Fiscal Year:	FY 2013	**Task Last Updated:**	FY 09/01/2012
PI Name:	Miller, Christopher Ph.D.		
Project Title:	AD ASTRA: Automated Detection of Attitudes and States through Transaction Recordings Analysis		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **BHP**:Behavioral Health & Performance (archival in 2017)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **Team**:Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	cmiller@sift.info	**Fax:**	FY
PI Organization Type:	INDUSTRY	**Phone:**	612-716-4015
Organization Name:	Smart Information Flow Technologies, LLC		
PI Address 1:	211 N 1st St, Suite 300		
PI Address 2:			
PI Web Page:			
City:	Minneapolis	**State:**	MN
Zip Code:	55401-1480	**Congressional District:**	5
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2010 Crew Health NNJ10ZSA003N
Start Date:	11/01/2011	**End Date:**	10/31/2014
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Leveton, Lauren	**Contact Phone:**	
Contact Email:	lauren.b.leveton@nasa5.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Wu, Peggy (Smart Information Flow Technologies, LLC) Schmer-Galunder, Sonja (Smart Information Flow Technologies) Rye, Jeffry (Smart Information Flow Technologies)		
Grant/Contract No.:	NNX12AB40G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Long duration missions present unique challenges to the behavioral health of astronauts. Factors such as lack of team coherence, workload, social monotony, access to family and psychosocial support, and interpersonal and cultural differences can affect both crew welfare and task performance. Metrics and methods for assessing these factors are difficult to obtain because some are inherently qualitative, while others may not be amendable to self reports. Since these factors are affected, even largely the product of, interpersonal communication, it is not surprising that interpersonal communications are our primary key to them. There are already rich sources of interpersonal communication data--both intra-crew and between flight crew and ground-- which are created and archived during International Space Station (ISS) missions. Recent research suggests that verbal and non-verbal communications can be automatically processed in a variety of ways to provide insight into team cohesion, affective and cognitive states and team performance. We propose to leverage prior work of our own and of others in cultural and socio-linguistic theory to develop standardized, non-intrusive and largely automated methods for data collection and knowledge extraction about factors salient to crew psychosocial well being from existing communications data streams. We will propose candidate assessment techniques for relevant team coherence and performance factors, develop them for ISS operations and then test, tune and validate them in a series of experiments involving first ground-based archival data but culminating in an ISS Flight Definition study. The assessment technologies created will enable the identification and tracking of serious threats to individual and group behavioral health and task performance, providing empirical data with which countermeasures and training and crew selection approaches can be systematically created.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The ability to non-intrusively assess individual psychological and team social states would be a huge boon to a wide range of business and government endeavors. We have already received interest from military agencies seeking to assess the readiness and performance of their own teams, to train military personnel in team interactions within or outside their own culture, and to assess the character and relationships of those in the enemy camp. Similarly, we are currently in talks with marketing research and organizational management evaluation firms who wish to make use of our approaches to assess opinion leaders and team performance. Similar opportunities exist for any organization in which teams must work together over extended periods to achieve high performance: military, industrial processing, exploration, medical teams, etc. We have already (prior to the beginning of this NRA) applied for a patent for our unique approach to examining politeness behaviors to assess power (and other) relationships in teams.
Task Progress:	The overall objective for the project is to identify suitable combinations of processing techniques (which we will call “Non-Intrusive Psycho-Social State Assessors” or NIPSSAs) and data streams for assessing psycho-social states of interest to NASA. The first year of our project was targeted to assess available techniques, likely data streams, and desired state assessments to identify promising combinations—and then to prototype and assess such techniques on historical (i.e., previously captured) data representative of NASA missions and operational contexts. Task progress during this year includes the extension of a prior literature review of available NIPSSA techniques culminating in the development of a table indexing candidate NIPSSA methods and the types of psycho-social states they are capable of identifying. This table currently consists of 165 entries spanning 12 primary categories. After reviewing possible data sources, and prioritizing NIPSSA method maturity vs. desired state assessment vs. data availability, we settled on a parallel focus on two broad data x detection method x psychosocial state combinations. These were selected as having a high likelihood of concurrently (a) being present in future space operations, (b) being assessable by non-intrusive methods, (c) providing data about psychosocial states of interest to NASA, and (d) doing so via automated methods. They are: Approach #1—Individual Psychological State from Individualized Reflective Log Data (as included in an individual’s journal, diary or more recently, in blogs and tweets). Approach #2-- Relationships and Team States from Interactive Task Communication Data – that is, data generated during team interactions primarily in working environment. Due to the challenge of obtaining suitable historical data for testing initial NIPSSA approaches on these two data types and our specialized needs of representative data together with concurrent validation data (assessing the same psychosocial state via