. It just means setting up that ancient EKG and heart monitor machine. Even having done it before, I just barely finished on time.

OK, back to reality. VO2 max tomorrow. These big events always stress me out a bit. Too many people watching the data. Too many flight surgeons involved. Fingers crossed for good results.

I had my PMC and PPC today. All is good both physically and mentally. I had a little water behind my eardrum, but so far it has not been an issue. My bicep is no better but I will survive. I had nothing negative to report to either of the Docs.

For missions outside of Earth orbit, that is missions that have no simple return capabilities, one of the crewmembers being a physician makes sense. The judgment and skill required to take definitive care of more serious medical problems would be best found in a physician. Internist or surgeon? Difficult to say, because it depends on the person. One could argue that general surgeon could be taught to be an internist more easily than vice versa.

Headache

Another headache today and this one got pretty bad. Had a small headache about 5 days out of 7. Not sure if it is adaptation or CO2.

But the big issue this week, that we are dealing with, is CO2. A lot of us have had CO2 symptoms. X is very sensitive to it. Even Y said [he/she] has had headaches.

Yesterday the CO2 was down around X because they had turned on the Amine swing bed and I felt pretty good. I could even smell better and noticed that Node3 smells like urine. The CO2 is back up to 3.3 today and I felt a little more frustration this morning and am fighting a headache. I wonder if it is the change or the magnitude that changes how I feel.

X [cosmonaut] said he had a headache last week. I was just talking to Y [another cosmonaut] and he feels it in the morning. I can feel at different times, in varying amounts - just kind of tingling lips, a little bit elevated heart rate and respiration, and a full head are the symptoms I have. It's not terrible. It's no medical emergency or anything like that, but it is noticeable. We had them start up a second CDRA [Carbon Dioxide Removal Assembly] for us, which has been very nice... well, it will be, hopefully. It is not working yet, so we still have CO2 symptoms. Anyway, CO2 has been the word of the week.

They have been keeping the CO2 low for two weeks, but now it is heading back towards 4. I am noting in the journal that it has been nice feeling like myself again, but now I will be returning to the land of fuzzy thinking and headaches. If I fly again, I'm going to need a note from the doctor that says the CO2 must stay below 3. It makes my life completely different up here. I will miss you low CO2!

Medication

I took a half of caffeine pill to give me some energy today. We will see if it helps.

I found Meclizine to be super effective for the first two days. I took a Phenegran the first night with no noticeable results. Took Meclizine the next morning and felt great all day.

Well, CO₂ is up to 3.0 and I can feel it. X is really feeling it. It is just one of those annoying things that they don't really fix for us. They just ask us questions, How do you feel, but nothing ever changes with the CO₂. It's not terrible for me, but I do take a Motrin usually every day.

I took a Sonata and then learned that at 0130 we received a warning tone onboard and I didn't hear it; I am usually a light sleeper. It is a good to know that the tone outside a sleep station is not loud enough if I have taken a sleep medication. From now on, I will refrain from any sleep meds unless it is a critical day ahead.

Vision

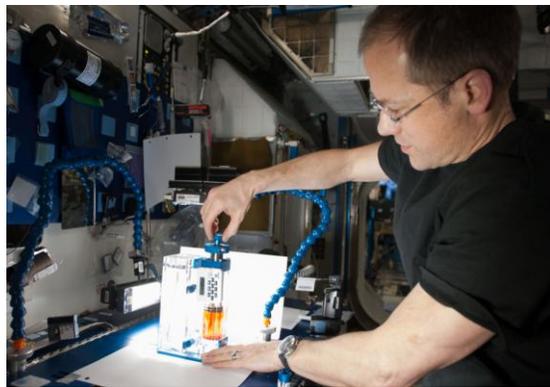
I have not noticed any changes to my eyesight.

It seems my eyes have changed over the past 2 weeks. I am not sure and will have an eye test soon to find out.

My close up vision has been blurry since I got on orbit. I did not have this issue on the Shuttle, but I am a few years older now. I used a loaner pair of glasses for my first 2 days and found my prescription glasses today so life is much better. I took the visual acuity test just to get some background data in case it gets worse. Looks like I will be using reading glasses for the next [several] months.



Dental examination on *Skylab I*.



The role of crew physician is well-established in the science fiction and expedition traditions.

Safety

Most of the statements assigned to the Safety category during Phase 2 were references to Caution and Warning events, nearly all of them false alarms in the Russian segment. However, several were real. To those of us on Earth, the threat of collision with a micro-meteoroid or space debris looms large, but fire is the biggest safety concern to those actually living and working on the ISS. A few examples of relevant journal statements follow.

Another smoke detector alarm today. I was exercising but made sure I checked out the situation. It is good training to react as if it is a real emergency.

False alarms - every day we expect to have some random warning at some point and it's just one of those things. I started a scoreboard in the lab of these false alarms.

We found out that we are Red for a possible conjunction tomorrow. The ground is getting everything thrown at them. It is a like a sim [simulation] nobody could have thought of doing (degraded power, MBSU install problems, 3A Channel, Solar Activity, and Conjunction). ["Conjunction" is a euphemism for COLLISION with a piece of space junk; this one was resolved without having to maneuver the ISS. Note how the astronaut's concern in the statement is for the stress on ground personnel caused by the problems, rather than on the threat to himself. This reaction reflects the kind of personality that is likely to perform well during emergencies.]

Leadership

Journal statements assigned to the Leadership category during Phases 1 and 2 were primarily descriptions of instrumental leadership and references to meetings and feedback to crew members provided by expedition commanders. Some of the statements were written by leaders and others were written about leaders. The content and tone of the statements suggest that expedition commanders were conscientious and that their efforts were appreciated on the ground and by crewmates. Examples follow.

Made conscious effort to get everyone together for dinner in Node 1 today. Glad we did.

I don't think the crew morale and mutual respect could be any better. I am very satisfied that I'm able to help and do my part as commander to run a happy and satisfied ship. All is in good order.

X is a master of good natured fun. I think when he leaves we will see a shift in the enjoyment of the people working the ground jobs. He is brilliant at knowing the perfect balance of fun with professionalism. I am in awe constantly. My love of joking around is immense but I am a mere child next to the talents of my commander. He is gifted.

[Micromanaging] doesn't work with astronaut crews; ISS crews are older and more experienced. They have specific desires and personal goals for their mission, which they know may be the last time they are ever in space. And, they may have a town, a city, state, or even a nation following them. An ISS commander must take this into account, and decide what battles are worth fighting.

Waste Management

Journal statements assigned to the Waste Management category concerned waste-related equipment, trash, and human waste issues. Two examples follow.

Our WC is going down. It started last night. We worked on it into the sleep period and got it working; but this morning it failed again, got it working, it failed again. So they are having a meeting on the ground now. Hopefully, they will come up with a solution. Right now we have to use the Russian [facility], which is kind of a pain. I feel a little uncomfortable. It's like going to your neighbor's house and asking to use the bathroom. I would feel more comfortable if we had our own working.

I am starting to notice all the things we will need to improve if we ever truly want to go to Mars. We throw away SO much packaging. Especially food. It shocks me how much waste we produce on a daily basis.

Habitat Hygiene

Journal statements assigned to the Habitat Hygiene category described routine Saturday morning cleaning tasks and other, less-frequently performed housekeeping chores. Examples:

Let me say it was a mess. It is amazing the amount of dust that can accumulate. It is now very easy to see why people were having congestion problems.

Smells are the most interesting. Node1 is getting a bit ripe and X has no notice of it. I'm guessing it is from wet trash so I'll see if it goes away when we change the bag later.

One note about future vehicle design: make it easier to clean. I find it comical that we have to remove floor panels using wrenches to get to air return ducting with the vacuum. We also have to vacuum air inlet grids that look like waffles... you must stick the vacuum into each individual square. Talk about inefficient.

Personal Hygiene

Statements assigned to the Personal Hygiene category should be read by anyone contemplating volunteering for a three-year expedition to Mars. A few of the least-gross examples are reproduced, below.

It amazes me that 150ml of hot water on a "hygiene towel" can bring me such joy and satisfaction. We get one every other day. Hygiene towel days, as we call them, are very nice days!

Two weeks here and just now beginning to sense that I smell bad. Or maybe it's me and my crewmates. But on weekends we can throw away some old clothes, scrub ourselves down well after the workouts, and put on brand new clothes.

The only noticeable hygiene issue is gym clothes that can only be changed out every two weeks if we stay within the consumable allowable usage rate. I have not noticed any bad smells from fellow crewmembers, only from myself after a week's worth of workouts using the same shirt and shorts.

One doesn't get as dirty in space. There's no external dirt to get on you – the only grime that accumulates is your own skin mixed with body oils. That rubs off with a good scrubbing. Hair shampooing is not quite as good with the rinse less shampoo – hair gets "crunchy" after several uses, and you have to give your head a scrub with just water after a while. For males, haircuts make that whole issue go away.

Passing gas. No one ever warned me about the frequency and often times awful smell of gas up here. If you are someone who is bothered by that, you are going to be in for a tough time [in a space craft]. I suppose due to the floating nature of everything inside, passing gas is about a constant occurrence. Just wanted to mention that. Humans are pretty stinky creatures when there is no shower and normal sanitary means.



William Clark Writing in His Journal at Eagle Creek, 31 May 1805, by Gary R. Lucy.



The *Fram* in the Ice, by William Gilkerson

Fridtjof Nansen reclined in his snug cabin onboard the *Fram* reading an account of Elisha Kent Kane's disastrous expedition in search of Sir John Franklin in 1852. The temperature outside was -36 degrees F (-38 degrees C) and the sturdy ship and polar icecap on which it was cradled were shrouded in the perpetual darkness of the Arctic winter. The *Fram* had been locked in the ice for six months, but Nansen and the other 13 members of the Norwegian Polar Expedition were enjoying the experience and feeling guilty about their comfortable conditions while loved ones worried about them at home. Nansen reached for his journal and wrote:

Thursday 28 December 1893

*I am almost ashamed of the life we lead, with none of those darkly painted sufferings of the long winter night which are indispensable to a properly exciting Arctic expedition. We shall have nothing to write about when we get home. I may say the same of my comrades as I have said for myself; they all look healthy, fat, in good condition; none of the traditional pale, hollow faces; no low spirits—any one hearing the laughter that goes on in the saloon, the fall of greasy cards, etc., would be in no doubt of this. But how, indeed, should there be any illness? With the best of food of every kind, as much of it as we want, and constant variety, so that even the most fastidious cannot tire of it, good shelter, good clothing, good ventilation, exercise in the open air *ad libitum*, no over-exertion in the way of work, instructive and amusing books of every kind, relaxation in the shape of cards, chess, dominoes, halma, music, and story-telling—how should anyone be ill? Every now and then I hear remarks expressive of perfect satisfaction with the life.¹³*

¹³ Nansen, Fridtjof. *Farthest North*. Volume 1, New York: Harper & Brothers, 1897 (pages 354-356).

NET POSITIVITY/NEGATIVITY

It was described previously that each parsed journal statement was assigned a code to indicate whether the statement was positive, negative, or neutral in its tone or content and that a metric called Net Positivity/Negativity (NPN) was derived by subtracting the proportion of negative entries from the proportion of positive entries.¹⁴ This metric was calculated for all category assignments by quarter for each expedition. NPN analyses were performed by journal with data from all categories combined and by journal focusing exclusively on statements assigned to the Adjustment category. The results of these analyses are presented in four sets of figures in the following pages; Phase 1 and Phase 2 figures for all categories combined are presented first, followed by Phase 1 and Phase 2 figures for statements assigned to the Adjustment category. All figures use a -1.0 to +1.0 scale to facilitate comparisons.

NPN analyses were conducted to test hypotheses concerning a “third quarter phenomenon,” a decline in affect, general attitude, or “morale” during the third quarters of missions, regardless of duration. The third quarter phenomenon was suggested by anecdotal accounts and evidence from previous content analyses of expedition journals. Analyses also were performed by dividing the journals into six chronological segments (the rough equivalents of months), but no patterns of NPN were evident. More information about the third quarter phenomenon is presented in Appendix D.

