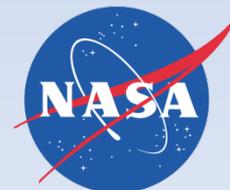


Capturing the Dynamics of Team Cohesion and Collaboration

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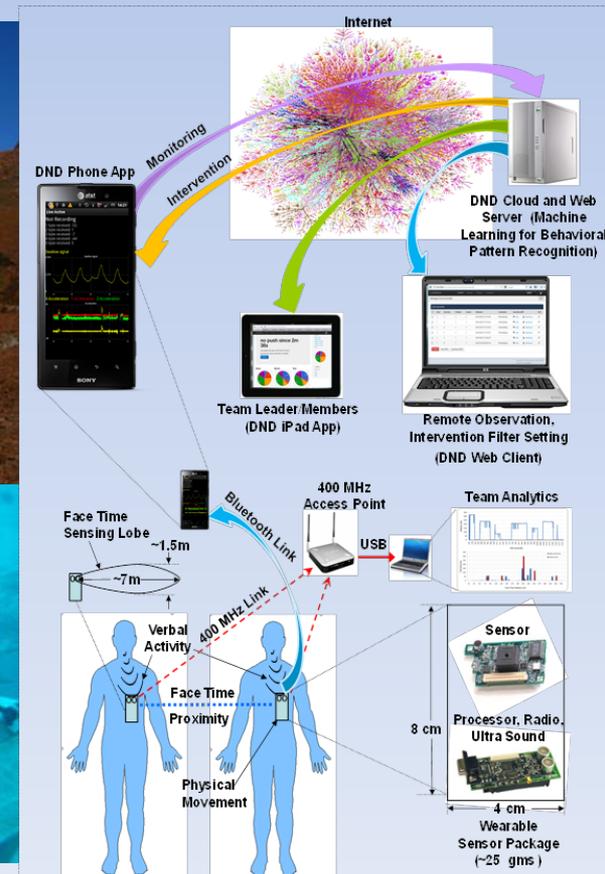


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Teamwork processes – entailing cognitive, motivational, affective, and behavioral aspects – have been researched in the psychological and behavioral sciences for well over a half century. Several lines of systematic research, large scale literature reviews, and meta-analytic summaries have firmly established that team processes, as key indicators of psycho-social team health, are critical contributors to team effectiveness, especially for “action” teams performing complex, interdependent tasks (Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Kozlowski & Bell, 2003; Kozlowski & Ilgen, 2006; Mathieu, Maynard, Rapp, & Gilson, 2008). Disruptions to teamwork, due to conflict, low cohesion, or poor collaboration, have the potential to threaten team effectiveness. This is particularly the case under the isolated, confined, and extreme (ICE) conditions that can be anticipated for long duration space missions. These difficult operating environments are further challenged by high team autonomy and time lagged communications with ground. For high reliability teams, a disruption in good teamwork, especially at an inopportune time when well-coordinated teamwork is critical, can have disastrous consequences (Weick, Sutcliffe, & Obstfeld, 1999). Thus, the capability for NASA to measure, monitor, and regulate (i.e., intervene) good teamwork interactions for flight crews and ground control teams is essential for overall mission effectiveness for the NASA strategic plan for space exploration (NASA, 2011). Developing this countermeasure capability is the goal of this ongoing research program.

This proposed ground-based research is designed to address the following Program Requirements Document (PRD) Risk and Behavioral Health and Performance (BHP) Integrated Research Plan (IRP; 2011).

PRD Risk: Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team.

IRP Gap – Team1: We need to understand the key threats, indicators, and life cycle of the team for autonomous, long duration and/or distance exploration missions.

The proposed research has three specific aims and associated deliverables that represent an integrated approach for measuring, monitoring, and regulating teamwork processes and long-term team functioning:

- (1) *Benchmark long duration team functioning in ICE analog environments.* This research will use Experience Sampling Methods (ESM; daily assessments) to assess team functioning in ICE environments. The product of this research aim is to quantify the expected range of variation in key teamwork processes (e.g., cohesion, collaboration, conflict), identify internal and external shocks that influence variation, and assess dynamic effects on team performance. Benchmark data in ICE analog environments are essential for developing standards to distinguish expected variation in teamwork from anomalies indicative of a threat to team functioning. Such standards are essential for triggering countermeasures / interventions.
- (2) *Extend engineering development of an unobtrusive monitoring technology* (i.e., a wearable wireless sensor package). The product of this research aim is to advance development of a prototype monitoring technology to capture dynamic multimodal (i.e., physical, physiological, and behavioral) data capturing team member and teamwork interactions. Initial validation has demonstrated the reliability and accuracy of the monitoring technology sufficient to establish proof of concept. Proposed extensions are designed to (a) add additional sensing capabilities (i.e., swallow monitoring for food intake and stress assessment) and (b) technology development to make the system more robust (i.e., packaging, energy efficiency; hardware, algorithms, and software). Additional laboratory validation is planned (i.e., a programmatic, phased process of assessing more complex teamwork interactions), as well as out-of-the-lab field demonstration.
- (3) *Develop teamwork interaction metrics and regulation support systems.* The monitoring technology has the capability to provide high frequency data streams on a range of team interaction and individual-level indicators. The product of this research aim is to develop three additional supporting components required for these dynamic data streams to be utilized as a countermeasure for teams to regulate teamwork interactions and psycho-social health. (a) Metrics: Algorithms need to be developed that parse the raw data streams into meaningful measures, then the metrics need to be validated; (b) Data Fusion and Team Regulation Protocols: The multivariate time series metrics need to be fused into a coherent assessment of ongoing individual and team functioning. Anomalies, that signal a departure from normative functioning, have to be classified to then drive the provision of feedback and / or team regulation interventions; (c) Distributed Networked Dashboard: A system architecture is needed to integrate sensor information and data fusion, direct feedback to maintain good teamwork and, when the system detects an anomaly in team functioning, appropriate feedback and countermeasures need to be triggered to help an individual or the team regulate team processes. Flexible options for distributing and displaying team status assessments and countermeasures need to be provided (e.g., individual team member, dyads, team leader, ground control).

To accomplish the product objectives highlighted above we have developed a multidisciplinary research team composed of experts spanning team development, regulation, and effectiveness (Kozlowski); psychological measurement of motivation, affect, and stress (Chang); and wireless monitoring of team member interactions (Biswas).

The proposed research will contribute to reducing the risk of team performance decrements due to poor teamwork interactions by (a) characterizing normative and anomalous patterns of team functioning; (b) monitoring team member interactions; and (c) providing regulation support to maintain teamwork and to trigger countermeasures when needed to aid team recovery.