other, validated techniques that we could use for correlation analysis with our new, non-intrusive approaches), we were unable to obtain a data set that met all requirements for our first year. This forced a focus on diverse data sets together with creativity in identifying validation data or conditions in our initial experiments this year. It also makes a core goal in Year 2 the production of such paired interaction data with validation data in across a series of analog experiments. For Individualized Reflective Log Data and Analytic Methods we used a trove of publicly available astronaut journal, blog, and tweet data which NASA itself had collected and was making publicly available. These logs provided a conservative test for our approach due to the expectation that they would contain little evidence of emotional and attitudinal variations, especially of more negative emotions. Emotional content, past/present/future focus, group vs. individual focus and their correlations were identified from the journal entries utilizing James Pennebaker's Linguistic Inquiry and Word Count (LIWC) tool, along with analysis of novel topic categories we created such as references to “space” or a category of crew-related terms. As an example, findings implied nostalgia, melancholy, and perhaps loneliness in the journal entries of one astronaut, along with the tendency to move from a dominance of future tense usages (focusing on new and expected experiences) at the beginning of an ISS mission, to more present tense during the middle of the mission, followed by an increase in both future and past tense usage (perhaps indicative of a broader focus and reflection) toward the end of the mission. Correlations showed specific trends for individual astronauts including a positive correlation of crew terms and anxiety terms in one set of blog entries and a negative correlation of crew usages with both general and positive affect terms in another’s. Sentiment was assessed utilizing our previously pioneered techniques in Latent Semantic Analysis (LSA). Example findings include generally positive valence entries with fluctuations over time and between different astronauts. Additionally, fluctuations in attitudes about specific systems, equipment, procedures, and crew or ground support personnel were tracked in passages where those terms appeared. For Interactive Task Communication Data and Analytic Methods we first utilized team interaction data in textual chat generated by student subjects interacting in a planetary exploration simulation with tasks explicitly emulating astronaut missions and work. Initial analyses utilized our previously created algorithms for deriving dynamic power relationships from politeness usages between individuals. We successfully showed variations in relationships between the group interaction styles. An independent variable within the experimental design allowed us a specific, validated test: Half of

	all trials included a “Mission Commander” (a confederate) and who directed explorations activities according to a schedule, while the other half were “autonomous” in that the teams negotiated their own schedule and activities among themselves. Our power detection NIPSSA was successful at identifying the power exerted by the mission controller in the team interaction data and consistently assigned him/her the highest power rating across all 7 team trials in that condition. Given the similarity of textual communications in this planetary exploration simulation to radio communications in space flight, we have begun to analyze transcriptions of communications from the Apollo missions using the same NIPSSA approach. In one particularly interesting, initial finding, we have found that results of our processing of the Apollo 13 communication logs look radically different than those for other Apollo missions. CapCom (the “Capsule Communicator”—the primary communicant for all of Ground Control to the capsule) for Apollo 13 was communicating much more frequently with the astronauts and was assessed as exerting radically more power or authority than in other missions, or than he did prior to the O2 incident even within the Apollo 13 mission. These initial successes in the team interaction data approach have led to ongoing follow on studies which are still in progress to 1) Rate the simulation data on team power relationships and determine inter-rater reliability of these ratings and provide a finer-grained correlate for our power assessment NIPSSA, 2) Applying the same algorithms to Apollo Radio Communications (an initial result is described above), 3) Constructing another NIPSSA, using the same core software techniques, to score "team comfort" (defined as conditions when the team is operating on a routine, well-understood task without undue pressure from work or social sources) to, ideally, provide a correlate for team performance, at least on routine tasks. Our initial work shows promising tools and methods, and has identified some tantalizing, possible team and individual trends (such as the tendency for a powerful leader to increase team work focus to the point of reducing social interactions or the possible tendency for individuals to go through an “arc” of focus on the future and present in their reflections at the beginning of a mission, the present during the middle, and to shift focus to past and future toward the end); however, our NIPSSAs are far from fully validated, nor is the set complete. Much more work could and should be done. The lack of corresponding, independent validation data in almost all of the above analyses needs to be corrected in future studies. Also, through our analyses and discussions with other NASA performers this year, it is apparent that other NIPSSA tools, especially in the team interaction domain and based on team process and/or role behaviors, might provide more useful data. For both of these reasons, we are focusing on participating in several analog studies in the second year of our effort. This multi-faceted approach is designed both to continue the development and validation of our varied NIPSSA techniques and also to provide and distribute the assistance of our tools as broadly across as varied a set of data types and conditions as possible.
Bibliography Type:	Description: (Last Updated: 12/08/2015)