NPN BY JOURNAL: ALL CATEGORIES COMBINED

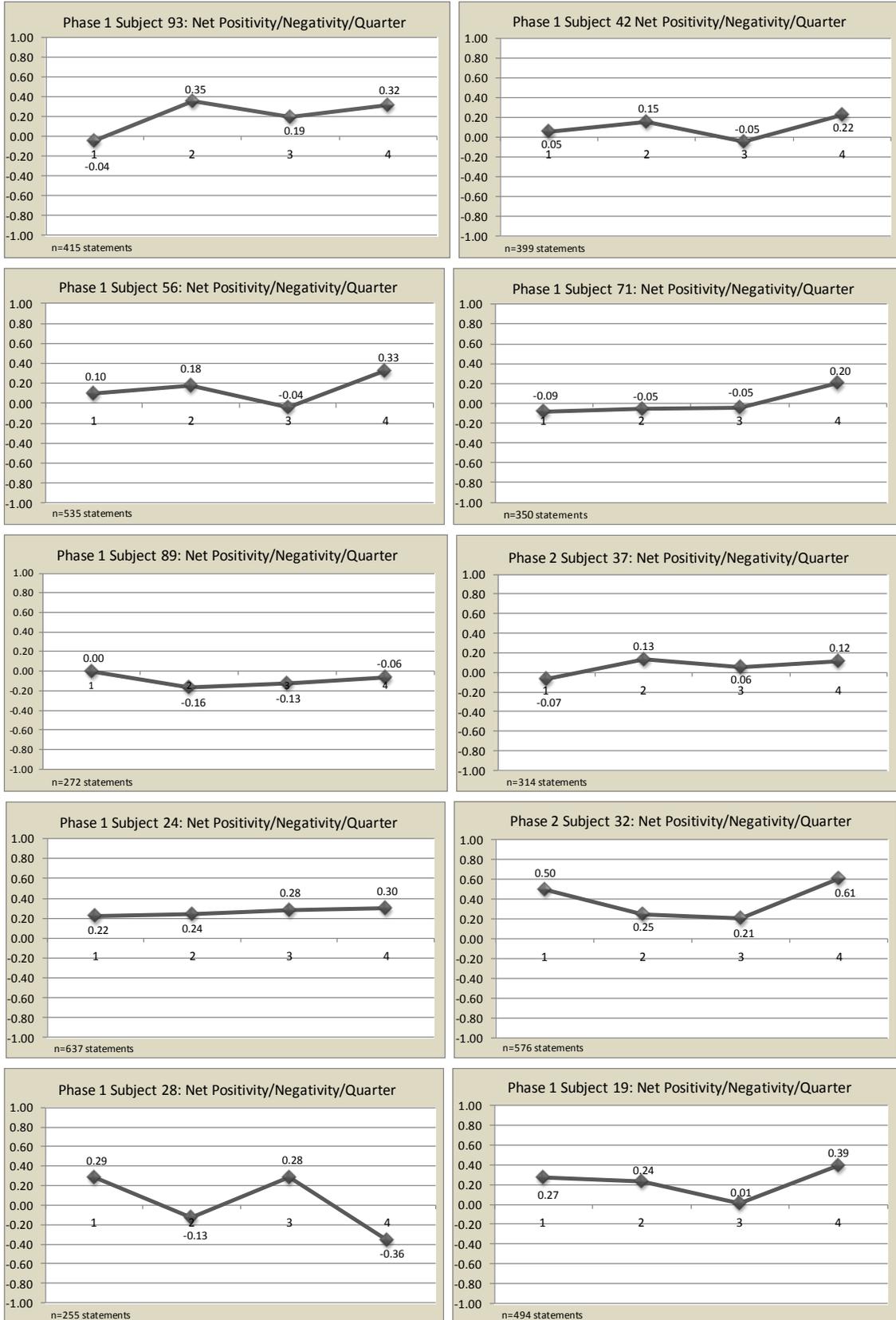
The first set consists of 10 figures, one for each of the Phase 1 journals (tan backgrounds); the figures illustrate NPN by quarter for all of the categories combined during the period of two- and three-person crews. The second set of 10 figures (blue backgrounds) present the NPN calculations for each of the Phase 2 astronauts, who were members of six-person crews. Subjects were assigned number codes using a random number generator and the order of the expeditions has been scrambled to prevent identification of study participants. Six of the 10 Phase 1 figures and eight of the Phase 2 figures show declines in average NPN during the third quarters of the expeditions (i.e., 14 out of 20 for all categories combined).

NPN BY JOURNAL: ADJUSTMENT ENTRIES ONLY

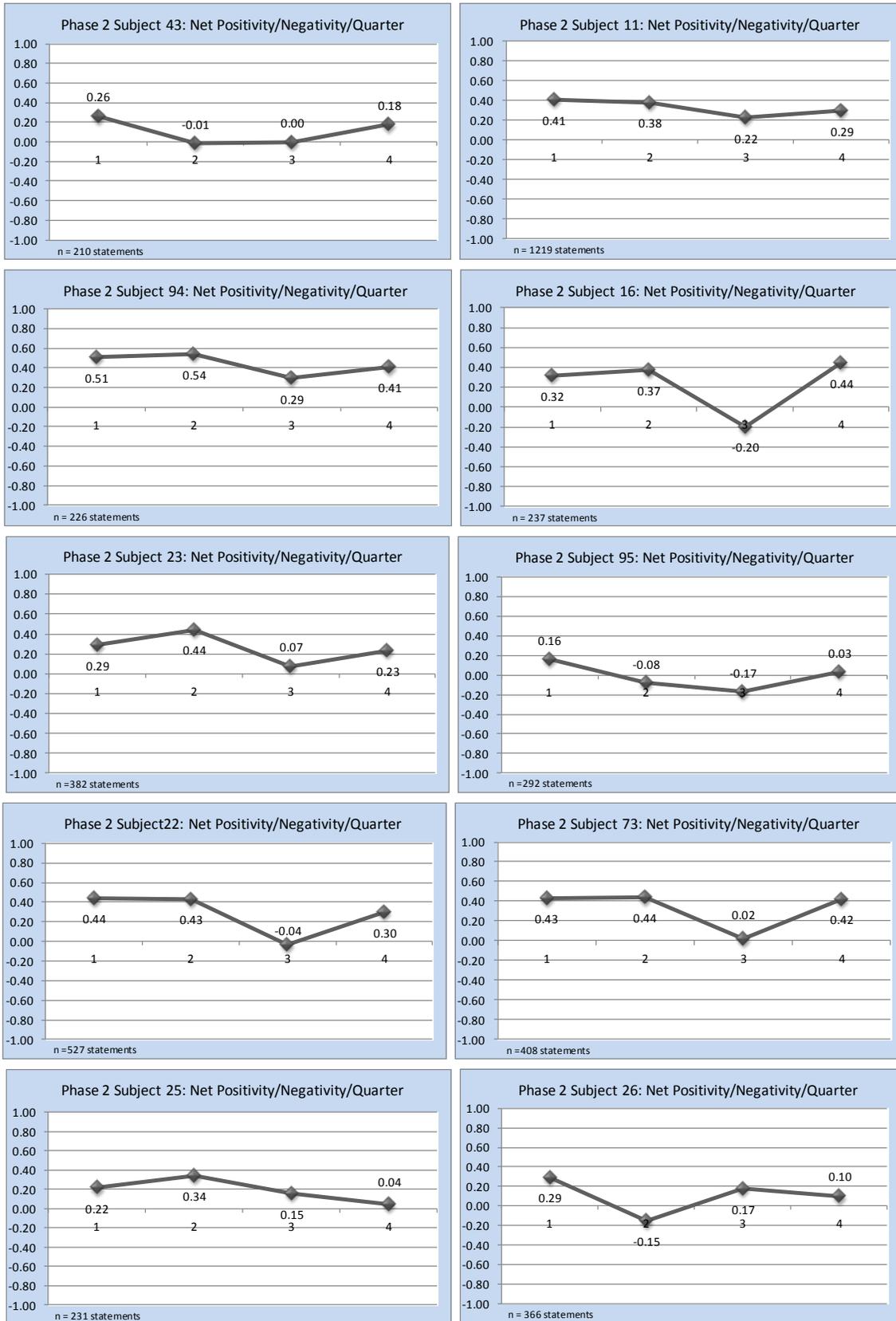
The third set (tan backgrounds) also consists of 10 figures, one for each of the Phase 1 journals, but illustrates NPN by quarter for the statements assigned to the Adjustment category only. The fourth set of 10 figures (blue backgrounds) presents the NPN calculations for the statements assigned to the Adjustment category in Phase 2 journals. This analysis focuses exclusively on statements concerning adjustment to life onboard the ISS and was performed because the Adjustment category most-closely reflects what might be characterized as individual attitude or morale. Nine of the 10 Phase 1 figures and eight of the 10 Phase 2 figures show a decline in NPN during the third quarters of the expeditions on this measure (i.e., 17 out of 20 for adjustment statements only). The one exception during Phase 1 (Subject 71) exhibited the lowest individual NPN value of the study during the second quarter. It also is noteworthy that a third quarter decline in Adjustment NPN was found for Subject 24, whose combined measure of NPN showed a linear, positive progression and for Subject 28, whose combined NPN increased substantially during the third quarter and was the only one to decline during the fourth quarter. Also, of the two exceptions during Phase 2, Subject 43 had the highest NPN scores on Adjustment overall (e.g., 1.0 in the first and third quarters) and Subject 26 experienced inordinate difficulty during the second quarter, which is reflected by the corresponding NPN value.

¹⁴ Proportions were used in the NPN analyses to control for differences in the numbers of entries written by the astronauts (i.e., to give equal weight to each of the 20 journals).

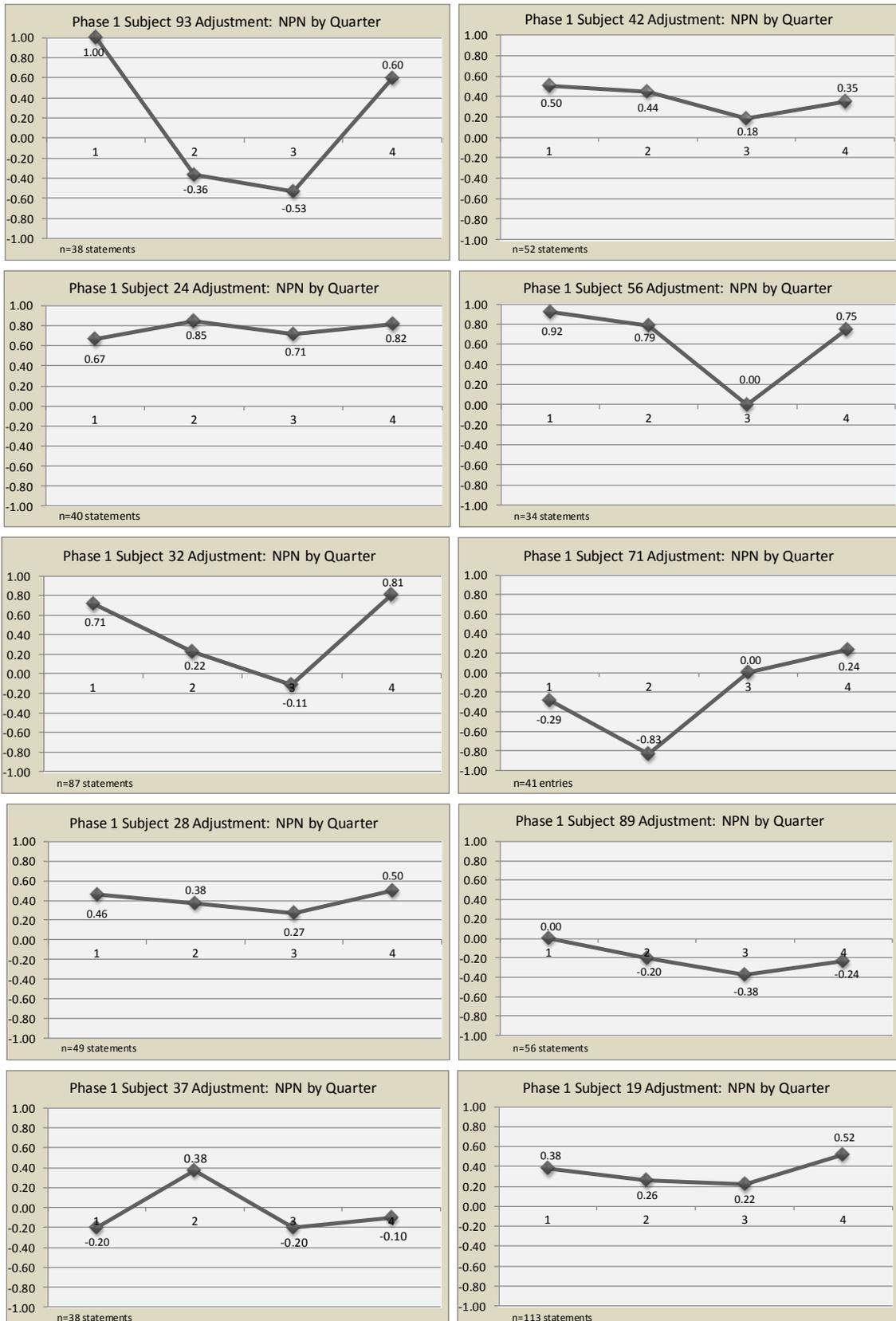
Phase 1 Net Positivity/Negativity by Quarter: All Categories Combined



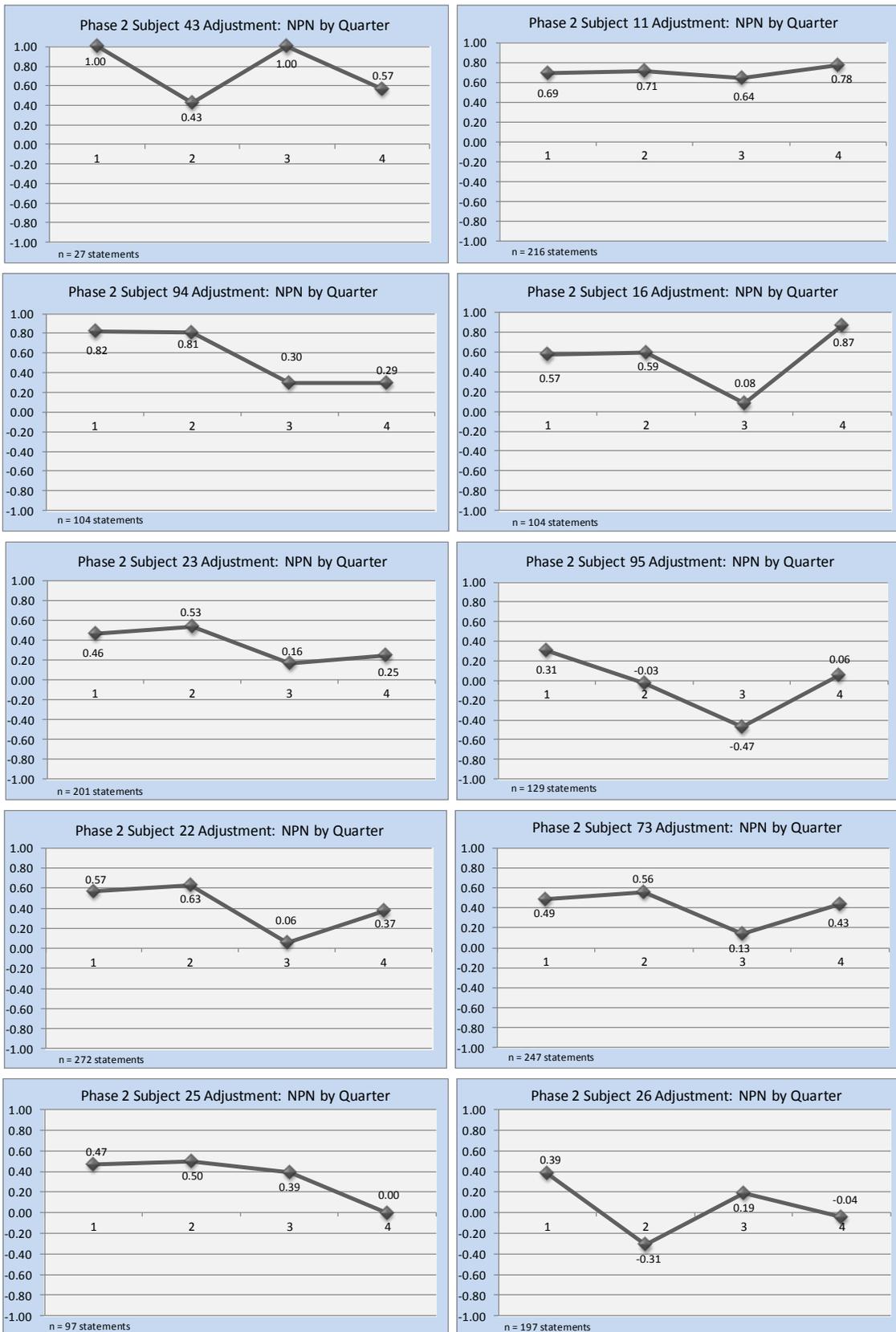
Phase 2 Net Positivity/Negativity by Quarter: All Categories Combined



Phase 1 Net Positivity/Negativity by Quarter for Each Journal: Adjustment Statements Only

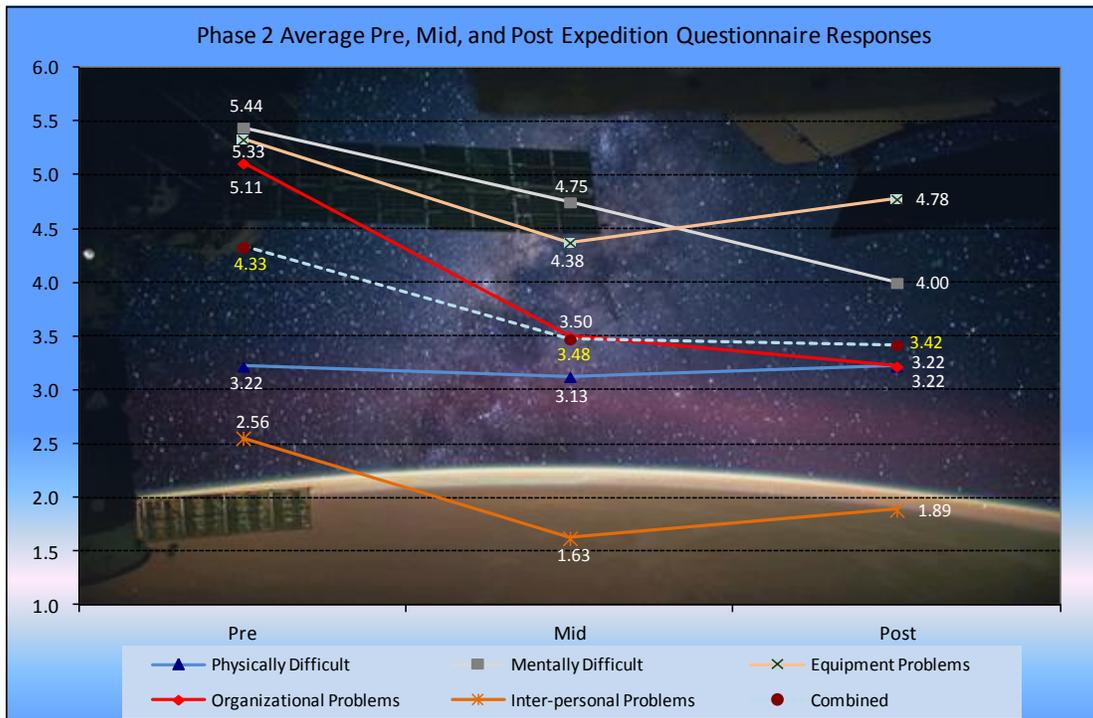
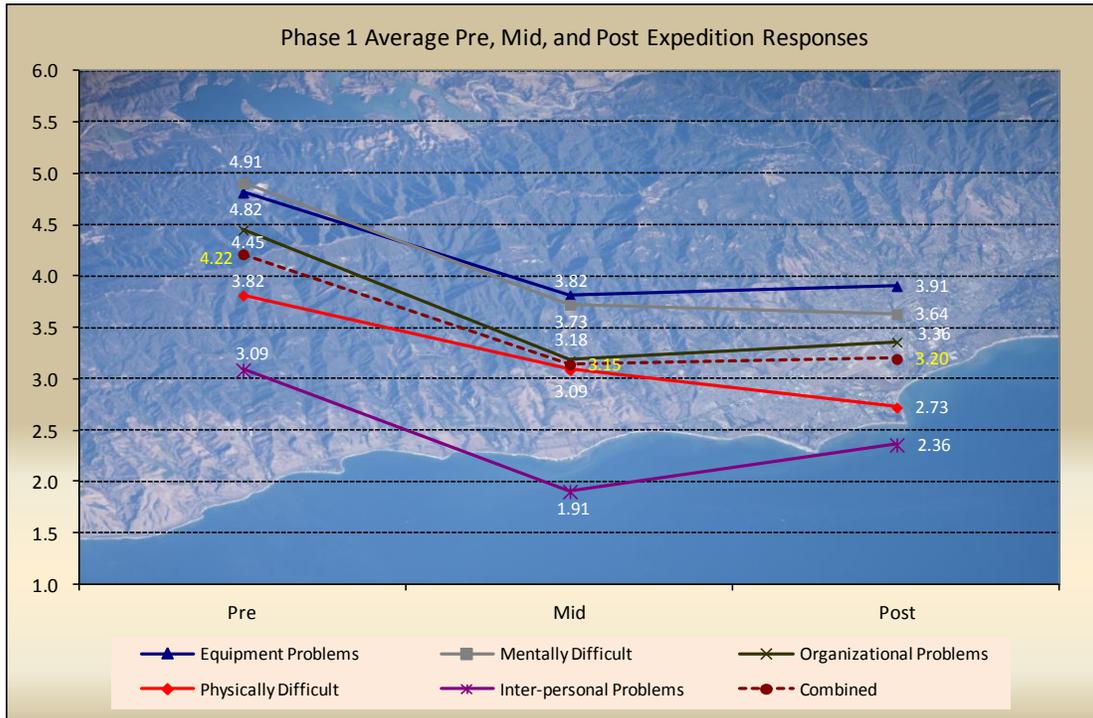


Phase 2 Net Positivity/Negativity by Quarter for Each Journal: Adjustment Statements Only



QUESTIONNAIRE RESULTS

Results of the five scaled questions on the pre-, mid-, and post-expedition questionnaires are presented in the following figures for Phases 1 and 2. All mid-mission values are substantially lower than pre-launch estimates during both phases. Estimates of physical and mental difficulty are lower still during the second halves of Phase 1, while interpersonal problems increase. Equipment and interpersonal problems show an increase during the second halves of Phase 2 expeditions. Overall, fewer problems were experienced than astronauts expected would occur.



IMPLICATIONS

At the time of this writing, 222 people have been onboard the International Space Station since the first components were delivered to orbit in 1998, which is nearly half of all people who have made it to low Earth orbit, or beyond; 47 Americans, 37 Russians, 10 Europeans, 5 Japanese, and 2 Canadians have served as crew during 45 ISS “increments” since Bill Shepherd rang a ship’s bell to commence Expedition 1 in October 2000. Several astronauts and cosmonauts have returned for a second tour of duty. Cosmonaut, Gennady Padalka, has served as crew on four ISS expeditions, which combined with a previous mission to the Russian *Mir* station amounts to the current record of 879 days in space.¹⁵ And, one American and one Russian recently returned from nearly a full year on the ISS.

I was referring to the current period when I wrote in a 1984 report that astronauts would perform admirably even under extremely austere conditions if they were among the first crews of a space station or interplanetary craft; however, our research and development efforts should be directed toward the design of equipment and procedures that are not only tolerable, but conducive to work during *routine* operations.¹⁶ Our word “routine” is derived from the French for a customary path. Life onboard the ISS has become routine and low Earth orbit a well-traveled highway during the station’s first fifteen years of operation.

It is clear from the journal entries analyzed during the current study that conditions onboard the ISS are far better than tolerable, but short of what is necessary to support optimum human performance for sustained periods of routine operations. Crews have performed admirably, as expected, and the journals contain many positive statements about living and working in space. However, the tone and content of some entries describe serious problems and convey levels of frustration and annoyance that could increase now that ISS operations have become routine.

The most salient implications of study results are presented below in sections devoted to the category, subcategory, and Net Positivity/Negativity analyses, followed by a discussion of questionnaire results; discussions compare Phase 1 and Phase 2 results, where relevant. The report concludes with recommendations and a final note.

IMPLICATIONS OF THE CATEGORY ANALYSIS

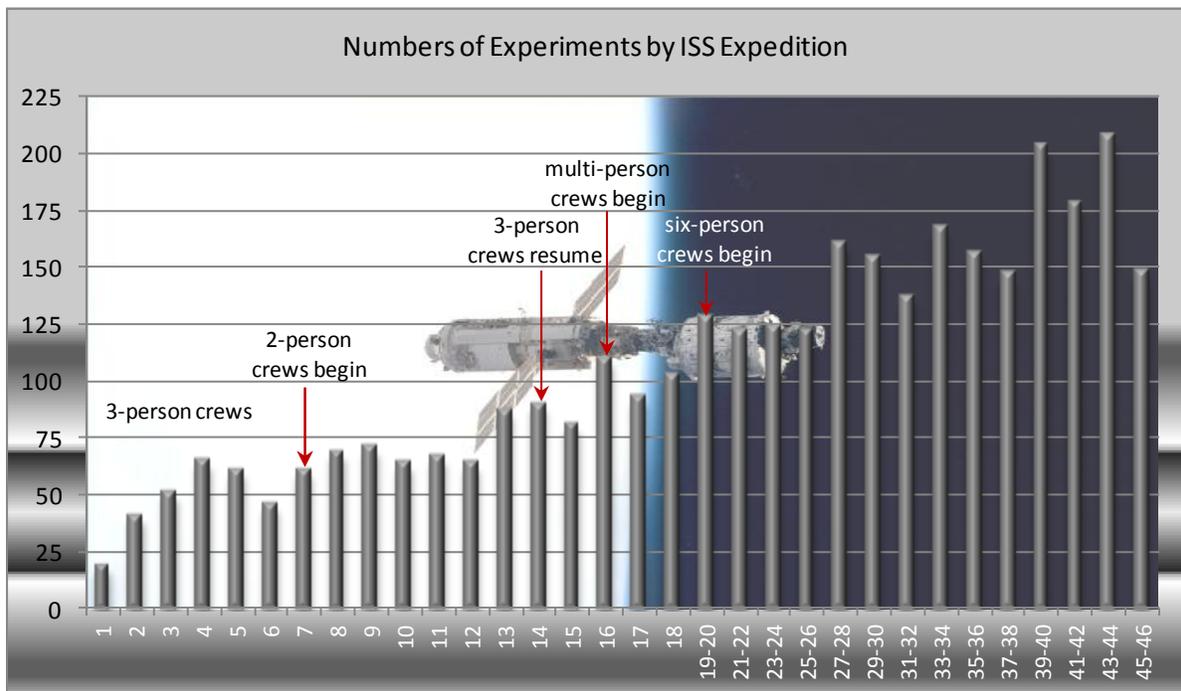
The top four behavioral categories during Phase 1, Work, Outside Communications, Adjustment, and Group Interaction, received 59% of all primary, secondary, and tertiary category assignments of journal statements. Adding Recreation/Leisure, Equipment, Event, Organization/Management, Sleep, and Food to form a list of the top ten categories accounts for 88% of all category assignments. Nine of the top ten Phase 1 categories were in the top ten during Phase 2, with only a slightly different order: Adjustment, Work, Outside Communications, Group Interaction, Equipment, Recreation/Leisure, Food, Event, and Organization/Management; Exercise replaced Sleep during Phase 2. The top four categories accounted for 61% of all statements during Phase 2 and the top ten accounted for 86% of the total. The remaining 14 categories of behavioral issues are relatively unimportant, according to the assumptions of the study described in the Introduction to this report. Some of the issues that have been considered by behavioral scientists to be very important received too few category assignments to be included in the presentation of results, such as Internal Communications, Habitat Aesthetics, and Privacy/Personal Space. Each of these categories has been the subject of study and passionate debate, but combined they represent less than 1% of all journal statements in the database from Phases 1 and 2. Why might this be?

¹⁵ https://en.wikipedia.org/wiki/List_of_International_Space_Station_visitors (accessed on 10 March 2016).

¹⁶ Stuster, J. *Space Station Habitability Recommendations Based on a Systematic Comparative Analysis of Analogous Conditions*, Moffett Field, CA: Ames Research Center. NASA Contractor Report No. 3943, 1986 (originally published as an Anacapa Sciences, Inc., Technical Report in December 1984).

It is possible that these issues were addressed sufficiently by design of equipment and procedures to mitigate legitimate concerns, but it is equally likely that key factors have not yet conspired to elevate their importance. No one would deny the criticality of maintaining the proper mixture of gasses in the ISS to sustain human life, even though out-gassing and leaks were mentioned infrequently by astronauts in their journals. The relatively few references mean that the life support system has functioned reasonably well, not that it is unimportant. The same probably is true for some of the infrequently mentioned behavioral issues. However, component failure, human error, or other perturbations could alter the balance and promote a previously low-priority issue to critical status. For example, the emergence of social media during Phase 2 of the study is responsible for a sharp increase in the number of statements reflecting a Lack of Teamwork, as some crew members were not available to assist others due to social media activities, and at the same time were perceived as receiving disproportionate personal credit for the accomplishments of the crew as a whole. Management's criticism of astronauts' efforts to generate awareness of the ISS through social media also is responsible for the deepest drops in individual morale experienced during Phase 2 (i.e., encouraging astronauts to participate and then criticizing the products of their efforts).

Even changes implemented to improve conditions could have unintended, negative consequences. For example, the shifts to three-person crews with Expedition 14, to multi-person crews with Expedition 16, and to permanent six-person crews with Expedition 20 have permitted greater distribution of the tedious inventories and logistics tasks that seemed to dominate crew time during earlier increments. Larger crews also have resulted in greater science productivity, as illustrated by the following figure.¹⁷ However, the doubling of crew size inevitably has had a cascading series of unintended effects, such as increased competition for exercise equipment, greater wear and tear on facilities, and more opportunities for interpersonal conflict, to name a few.



¹⁷ Source: http://www.nasa.gov/mission_pages/station/research/experiments/experiments_by_expedition.html#1 (accessed and counted manually on 4 November 2015). Note: The image depicts the ISS in February, 1999 prior to permanent occupation; a copy of the photograph hangs in the current author's office.

All ten Phase 1 subjects participated in the study prior to the advent of permanent six-person crews; when bedtime came, they would attach sleeping bags to bulkheads, but did not experience crowding and only complained of privacy issues when shuttle crews visited temporarily. The ten Phase 1 astronaut journals contained only 36 entries concerning privacy and personal space—too few to even justify inclusion in the subcategory analysis. If privacy and territoriality are important to remote duty crews, as evidenced by anecdotal accounts from the expedition literature, why were these issues ranked so low in the (previous) French Diaries and Phase 1 Journals studies? The leaders and physicians at the French research stations were the only members of their expeditions to have private quarters, to which they retreated frequently for respite from the stations' crowded conditions. Similarly, most of the Phase 1 astronauts' statements on this topic described having entire modules of the station to themselves for working and sleeping. Privacy/Personal Space was a non-issue for the participants in the French Diaries study and for the members of two- and three-person ISS crews, but that is rare in isolation and confinement, and was predicted to change with the increase to permanent six-person crews. However, Phase 2 astronaut journals contained even fewer statements assigned to the Privacy/Personal space category than Phase 1 journals.

The effects of crew size on privacy and personal space cannot be definitively evaluated with journals data, because the ISS continued to grow as crew size increased. Harmony (Node 2) was installed in November 2007, near the end of Phase 1 (adding 2,666 cubic feet, or 75.5m³ to the station); Columbus, the European Space Agency's science laboratory, was installed in February 2008; the Japanese Experiment Module (JEM) was installed in June 2008; Tranquility and the Cupola were installed in February 2010; and, the Leonardo Permanent Multipurpose Module (PMM) was installed in March 2011. Each new module increased the volume of the station and offered opportunities for crew members to seek relief from constant proximity to other personnel. However, it was probably the installation of four private quarters in the Harmony module that had the biggest effect on eliminating privacy and personal space as an issue onboard the ISS. Two private sleeping quarters were installed in November 2008 and two more in September 2009; each is approximately the size of an old-fashioned telephone booth, which was precisely the recommendation of the 1984 space station analog study, cited previously (i.e., 84 cubic feet, or 2.4m³).



Crew quarters in Harmony.



One of two crew quarters located in the *Zvezda* module.



Four private crew quarters in the Harmony module.

IMPLICATIONS OF THE SUBCATEGORY ANALYSIS

Twenty astronauts wrote more than 8,200 separate journal statements, which were assigned to 24 major categories of issues with behavioral implications; 14 of those categories received sufficient numbers of assignments to be included in the subcategory analysis, which further divided the entries into more than 100 “themes” or subcategories based on similarity of topic according to the established coding procedures. Many examples of journal statements that address the subcategories were included in this Phase 2 report and in the previous Phase 1 report to illustrate results of the analysis. More excerpts from the journals were included in both the Phase 1 and the current Phase 2 reports than originally intended because the astronauts wrote eloquently and candidly about their experiences and observations, and their own words are far more credible and informative than an investigator’s summary.

The primary implications of the subcategory analysis are presented below and additional implications are discussed among the recommendations based on study results, which appear later in this report.

Schedules and Time-Related Stress

The main theme to emerge from the subcategory analysis concerns the pressure of work schedules on crew personnel, which is caused largely by unrealistic time estimates made by the mission planners who prepare the timelines that schedule nearly every minute that an astronaut spends on the ISS. This was the leading concern during Phase 1 and again during Phase 2 of the study, despite efforts to improve the accuracy of scheduling estimates. Many jobs create time-related stress for the incumbents, from assembly-line workers to corporate and government engineers, scientists, and managers. Stress of this type is tolerable when experienced occasionally, but it can quickly become dangerously intolerable when a job involves a relentless stream of scheduled deadlines with insufficient time allotted to perform the tasks. The usual consequences of this condition are fatigue, low morale, interpersonal problems, and a propensity for error. The crew of *Skylab 4* also experienced time-related stress during their 84-days in space in 1973, as described by mission commander, Gerald Carr:

Everything was done sequentially on a very tight schedule. We were all so success-oriented and job-oriented that “following the carrot” got us in trouble, because if you make a mistake it is hard to go back and do the task over again. If you do, you get farther behind, the work keeps piling up, and you finish the day frustrated because you didn’t accomplish all that had been scheduled. There is going to be a morale effect because of all that pressure and the fact that you are not doing what you set out to do. There was no slack in the schedule; it only made the situation worse.¹⁸

Every tenth day was supposed to be a day of rest for the *Skylab* crew, but they sacrificed their first three days off in an attempt to catch up to the schedule. When mission controllers suggested that they work through their fourth assigned rest day, Colonel Carr’s response was, “No, we had better not work today; we had better get some rest.” The crew took their scheduled day off, which was widely and incorrectly described as a mutiny in space. It was, in fact, a triumph of reason and leadership over unrealistic scheduling demands. NASA learned about the importance of providing off-duty time for crew from this incident, which also led to removing all tasks from the schedule that were not dependent on the station’s orbit and placing them on a “task list.” Despite these lessons and decades of subsequent space operations experience, the agency persists in scheduling insufficient time for the performance of many tasks. The following entries from the Journals database echo the *Skylab 4* commander’s words.

¹⁸ Carr, G. Untitled presentation. In, Behavioral Issues Associated with Isolation and Confinement: A Panel Discussion Conducted at the Tenth Psychology in the DoD Symposium, J. Stuster, chair and editor. US Air Force Academy, Colorado Springs, CO, 17 April 1986.

The most significant stress factor so far is that everything on the schedule takes longer than planned. So I'm always behind. There are all kinds of reasons ranging from my own speed to not finding something where it is supposed to be. But the bottom line is that running behind schedule all day is stressful.

We are, by nature and by training, performance and goal-oriented. We tend to feel bad about ourselves if we do not complete the plan. I am aware of this and have consciously tried to get perspective on this and not feel that I must complete all tasks and in the given time. However, I think there is an underlying frustration that builds when I do not complete everything on time.

Time pressure also contributed to interpersonal problems during Phase 2 that were unknown during the Phase 1 expeditions. In particular, astronauts during Phase 2 complained of occasions in which they solicited the help of another astronaut, but failed to receive it promptly because the crew mate was engaged in a task and disinclined to break away. These occurrences were perceived by one party as a lack of teamwork, and by the other as impatience. The most serious rift among US crew mates during both phases of the study occurred when an astronaut requested help during Phase 2 that was not immediately forthcoming. A statement that describes an unrelated incident captures the essence of the problem, which is largely caused by the desire to perform tasks on time and without errors:

Working here is a bit like working in the ER. You must concentrate on what you're doing, but also be ready to take care of the next five or six things on your mental list once you're done. Plus there are numerous distractions. At times, if a crewmate starts talking to me while I'm working, I'll listen but won't look away from my work and [only] give one-word answers. I don't want to slow down (or lose focus).

Tedious and Frustrating Work / Procedure Problems

The shift to larger crews has provided opportunities for schedulers to distribute the tedious tasks. Sharing housekeeping chores and unpleasant work equally is a tradition of polar explorers and the practice, enabled by larger crew size during Phase 2, reduced the levels of frustration experienced by ISS crew during the earlier increments. The following journal entry illustrates the transition.

Teamwork can now suddenly be part of the approach to the entire day. This is a huge difference, which enables synergy that makes it possible to get more than twice the work done.

Only a portion of the astronauts' work-related criticism was directed at the tasks. Few Phase 1 astronauts derived the satisfaction they needed to remain motivated from counting light bulbs, underwear, or food containers; they complained about such tedious work, but recognized that certain menial tasks were necessary. No Phase 2 astronauts complained of having to perform inventories and all cheerfully incorporated housekeeping chores into their Saturday morning schedules, which further commends having more crew members to share the load. The majority of the journal statements that criticized work concerned the procedures that astronauts were directed to follow when performing the tasks. Adding people to the crew increases the station's capacity for work, but it also increases opportunities for ill-conceived and poorly-written procedures to annoy more crew. Several examples of Phase 2 procedure problems were included in the presentation of results and three more are provided below to suggest that all procedures receive thorough reviews periodically as part of an on-going quality control effort.

Sometimes, it's like we're being setup to fail by quirks in procedures or poorly written directions. I am frustrated that words used to describe items in procedures are not the same as the words on the equipment... We don't go back and review procedures to see how they may be updated to better serve the crew.

The challenge here is almost purely mental. Dealing with the frustration of difficult working positions, equipment floating away, stability, computer failures, bad procedures, disappointing outcomes wears on one after a while.

Trivial Issues Are Exaggerated

The exaggeration of trivial issues is a well-known principle of life in isolation and confinement. Minor annoyances, differences of opinion, and perceived transgressions that would be inconsequential under normal conditions can be magnified by isolated and confined personnel into issues of monumental importance. This tendency might even be greater for astronauts than for most remote duty personnel, because as a group astronauts are uniformly high achievers with high expectations for themselves and others. That is, the astronauts who participated in this study possess enormous capacities for work, but this trait often is accompanied by low tolerance for poor performance by others. The astronauts largely refrained from voicing their disappointments to the ground and to fellow crew members, but many journal statements expressed the sentiments illustrated by the following examples.

One of my frustrations up here is that we constantly have to redo work. For example, X changed a cable today that I had installed about a month ago. Why didn't the ground have me install the correct cable at that time?

I am not looking forward to this week. I will have more tedium, starting with the final battery search. If this battery is so important, why didn't the ground do their homework to begin with and have me separate it months ago when the items were gathered, rather than have me search through the trash now?

I think I need to get out of here. Living in close quarters with people over a long period of time, things that normally wouldn't bother you at all can bother you after a while. So, I think I should move on and do something different and not be stuck doing the same thing with the same folks. That can drive anybody crazy.

Astronauts and ground personnel realize the importance of maintaining pleasant relations and some probably are aware that isolation and confinement can influence behavior in predictable ways, such as the exaggeration of trivial issues. The pattern of "praise inflation," described in the previous Phase 1 report, appeared to be a response to this understanding. There was no evidence of the practice in the Phase 2 journals, which suggests a maturing of the relationship between ground and on-orbit personnel. Flight directors and controllers review events and talk among themselves in a continuous effort to improve their performance. And, ISS astronauts share their experiences and observations with their colleagues to help prepare new crews for living and working on the ISS. These are the mechanisms of institutional and cultural change that have contributed to gradual improvements in effectiveness reflected in astronaut journals during the dozen years in which the study has been conducted.

Phase 1 journals included many complaints about ground personnel that could not be expressed directly without jeopardizing essential relationships, but there was very little of that in the Phase 2 journals. Ground personnel and astronauts have learned from experience and developed mechanisms to adapt effectively to the special conditions of remote duty. The content of communication has improved with a corresponding decrease in the incidence of trivial issues being exaggerated. This evolution of the relationship is reflected in the following excerpts from astronaut journals.

This was the second time this mission that I've had to make the call that we're getting tired. I don't like having to do that, but everyone jumped right in to help us out. Got a bunch of gray space (free time) added [to the schedule] for the 3 USOS crew.

My rule is that, if you feel like saying something smart-alecky, wait one hour, and then if you still feel like saying it, go ahead!¹⁹

¹⁹ This is similar to Dr. Desmond Lugg's Rule of 10, which he taught to Australian Antarctic personnel: Whatever your initial inclination, divide it by ten before responding. My grandmother's favorite advice also applies here: "Choose your words carefully; the least said is the easiest mended."

Adjustment to the Conditions

Providing an appropriate habitat and meaningful work to a carefully-selected and well-trained crew can reduce the stress that accompanies life in isolation and confinement and thereby contribute to the likelihood of a successful mission.²⁰ However, it is not possible to eliminate all sources of stress or the possibility that conditions might change and allow previously-addressed problems to emerge. Stress is cumulative if not mitigated in some manner and individuals respond differently to chronically stressful conditions. Most develop constructive coping methods, such as exercise, devotion to work, engaging in a personally gratifying activity, or commiserating with a comrade. Others respond with poor sleep, physical problems, degraded task performance (errors, omissions), irritability, withdrawal from social contact, or more serious behavioral aberrations.²¹

The Adjustment category rose from third rank during Phase 1 to the most-frequently-assigned major category of behavioral issues during Phase 2 of the study. This slight change can be interpreted as further evidence for a maturing of all components of the ISS, as viewed from a systems perspective. That is, while Work remains a salient issue, astronauts now appear to be equally interested in the factors that contribute to successful adjustment to the physical and behavioral conditions of life on the ISS. The results of the subcategory analysis were reviewed to identify astronauts' explicit references to activities or factors that contributed to their successful adjustment. The review found the leading contributor to be what has been described in this report as "meaningful work," which includes extravehicular activity (i.e., EVA), science experiments, Earth photography, and construction/installation; study participants during Phases 1 and 2 also reported deriving satisfaction from completing almost any task within the allotted time. Additional contributors to personal adjustment identified by the review are: the IP phone (and email); Psychological Support activities (e.g., teleconferences with family, crew discretionary events); onboard celebrations (e.g., holidays, birthdays, milestones); meals and movie nights together; and personal projects (e.g., Earth photography, engagement with ground personnel). Also, nearly all study participants mentioned writing in their personal journals as an activity that helped them adjust to living and working on the ISS. For example, after writing one of the most negative entries of the entire study, a Phase 2 astronaut took the time to log in to a Station Support Computer and type:

Thanks journal. Venting complete. I feel much better now... It is funny. A bunch of hours later and I am completely over this issue. Not a care in the world about it. Glad I could vent to the journal and not via email, because that could be catastrophic to my career.



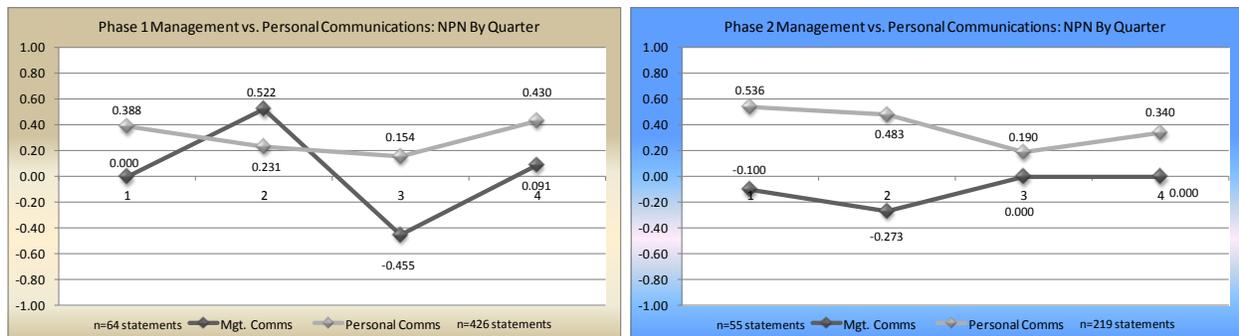
"The view fixes anything," according to a Phase 2 astronaut's journal.

²⁰ "Stress" is used in this context to refer to the effects of specific and general stressors to which ISS crew are exposed. These include microgravity, separation from friends and family, schedule pressure, personal and external expectations, and constrained choices, among others.

²¹ The examples of emergent psychosis among polar explorers represent the extreme of this response, but even less seriously disturbed individuals can threaten mission success.

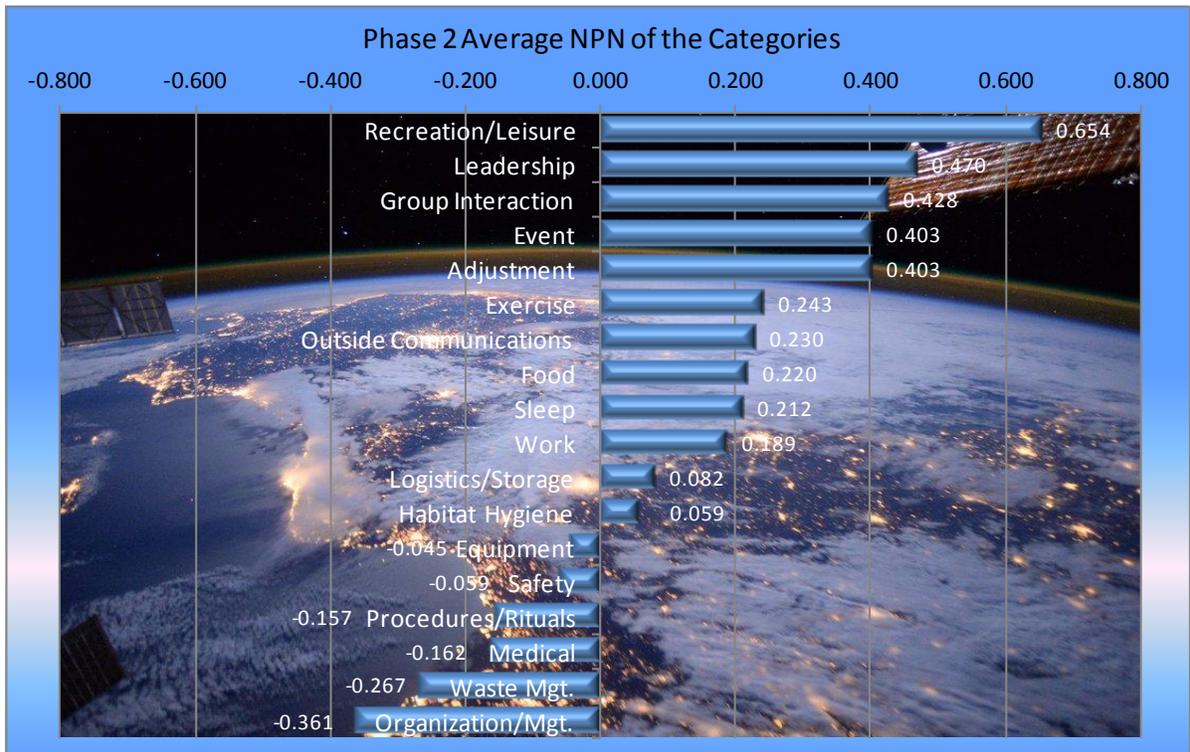
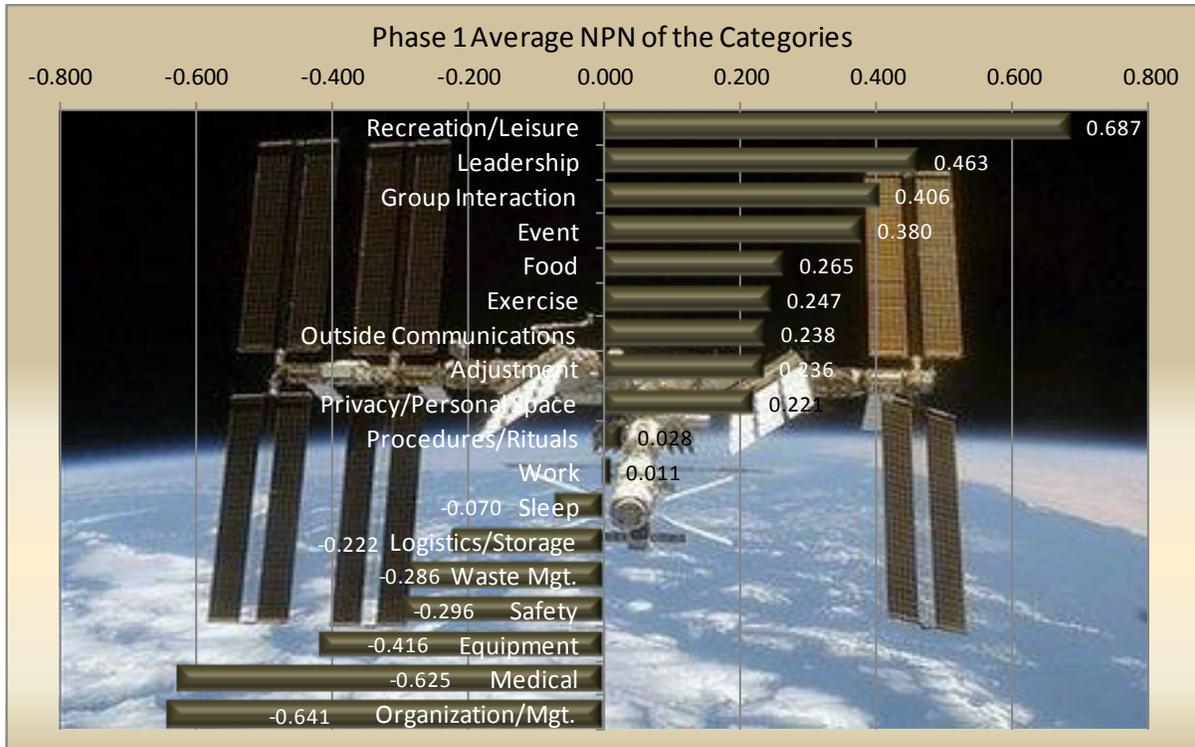
IMPLICATIONS OF THE NET POSITIVITY/NEGATIVITY ANALYSIS

The Net Positivity/Negativity analysis found evidence of a third quarter phenomenon in both Phase 1 and Phase 2 of the study. Six of the ten Phase 1 journals showed a decline during the third quarter in the combined measure and eight of the ten in statements assigned to the Adjustment category. Nine of the ten Phase 2 journals showed a decline during the third quarter in the combined measure and eight of the ten in statements assigned to the Adjustment category. That is, 14 out of 20 journals showed the effects of a third-quarter phenomenon when all 24 categories were combined and 17 out of 20 journals showed effects of a third-quarter phenomenon in Adjustment alone, the category that most closely reflects individual morale. A comparison of subcategories within the Outside Communications category showed that on average, statements concerning management and personal communications both declined during the third period in Phase 1, with the dip more pronounced for the management subcategory, but only statements concerning personal communications declined during the third quarter in Phase 2; management-related communications actually increased during the third quarter, on average, in larger Phase 2 crews. The results of these analyses are illustrated in the following figures.



An average measure of NPN was calculated for the top 18 major categories in Phase 1 and Phase 2. This analysis found journal statements concerning Recreation and Leisure to be the most positive in tone, and statements about Organization and Management to be the most negative during both phases of the study, as illustrated in the following figures. The figures also show that Adjustment increased in NPN (from 0.236 in Phase 1 to 0.403 in Phase 2), the 71% increase suggesting a general improvement in morale over time on the ISS. That change was accompanied by substantially increased NPN for Sleep statements (from -0.070 in Phase 1 to +0.212 in Phase 2), Logistics/Storage statements (from -0.222 in Phase 1 to +0.082 in Phase 2), Work statements (from 0.011 in Phase 1 to 0.189 in Phase 2), Organization and Management statements (from -0.641 in Phase 1 to -0.361 in Phase 2, but still was the most negative of the 18 categories), Medicine statements (from -0.625 in Phase 1 to -0.162 in Phase 2), and Privacy and Personal Space statements; Privacy and Personal Space did not even make it to the top 18 categories in terms of NPN during Phase 1, but was the ninth-highest ranked category during Phase 2, which is probably attributable to the installation of the four private crew quarters in the Harmony module at the conclusion of the Phase 1 expeditions.

The only category of journal statements to decline in average NPN was Procedures and Rituals (from +0.028 in Phase 1 to -0.157 in Phase 2). This change reflects increasing frustration with problematic procedures that are prepared to guide technical work on the ISS, combined with proportionately fewer occasions when the entire crew gathers to celebrate milestones and other events. An unexpected general decline in interaction between US and Russian crew members has accompanied the increases in crew size and station volume. This change is partially attributable to the increased size of the station, but also to management policies and other factors and events that are external to the station and the individuals involved (e.g., economic issues and news coverage of current events).



"They can't imagine what it's like and what we have to deal with every day to make things work. It's not their fault, but they can't see it from our perspective." - Astronaut Journal Excerpt

IMPLICATIONS OF THE QUESTIONNAIRE RESULTS

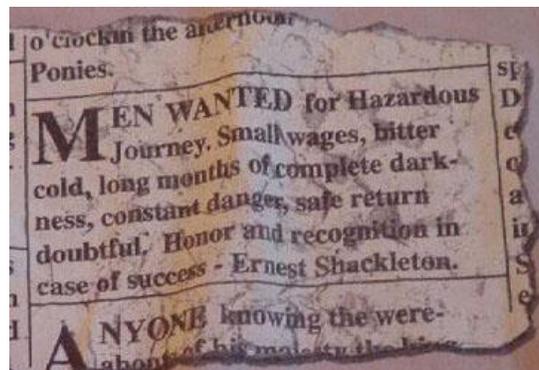
The primary implication of the questionnaire results is that life onboard the ISS is not as difficult as the astronauts expect it will be prior to launch. Overall, mid-expedition responses to the five scaled questions were 24% lower than the pre-launch values during Phase 1 and post-expedition responses were 27% lower. Phase 2 mid-expedition responses were 20% lower than pre-launch estimates, and post mission responses were 21% lower. In other words, Phase 2 astronauts were slightly more accurate in their expectations than the Phase 1 participants, but still were pleasantly surprised to find the experience of living and working on the ISS for many months to be less arduous than expected.

Astronauts showed a similar pattern during Phase 1 and Phase 2 in their estimates of equipment problems, with average values dropping 17% at the mid-points of Phase 1 expeditions and 18% at the mid-points during Phase 2. Phase 1 post-expedition values remained 17% lower than pre-launch expectations, while the value increased to only 10% below pre-launch estimates during Phase 2. There were many malfunctions of exercise equipment and the waste management system during the second halves of Phase 2 expeditions, which must be expected with a doubling of crew size.

Astronauts' average estimate of organization/management problems during Phase 1 declined by 26% at the mid-points and by 23% at the ends of expeditions, compared to pre-launch values. Phase 2 astronauts' average estimates on this measure declined by 32% and 37%, respectively. The difference between the averages indicates that Phase 2 astronauts continued to expect agency management to cause problems for them while onboard the ISS, but those expectations were only partially met, compared to Phase 1. Both phases of the study were punctuated by disputes between agency managers and on-orbit personnel, but these data suggest that managers are learning to avoid causing organizational problems for ISS crew, despite some of the examples mentioned previously and others that have not been included in this report.

The physical demands appeared to be progressively easier for the Phase 1 astronauts to handle as they gradually adapted to the conditions, with post-expedition responses 30% lower than pre-launch expectations. Phase 2 astronauts showed no drop on this scale, which is probably attributable to muscle strains from using the ARED and persistent complaints about the effects of high CO₂ levels.

Phase 1 and Phase 2 astronauts showed similar patterns in their estimates of mental difficulty, with the Phase 1 average declining 29% and Phase 2 declining 27% from pre-launch to post-expedition. Also, astronauts' pattern of average responses on the interpersonal problem scale was almost identical during Phase 1 and Phase 2, with estimates declining 37% and 36%, respectively at the mid-points of expeditions and 25% and 26% at the ends of the expeditions. It is important to note that the astronauts' estimates of interpersonal problems were the lowest of the five measures.



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The questionnaires also asked astronauts what they anticipate will be the most difficult and the most enjoyable aspects of their ISS expeditions on the pre-mission form, and what actually were the most difficult and enjoyable aspects on the mid- and post-mission forms. Responses varied immensely, but the following paragraphs summarize the data.

- Nine astronauts listed adapting to the social and physical conditions on the ISS as the most difficult aspect expected, but only three astronauts reported it to actually be the most difficult aspect. All three described the problem as difficulty remaining patient in their relations with ground personnel.
- Six astronauts listed separation from family as the most difficult aspect expected, but only one reported it as actually the most difficult aspect (another reported dealing with stress in the family as the most difficult aspect). Weekly family teleconferences and nearly unlimited access to the IP phone allow astronauts to remain in contact as much as they wish, a luxury of low-Earth orbit that will not be possible for planetary explorers.
- Five astronauts listed handling the work on the ISS as the most difficult aspect expected (e.g., high workloads, performing tasks without errors), and five astronauts reported that handling the work was, in fact, the most difficult aspect of life on the ISS.
- Four astronauts listed maintaining a high level of motivation as the most difficult aspect anticipated, but no astronaut reported it as an actual difficulty.
- Only one astronaut listed dealing with NASA management and Astronaut Office issues as the most difficult aspect expected, but four reported it to be actually the most difficult aspect of their expeditions.
- Twelve astronauts wrote that they expected the unique features of living and working in space to be the most enjoyable aspects (e.g., weightlessness, views of Earth), but only five listed these features as the most enjoyable aspect after the expeditions.
- Six astronauts wrote that they expected the satisfaction derived from successfully performing their work to be the most enjoyable aspect, and eight reported satisfaction from work as actually the most enjoyable aspect after their expeditions. These responses are not surprising based on the high ranking of Work in the category analysis.
- Three astronauts wrote that camaraderie and crew solidarity were expected to be the most enjoyable aspects, and five reported the pleasure of living and working with their crewmates were the most enjoyable aspect at the conclusions of their expeditions.
- Remaining focused while performing certain tasks, sleep-shifting, and maintaining physical fitness were reported as the most difficult aspects of missions by some astronauts, while communicating and having fun with ground personnel and working out on the exercise equipment were the most enjoyable aspects for others.



Astronauts' camaraderie illustrated by shaved heads in response to a World Cup outcome.

RECOMMENDATIONS

The 20 personal journals that are the subject of this study provide a detailed record of ten person-years of living and working in space. Many recommendations can be derived from the nearly 500,000 words composed by the astronauts about their experiences onboard the ISS. Those sufficiently interested in the topic to have read the Results section of this report probably have identified several actions that would improve adjustment to long-duration isolation and confinement. The following list presents only the most salient items to emerge from the analysis. Some of the recommendations are to improve ISS operations and would involve additional work by astronauts to implement or effort by ground control, mission planning, and/or management personnel. Recommendations also are offered for expeditions beyond low-Earth orbit, to asteroids, the moon, and Mars.

- Distribute tedious and housekeeping tasks as evenly as possible among the crew. This was the first recommendation of the previous journals report and appears to have been successfully implemented, enabled by the doubling of crew size.
- Do not allow agency lawyers to interfere with operations onboard space craft. The time for lawyers and other personnel who are uninformed about the issues associated with isolation and confinement to assert themselves into mission planning has passed long before launch. The most serious declines in crew behavioral health to occur during the 12 year study were caused by lawyers canceling previously-approved on-orbit activities.
- Design tasks to have tangible results, to the extent possible. For example, encourage astronauts and investigators to collaborate on biological and physical science experiments. This recommendation is derived from space analog and ISS experience and will be especially necessary during the transits of longer-duration, expedition-class missions, when days will blend one into another and become, "Just the same old stuff--Groundhog Day-ish kind of things..." in the words of a Phase 2 astronaut.²²
- Schedule sufficient time for the performance of all tasks. Include time to locate and assemble tools, materials, and procedures needed, and time to set-up, perform the task, and return all items to their previous locations. Allocate additional time in the schedule when in doubt of the requirements. Assign former ISS crew personnel to review schedules to ensure that sufficient time has been allocated to complete all task elements under operational conditions. Attempts have been made to improve the scheduling of tasks since the conclusion of Phase 1, but astronauts still report having to endure unrealistic expectations. It would be very simple to assign former ISS crew personnel on a rotational basis to review schedules.
- Note all errors (and deficiencies) in procedures as they are discovered during operations and correct the document within 24 hours if the procedure is expected to be used at any time in the future. This will avoid subjecting another astronaut, or the same one again, to the problem. Do not delay correcting procedures until it might be convenient to do so. Assign former crew personnel to review the modifications. This recommendation was included in the Phase 1 report and still requires implementation, despite efforts to improve the accuracy and clarity of procedures.²³

²² Attention to scheduling and task-design will be particularly important to maintaining crew behavioral health when time is no longer like a river running, but rather appears as a deep, still pool, to paraphrase the words of Admiral Richard Byrd describing his experiences at Advance Base, Antarctica, in 1934.

²³ A flight director explained that the process for changing a procedures is cumbersome and time-consuming. Institutional impediments to correcting and improving procedures must be removed.

- Assign former ISS crew personnel to review new procedures to ensure that the words used to describe items match the words used in ISS documentation and on labels.
- Allow ISS astronauts to control their individual schedules as much as possible.
- Encourage crew personnel to view the day's schedule as a task list, rather than a list of appointments that must be made.
- Involve crew personnel in discussions of all issues that might affect them, even relatively minor issues. Individuals may choose to decline, but it is important to ask.
- Schedule ISS crews to meet with the PAYCOM and MCC personnel with whom they later will be working as part of standard, pre-expedition preparations.
- Revive the Expedition Corps Training Program that was developed by the Astronaut Office in 1999 and include the two-day seminar in pre-expedition training. Add sessions about specific topics necessary for adapting to ISS conditions with the assistance of former ISS crew personnel and flight surgeons (e.g., how to obtain sufficient sleep, methods for expressing concerns, useful coping behaviors).
- Provide in-service training to MCC and PAYCOM personnel to increase understanding of the behavioral issues associated with isolation and confinement. This could be as brief as a two-hour session based on the Expedition Corps seminar, augmented by study results and recent operational experience.²⁴ Recently-conducted briefings of Journals study results for flight directors and controllers have been well-received.
- Enable the Psychological Support Office to expand delivery of the types of services already provided to ISS astronauts and their families, which are among the most important contributors to successful adjustment, according to the current study (e.g., crew discretionary events, family teleconferences, IP phone).
- Be especially careful about the food (to paraphrase Fridtjof Nansen's famous advice); that is, ensure individual requests are satisfied and that packages are labeled accurately. Include surprises in some containers in addition to the items indicated on a label; an unexpected treat contributes to morale among remote duty personnel when found (e.g., special food, extra tortillas, a note) and is a tradition of expedition outfitters.
- Include food items that can be assembled to create special meals to be shared by a crew to help celebrate holidays and other milestones; include lots of tortillas.
- Include plenty of energy bars to enable quick nourishment during high-tempo periods.
- Increase the variety of food items and ensure that all food is not produced by the same purveyor, which conveys a sameness "in taste and texture" that becomes annoying over time. An astronaut wrote: "We see too much of the same thing, which would be tedious if we didn't have our bonus food packs [and Russian items] to mix things up a bit."
- Increase the number of "healthy" food items and breakfast options, in particular. An astronaut wrote: "Fruit and yogurt are by far the highest desired/lowest supplied items. I am limited to <1 little pouch of fruit a day. Seriously? I'd eat 10 if we had the supplies. If I were to do this again, I wouldn't put an ounce of meat in my bonus food. I would fill it to the brim with granola, fruit, and yogurt."

²⁴ This recommendation was suggested by a highly-experienced payload communicator.

- Maintain sufficient backup supplies to ensure that normal quantities of food and other consumable items are available during contingency operations (i.e., eight months without the possibility of resupply). Distribute storage to avoid loss of all food in a single event.
- Consider packing food types together in a modular manner that eliminates the need to unpack from transport storage to restock onboard ISS storage (i.e., "ready to go BOBs"). The BOB could be the pantry mechanism, which would save approximately 20 minutes for each item restocking requirement and reduce the "hassle of different food groups floating all over Node 1."
- Expect third quarters of expeditions to be especially difficult for remote duty personnel. Schedule more crew discretionary events (CDEs) and meaningful or novel tasks during these periods.²⁵
- Space craft designed for long duration expeditions beyond low-Earth orbit must be equipped with optical and/or video telescopes to enable viewing of Earth and the destination. Space craft also must include facilities for continuous training and meaningful operations during transit periods to maintain crew behavioral health.
- Encourage personnel to credit all photographs and other products distributed on Earth to the entire crew, rather than to an individual member.
- Ensure large supplies of standard duct tape and other materials are available on ISS and planetary missions to fabricate technical solutions to problems under both routine and contingency circumstances. Also, it is time to consider an alternative to Kapton tape, according to some ISS journals.
- Develop a portable tool belt/material holder that can be used to gather needed items and then hang at a worksite on the ISS (or future space craft) to facilitate task performance. In the words of a Phase 2 astronaut: "It's key to have everything with you that you need at a worksite and a huge overhead to leave the worksite to retrieve something, since you need your hands to travel and yet you can't put anything down. You have to figure out a restraint method for every item before you can get going."
- Develop methods to increase the reliability of software used on the ISS and future space craft. Descriptions of software problems can be found in most journals; one astronaut wrote: "The state of the art in electronics and software is simply insufficient to ensure a crew can stay alive on an Exploration Class mission. Multiple cases this increment where software glitches/downloading problems caused fairly large impacts."
- Earthbound software interfaces are ineffective in space, where users lack stability much of the time. For example, *make graphic user interface features larger than normal to minimize the need for pinpoint accuracy when using a cursor*. Example journal statement: "Having to use a rubber peg to move a cursor and having to align the cursor with a tiny arrowed box at the bottom of the screen to be able to move the schedule so you can search the timeline all require effort that over time begins to irk me. Who knows how much time over [the] months is wasted when I interact with OSTPV 50 to 100 times a day with that interface?"

²⁵ Most of the journal entries concerning CDEs were written during the second and fourth quarters of expeditions. It is unknown whether the number of reported CDEs during third quarters reflects depressed affect or fewer events.

- A conventional, paper calendar displayed in the galley area might be useful to help mark the passage of time. An astronaut echoed the words of several others with: "The days here are each part of a running scroll of work/rest/prep time without sufficient breaks to separate one day from the next."
- Schedule events on ISS and future longer-duration expeditions at one or two-week intervals to help mark the passage of time. [See comment at the bottom of page 49.]
- Continue the Journals Flight Experiment.

The final recommendation, above, was made at the end of Phase 1; the Astronaut Office concurred and encouraged BHP to continue the study, which made the Phase 2 research described in this report possible. There were compelling reasons for continuing the Journals research. In particular, conditions changed on the ISS during the Phase 1 study period and subsequently: STS resumed, equipment and modules were added, operations benefitted from experience, crew size doubled, and multinational composition and the numbers of visitors increased. For these reasons, it was appropriate to study the effects of these changes on behavioral issues, to the extent possible. However, an equally compelling reason for continuing the journals flight experiment was that it served as an outlet for frustration that if expressed directly could damage relationships. Study participants recognized this unintended benefit of the experience during Phase 1 and again during Phase 2, as illustrated by the following entries and public statements.²⁶

I feel like I am complaining in these journals, and maybe that is what they are for.

I often I use this journal to vent my frustrations. This helps me collect my composure to deal with the situations. I must continue to look at the big picture and count myself lucky to be here.

I think it is good to write this down—typing gets out some of these frustrations.

Writing in this journal helps to let off steam!

So that was fun. Today's log was intended as an outlet for myself to just vent, and have some fun with the things that I notice that are not perfect.

I used it almost as a therapy for myself; if I were upset about something or frustrated, I'd write about it. Sometimes those entries were long.

Writing in my journal helped me keep proper perspective on events. It alerted me to when I was becoming too negative about something and reminded me of the things I enjoy about my job.

It is funny. A bunch of hours later and I am completely over this issue. Not a care in the world about it. Glad I could vent to the journal and not via email because that could be catastrophic to my career...

Continuing the journals experiment to provide an outlet for crew frustration, in addition to collecting data, is not a substitute for the psychological support services and medical consultations provided by NASA. However, there are institutional obstacles that occasionally prevent astronauts from communicating candidly with individuals in the organization, including their personal physicians; the relationship between operators and flight surgeons always is tempered by the physician's authority to disqualify his or her patient from flight opportunities. Several journal entries describe astronauts' reluctance to confide in anyone about certain matters. Mostly when astronauts refrained from speaking candidly during private conferences with medical or management personnel it was to avoid being perceived as difficult or a complainer, but they wrote about the issues that bothered them in their journals and felt better afterwards.

²⁶ The only regrets expressed by participants concerning the study were that they wished they had written more frequently in their journals, a regret also expressed by explorers of the polar regions.

The astronauts who benefitted in this manner might have experienced similar effects if their journals had remained unread by anyone else, but I doubt it. Rather, I believe the astronauts made regular journal entries and wrote honestly about their experiences because it was, 1) science (i.e., meaningful work); 2) an opportunity to contribute to improving conditions for future space crews; and 3) a reason to produce the written record they wanted to help recall events later (i.e., tangible results for their effort). The cathartic effects described by the astronauts seem to have been unexpected, but were derived primarily from knowing that someone outside the organization would read the entries sympathetically. They did not simply “let off steam,” they conveyed their frustrations to another human being. It is a relatively safe and effective coping mechanism that also happens to generate large volumes of behavioral data for analysis.

The Journals method described in this report has been included in a battery of "tests" known as the Behavioral Core Measures, that will be evaluated during 30-day simulations of asteroid rendezvous missions to be conducted at the Johnson Space Center, beginning in January 2016; additional evaluations will be conducted during winter-over experiences at an Antarctic research station and on the ISS. Study participants will make audio journal entries using a NASA-provided tablet computer, and then the current investigator will transcribe, code, and analyze the data using the procedures described in this report. Journals content and data generated by other components of the battery will be assessed to identify methods for objectively and unobtrusively monitoring crew behavioral health on expedition-class space missions.

CONCLUSIONS

The two phases of the Journals Flight Experiment have provided the first quantitative data derived from actual space operations on which to base a rank-ordering of behavioral issues. The first level of analysis identified the relative salience of 24 major categories of issues among which the top ten accounted for 88% of all category assignments during Phase 1: Work, Outside Communications, Adjustment, Group Interaction, Recreation/Leisure, Equipment, Events, Organization/Management, Sleep, and Food. The top ten accounted for 86% of all category assignments during Phase 2: Adjustment, Work, Outside Communications, Group Interaction, Equipment, Recreation/Leisure, Food, Event, and Organization/Management; Exercise replaced Sleep in the top ten during the second phase. The second-level of analysis identified subcategories within the major categories and calculated their temporal distributions. The third level of analysis focused on the tone of entries as an indicator of specific problems and general morale; results of the NPN analysis support hypotheses concerning a third quarter phenomenon. The operational implications of these and other study results were assembled, discussed, and some were presented in the form of recommendations to facilitate living and working in space, whether onboard the ISS, a spacecraft bound for an asteroid, or an interplanetary ship.

Much has been written about the personal qualities of astronauts—achievement-oriented, competitive, analytical, etc. There probably is substance to at least some of the generalizations, as well as considerable individual variation within the Astronaut Corps. However, the most salient personal quality evident from my interactions with astronauts during this study is that they share an unusually well-developed sense of self-awareness. I had been led to believe by Tom Wolfe's famous descriptions that astronauts tended to be overly confident and certainly unwilling to admit to possessing flaws or normal human frailties. I am sure that some astronauts are afflicted with these traits, but those participating in this study demonstrated keen awareness of their capabilities and limitations, an endearing personal quality that further distinguishes them from nearly everyone else.

The astronauts who participated in this study wrote candidly and insightfully about their experiences with the hope that their journals would be used to improve conditions for subsequent ISS crews and the crews of future space expeditions. I have done my best to mask the identity of participants and to prevent the attribution of statements to specific individuals. However, the astronauts whose journals are examined here deserve recognition for the discipline they exhibited by maintaining continuous records of their expeditions and the courage necessary to write honestly about all aspects of living and working in isolation and confinement.

FINAL NOTE

In the first days of the year 2001, the crew of ISS Expedition 1, Commander William Shepherd and Flight Engineers Yuri Gidzenko and Sergei Krikalev, watched the 1968 movie, *2001: A Space Odyssey* and the 1984 sequel *2010*—the latter describing a joint American-Soviet mission to Jupiter. The irony of former cold war adversaries living and working harmoniously in space was not lost on Bill Shepherd, who had spent most of his career as a naval commando preparing for war with the Soviet Union. He also felt strange watching a movie about a space expedition while he was on one, the same feeling expressed by several participants in the current study. Captain Shepherd wrote his final entry in the station log two months later:

Change of command is an ancient naval tradition — the passage of responsibility for mission, welfare of crew, and integrity of vessel from one individual to another. We are on a true space ship now, making her way above any Earthly boundary. We are not the first crew to board Alpha, or the last to depart. But we have made Alpha come alive. We gave her a name and put substance to the ideas — that our crews can work together as equals and our countries as partners. We pass to your care Alpha's log, with the hope that many successful entries are recorded here, that explorations carried out onboard are prodigious, and discoveries wondrous. May the good will, spirit, and sense of mission we have enjoyed onboard endure. Sail her well.



Expedition 1 Crew; note ship's bell on bulkhead.

We believe that when men reach beyond this planet, they should leave their national differences behind them.

— John F. Kennedy, news conference, 21 February 1962

Photographic images courtesy of the National Aeronautics and Space Administration.

APPENDIX A

NOTE CONCERNING THE 1961 NORTH AMERICAN AVIATION SIMULATION

Donald Brown is Professor Emeritus in the Department of Anthropology at the University of California, Santa Barbara; he is an expert in the peoples and cultures of Borneo and author of *Human Universals*, which is among the finest examples of synthesis in the behavioral sciences. While transitioning from employment as a technician at North American Aviation to studies at UCLA in 1961, he served as a subject in a 12-day simulation conducted by North American to help identify life sciences requirements for the Apollo Program. Dr. Brown provided the image that appears below the list of figures in the table of contents on page iv of this report (he is on the right) and the following description of his participation more than 50 years ago in one of the little-known studies that contributed to the human presence in space. Information about the Principal Investigator of the simulation is presented after Dr. Brown's delightful description of the experiment.

The thinking behind that experiment that I was aware of was the assumption that crucial parts of space flight would involve boring and repetitive activities, but that when action might be required responses might need to be both fast and accurate. So we were given a boring but demanding task to perform. A panel in front of us went right to the limits of our vision, so you had to keep your eyes straight ahead. The flashing of a light, that would be either red or green, was a rare event but you had to be continuously vigilant, as the time that elapsed after a light went on and you responded with the correctly colored key press determined one's pay. A mistaken response reduced one's pay.

We took our blood pressure, pulse, and heart rate periodically while we were not at the task. These were recorded in a journal. I do not recall whether we were invited or requested to write more in the journals.

One subject found it so frustrating that he opted out after about a week. He then sat around for the remainder of the time. We all got along well with each other. My two fellow subjects were med students at UCLA.

In turn, we were each on duty for 2 hours then off for 4, round the clock. There were two bunk beds, each with a red blanket. The turnover of air in the capsule was so vigorous that the blankets substantially disintegrated over the course of the experiment.

At one end of the capsule was a curtained-off john. It had a freezer of food in it, and as we removed food we inserted our feces in plastic bags. In the end there was a bit of panic as the doctor wanted to analyze the feces but no one had thought to ask us to identify whose were whose. As it turned out, we had all used different knots, so sorting them out was not a problem.

In our work and living space we were observed through a one-way window and I presume the psychologists were making various visual observations and probably had some sort of experimentation going on. We had all been psychologically and medically examined before the experiment.

One of the med-student subjects was an excellent cartoonist. He plastered the wall across from the observation window with sharply critical evaluations of "The Task."

One technical problem developed in the course of the experiment. It was a loose wire that I could have located and fixed in 2 minutes, but the experimenters outside wanted to discover remotely what it was and try to fix it themselves. They did ultimately determine the problem, which I then fixed.

Each of us had been allowed to bring a cubic foot of personal items into the capsule. I forget what all was disallowed. I think mostly we just took reading material.

The principal figure in charge was flight surgeon Dr. Toby Freedman from the medical school at UCLA. He is mentioned in *Angle of Attack*, but I do not know if he might have written something about the experiment. It surely must be the case though that the experiment was described in North American's proposal to NASA.²⁷ North American won the prime contract for the Apollo Project, and I have read somewhere that the simulation experiment was a solid plus for North American's proposal.

Dr. Toby Freedman

Toby Freedman was an Air Force flight surgeon during the Korean War and in 1954 was part of a team that treated the test pilot who had barely survived the first ejection at supersonic speed, which led him into the new area of aerospace medicine. He was hired by North American Aviation to assist on the X-15 project and when Harrison Storms received authorization to bid on the Apollo program, he brought Freedman to the aircraft plant in Downey, California, to handle the life sciences section of the proposal. Space life sciences had to be invented as they went along, as there was no previous experience in the effects of spaceflight on humans.

Toby Freedman's simulation experiment, conducted in a partitioned area of the factory's old cafeteria, led to several insights that were incorporated in North American's proposal. No one expected the company to win the contract, but NASA was impressed by the proposal's attention to detail, which included the first preliminary data concerning human performance in isolation and confinement.

Dr. Freedman continued to lead human factors engineering for North American (later known as North American Rockwell and then Rockwell International), and served as personal physician to the senior engineering managers, several of whom he nursed through heart attacks brought on by the stress of meeting the goal of landing astronauts on the Moon within the decade.



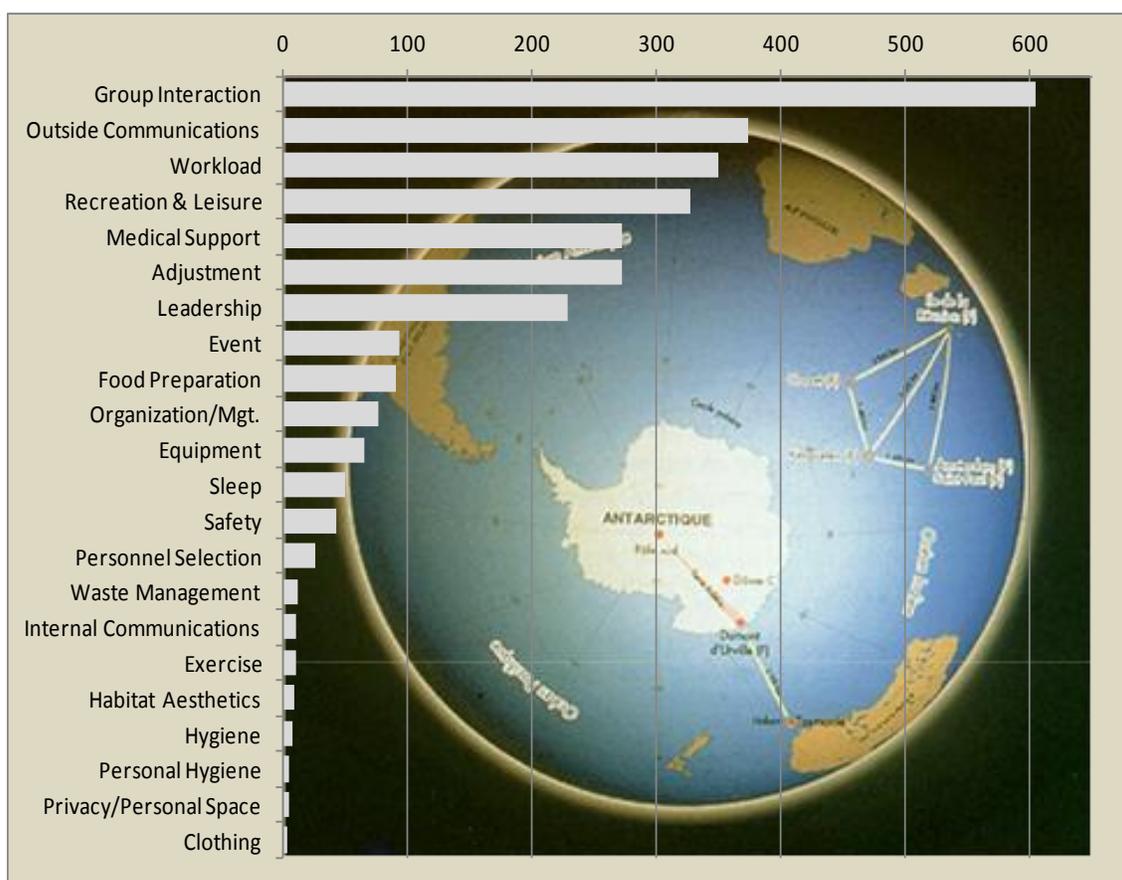
²⁷ Gray, M. *Angle of Attack: Harrison Storms and the Race to the Moon*. New York: Penguin Book, 1992. This is a thoroughly-researched and engaging account of the most challenging technology project of the Twentieth Century. The author dedicated the book to "the 400,000 men and women who built the first spaceship from Planet Earth and to the American people who picked up the tab." Mike Gray also wrote *The China Syndrome*.

APPENDIX B

THE FRENCH DIARIES STUDY

THE “FRENCH DIARIES STUDY”

A content analysis was performed of nine personal journals that were maintained for this purpose by the leaders and physicians at the Dumont d’Urville Antarctic facility and three French research stations located on small islands in the South Indian Ocean; the “diaries” were written during a 13-month period in 1993-1994 as part of the International Antarctic Psychological Program (IAPP).²⁸ The investigators assigned all diary entries to a primary category and more than half of the entries also were assigned to a secondary category, based on similarity of content. “Group Interaction” was found to be the most frequently-assigned of the 22 categories to emerge from the analysis, as illustrated in the following figure. Themes (clusters of entries on similar topics) also were identified from the diary entries within each category of behavioral issues.



Entries were coded as positive, negative, or neutral in tone, to permit analyses using a metric defined as net positivity-negativity, which was derived by dividing each journal into chronological quarters and then subtracting the proportion of negative entries from the proportion of positive entries within each segment. The analysis of Net Positivity/Negativity found evidence of a decline in morale during the third quarter, regardless of mission duration or location. Some study results were contrary to expectations. For example, shorter missions (69 to 180 days) generated greater negativity than longer missions (230 to 363 days) and diaries from the insular stations, where visitors disrupt the routine, were more negative than diaries from the isolated and austere Antarctic base. More than 100 specific themes were identified among the 22 categories of behavioral issues.

²⁸ The project was a collaboration among NASA’s Division of Life Sciences, the French Space Agency (CNES), Territoire des Terres Australes et Antarctiques Françaises (TAAF), and Institut Français Pour La Recherche Et La Technologie Polaires (IFRTP).

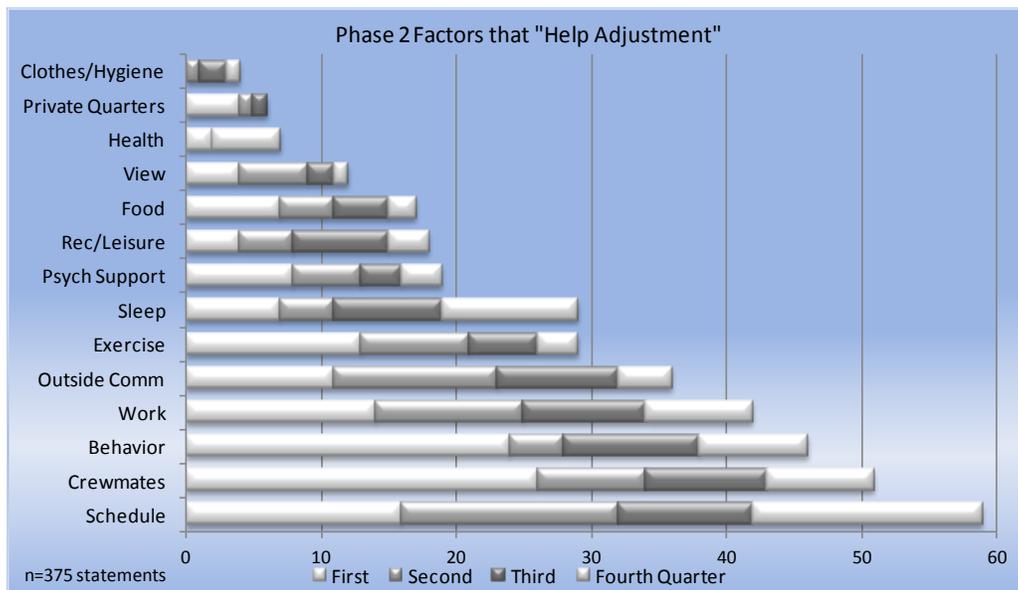


Dumont d'Urville Station, Terre Adelie, Antarctica.
Photo courtesy of Institut Française Pour La Recherche Et La Technologie Polaires,
now known as Institut Polaire Français Paul-Émile Victor.

APPENDIX C HELPS ADJUSTMENT

The 1,600 journal statements assigned to the Adjustment category during Phase 2 of the study describe examples of astronauts experiencing problems adjusting to life onboard the ISS and examples of successful adjustment. It was determined that journal statements assigned to the "Helps Adjustment" sub-category might be particularly revealing about the factors that contribute to successful adaptation to the physical and behavioral conditions of small groups living and working in isolation and confinement on a space craft. Other sub-categories (e.g., Beauty/Wonderment, High Morale) also describe successful adjustment, but the astronauts' comments assigned to the Helps Adjustment sub-category are the most explicit statements in their journals about the factors that enable men and women to adapt to the conditions and maintain high levels of performance for long durations.

The 375 journal statements previously-assigned to the Helps Adjustment sub-category from the ten Phase 2 astronaut journals were assembled, by expedition quarter, and each was assigned to a theme based on similar content (i.e., a sub-category analysis of the sub-category). The salience of the themes is described throughout this report, but the results of this particular analysis are illustrated by the figure, below, and explained in the following paragraphs.²⁹



Schedule. The most-frequently assigned theme concerns the relief astronauts experience when work schedules include sufficient time to perform tasks, during low-tempo periods, and on weekends when workloads are usually lighter than during the week. Example:

Really LOVING a quiet Saturday and looking forward to tomorrow.

Crewmates. Many journal statements describe the importance of compatible and helpful crewmates to successful adjustment. Example:

Realized something a good crewmate can do on a long-duration mission – listen to a colleague's concerns and try to understand them. And that's it. Just listening.

Behavior. This theme includes lessons learned about adjusting to the special conditions that are made explicitly in astronaut journals. Example:

It's important to have a routine up here so that you don't waste time with the little things.

²⁹ Thanks to Dr. Thomas Williams, Director of JSC's Behavioral Health & Performance Laboratory for the suggestion.

Work. The importance of performing meaningful work and achieving established objectives is described elsewhere in this report, but work emerged as a clear contributor to successful adjustment. Example:

A very satisfying task was setting up some Ultrasonic Background sensors today. It was a nice plan, well laid out, and I got to really build something for science. It went well.

Outside Communications. The IP phone and email enable communications with friends and family; both are contributors to successful adjustment. However, astronauts' primary engagement in outside communications is with mission and payload personnel and good relations with the ground can contribute immensely to adjustment to ISS conditions. Example:

Life continues to be extremely good up here, with crew dynamics at a new high. We are writing and receiving joke horoscopes from the ground, which adds a little interactive fun with MCC.

Exercise. Astronauts derive physical and intangible benefits from the exercise they must perform daily to counter the negative effects of (simulated) zero-gravity conditions. Example:

After the cleaning I did ARED and then CEVIS. Having the ability to work out is a life saver for me. To have those couple of hours every day is good for my body and mind.

Sleep. The relationship of sleep to human performance is among the most well-established behavioral principles, on Earth and in space. Example:

Always something to do here, but sleep is most important, so I am finishing up now. Good night.

Psychological Support. The important work of NASA's Psychological Support group is described in the discussion of other major categories (i.e., Outside Communications, Recreation/Leisure), but also was explicit in several journal statements concerning adjustment. Example:

We watched *The Avengers*. It was a fun movie to watch as a crew. The BHP [Behavioral Health and Performance] folks do a great job supporting us and we are lucky to have them.

Recreation/Leisure. The role of leisure activities in successful adjustment is addressed elsewhere, but cannot be overstated. Example:

Watching [World Cup] soccer on the laptop via Ku uplink has become the community activity of late. The Russians love to come down after work and watch... There is something great about watching live major sporting events up here. Gives a good connection to family and friends.

Food. Food is the quintessential habitability feature and the importance of special food was stated explicitly in astronaut journals. Example:

[We] had been talking about these bars for the last couple of weeks, so we immediately went down and opened a bag. New bag of Eggs/Fruits and now Bars – a good start for the week.

View. Earth viewing and photography are the principal forms of recreation on the ISS; the importance of the view to astronauts is demonstrated by the journal statement on page 83 and this example:

The one thing that is always changing and keeps me excited is the view of Earth.

Health. In space, as on Earth, one's physical condition is related to mental state. Example:

Knee is improving. It's amazing how health affects the mood here.

Private Quarters. Individual sleeping chambers contribute to adjustment by providing a space to which crew members can retreat from the stress of constant personal interaction. Example:

We each have our own private space... feeling like I am settling in.

Clothes/Hygiene. Clean clothes, a new sleeping bag liner, and a towel can mean a lot when living in austere conditions. Example:

It amazes me that 150ml of hot water on a hygiene towel can bring me such joy and satisfaction up here. We get one every other day. Hygiene towel days, as we call them, are very nice days!

APPENDIX D

THE THIRD QUARTER PHENOMENON

The term, "Third Quarter Phenomenon," was coined by Robert Bechtel to describe a characteristic of finite-time stressful situations that he identified primarily from anecdotal accounts collected during a study of life in cold regions (Bechtel and Berning, 1991). Bechtel found that the incidence of accidents, assaults, and requests for marital counseling peaked after the worst of the winter conditions had passed, rather than at the mid-point, as might be expected. He then read about the interviews of Antarctic winter-over personnel conducted by John Rohrer in 1958 as part of the International Geophysical Year (IGY) science program; those interviews led Rohrer to identify three stages of reaction to long-duration isolation: An initial stage of heightened anxiety; a second stage of settling into a routine, which is accompanied by depression; and a third stage of anticipation, which is characterized by emotional outbursts and aggressiveness (Rohrer, 1961). Rohrer observed that the sequence of stages remained the same regardless of the length of the mission. Bechtel also found a paper about adjustment to life onboard early Polaris nuclear submarines by psychiatrist, Jim Earls, which described a seven-stage response that included a "half way syndrome" characterized by depression; however, the data show the response occurring well after the half-way points of the missions, that is, during the third quarters. Earls cited depression as the most common response to long-duration submarine patrols and described the pattern clearly:

The crux of the various forces leading to this depressive position would appear to be the anger experienced by the various members of the crew. The anger is an outgrowth of the frustrations experienced by the submariner in dealing with his environment. However, there appears to be no personally or culturally acceptable means of discharging this anger. The paternalistic organization of the military system is one which does not permit the direct expression of anger and aggression toward the military system. In addition, there is the personal fear that the overt expression of anger may lead to a socially isolated position within an already isolated community. The individual has little opportunity to handle his hostile affect by sublimation, except through humor. The submariner is then forced to deal with his anger by denial, suppression, or turning against himself. The hostile affect becomes internalized, but it ultimately manifests itself as a depressive phenomenon. (Earls, 1969, p. 122)

Eric Gunderson and Paul Nelson reported sleeplessness, depression, irritability, and anxiety after the mid-winter period among 90 US Antarctic winter-over personnel (1963), which does not allow attribution to the third quarter, but is suggestive, as is the reference to "drifting behavior" as a late winter phenomenon by Popkin et al. (1974).

It was mentioned previously that the French Diaries study found evidence of a third quarter phenomenon across broad ranges of expedition durations and crew sizes (Stuster, Bachelard, and Suedfeld, 1999, 2000). Further, Marilyn Dudley Rowley and her associates reported evidence for a third-quarter phenomenon in the form of increased rates of deviance and conflict during polar and space expeditions (2000). G. Daniel Steel found moderate empirical support for a third-quarter phenomenon at a New Zealand Antarctic base using mood scales, with certain dimensions more susceptible to temporal effects than others (Steel, 2001). And, Greg Décamps and Elisabeth Rosnet reported third-quarter phenomena among 27 personnel of the French Dumont d'Urville Antarctic station, based on observations made by the expedition physician during a 50-week period (Décamps and Rosnet, 2005).

Nick Kanas and his international team of investigators found no evidence of a third quarter effect on any of the 21 subscales used in the Interactions Study to assess mood among US and Russian crew members during nine expeditions on Mir and the ISS (2006). However, the study discovered strong evidence to support displacement of tension and negative emotions from crewmembers to mission control personnel and from mission control personnel to management. Similarly, a study conducted in Lunar Palace 1, a space analog facility at Beihang University in the Peoples Republic of China, found no evidence of a third quarter effect during a simulated 80-day lunar mission. The Group Environment Scale (GES), the Work Environment Scale (WES), and a modified version of the Profile of Mood States (POMS, short version) were used as dependent measures; evidence of displacement of negative emotions to outside personnel was found (Wang and Wu, 2015). The results of these studies suggest that mood scales, the customary tools of clinical and social psychology, might be insensitive to the temporal fluctuations in individual adjustment measured by the systematic analysis of large volumes of journal content.

Psychiatric interpretation is beyond the scope of this study, which is concerned primarily with the behavioral outcomes of physical and cognitive processes. However, an exception must be made for “displacement,” which is the shifting of actions or feelings from one entity to a substitute when there are obstacles to the original object; it is probably the most widely understood psychiatric concept. The cliché example is, “The boss shouts at me. I go home and shout at my wife. She shouts at our child. With no one remaining, the child kicks the dog.” This common coping behavior might explain *some* of the negativity in the journal entries concerning ground control and management personnel. However, the most salient examples of negativity during the 20 ISS expeditions described by the journals were legitimate reactions to specific events (e.g., poorly-written procedures, insufficient time scheduled to perform tasks, management actions).

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14. ABSTRACT: Confidential journals were maintained by astronauts during expeditions onboard the International Space Station (ISS) and were analyzed to compare to journals that were obtained when crews and the station were smaller. Ten astronauts who were members of two- and three-person crews participated in the original study and wrote most about work, outside communications, adjustment to the conditions, and interactions with crew mates; ten additional astronauts who were members of six-person crews participated in the second phase of the study and wrote most about their adjustment to ISS conditions, followed by their work, outside communications, and group interaction. The study found evidence of a decline in morale during the third quarters of the expeditions and identified factors that contribute to sustained adjustment and optimal performance. Astronauts reported that they benefited personally from writing in their journals and questionnaire responses showed that living and working on the ISS was not as difficult as the astronauts anticipated before starting their six-month tours of duty.					
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