

**CREW FIELD NOTES: A NEW TOOL FOR PLANETARY SURFACE EXPLORATION** Friedrich Hörz<sup>1</sup>, Cynthia Evans<sup>2</sup>, Dean Eppler<sup>2</sup>, Michael Gernhardt<sup>2</sup>, William Bluethmann<sup>2</sup>, Jodi Graf<sup>2</sup>, Scott Bleisath<sup>3</sup>, and the DRATS Science Team; <sup>1</sup>LZ Technology/ESCG, 2224 Bay Area Blvd., Houston, TX, 77058; <sup>2</sup>NASA Johnson Space Center, Houston, TX 77058, <sup>3</sup>NASA Glenn Research Center, Cleveland, OH 44135; corresponding author: [friedrich.p.horz@nasa.gov](mailto:friedrich.p.horz@nasa.gov)

**The Issue:** The Desert Research and Technology Studies (DRATS) field tests of 2010 focused on the simultaneous operation of two rovers, a historical first. The complexity and data volume of two rovers operating simultaneously presented significant operational challenges for the on-site Mission Control Center, including the real time science support function. The latter was split into two “tactical” back rooms, one for each rover, that supported the real time traverse activities; in addition, a “strategic” science team convened overnight to synthesize the day’s findings, and to conduct the strategic forward planning of the next day or days as detailed in [1, 2]. Current DRATS simulations and operations differ dramatically from those of Apollo, including the most evolved Apollo 15-17 missions, due to the advent of digital technologies. Modern digital still and video cameras, combined with the capability for real time transmission of large volumes of data, including multiple video streams, offer the prospect for the ground based science support room(s) in Mission Control to witness all crew activities in unprecedented detail and in real time. It was not uncommon during DRATS 2010 that each tactical science back room simultaneously received some 4-6 video streams from cameras mounted on the rover or the crews’ backpacks. Some of the rover cameras are controllable PZT (pan, zoom, tilt) devices that can be operated by the crews (during extensive drives) or remotely by the back room (during EVAs). Typically, a dedicated “expert” and professional geologist in the tactical back room(s) controls, monitors and analyses a single video stream and provides the findings to the team, commonly supported by screen-saved images. It seems obvious, that the real time comprehension and synthesis of the verbal descriptions, extensive imagery, and other information (e.g. navigation data; time lines etc) flowing into the science support room(s) constitute a fundamental challenge to future mission operations: how can one analyze, comprehend and synthesize -in real time- the enormous data volume coming to the ground? Real time understanding of all data is needed for

constructive interaction with the surface crews, and it becomes critical for the strategic forward planning process.

**The Concept:** The 2008 and 2009 DRATS tests demonstrated that the geologically trained crews themselves must be a critical component in this synthesis process: they are in the best position to summarize briefly the salient characteristics of geologically significant features, of an entire station, or of the collected samples etc. It obviously takes any observer some time to differentiate between critical and non-critical information and to distill the essential facts. As a consequence, brief summaries and syntheses were occasionally offered by the 2008 and 2009 crews towards the end of their running commentaries related to a specific feature or task. These summaries were enormously helpful for the back room’s comprehension of geologic context and sample characteristics. As a consequence, such concise summaries, consisting of verbal descriptions and supporting still and video imagery, became part of a formal protocol for the DRATS 2010 simulations and they became known as Crew Field Notes (CFN). By definition, CFNs are concise summaries, ideally < 2minutes, of whatever a crew deems significant. Importantly, the 2010 CFNs were electronically tagged to go into a dedicated folder on the rover’s storage device that was distinctly different from that recording the general observations and running comments. This CFN folder would constitute the highest priority science data for downloading at the end of a traverse and was available by the time the strategic science team convened for their night shift. Obviously, timely downloading of these summaries assumes critical significance during those traverse times when real time communications between rover and Mission Control are down, either intentional [1, 3] or unintentional [2, 4, 5, 6]

**Operations:** DRATS 2010 distinguished between CFNs taken inside the rover cabin (IVA) and those taken in the field (EVA). The former were directly stored onboard the rover and employed rover-mounted cameras for photo documentation; the EVA-CFNs were

stored (initially) on a computer housed inside each crew's backpack/simulated PLISS (Portable Life Support System), and used a backpack-mounted camera devoted to the continuous documentation of EVA activities. The backpack camera was a fixed focal length HD-video device that was operated by a wrist-mounted control box; the default setting was in continuous video mode that could be interrupted –via push button- to obtain high resolution still images. All CFNs were initiated by simple push button, which tagged all subsequent information to go into the dedicated CFN folder, until the push button was activated a second time, marking the end of a CFN; for good measure, the crews would also verbalize the beginning and end of an intended field note.

**Protocols:** Obviously, a CFN could be initiated any time at the crews' discretion, especially during long drives. However, a series of mandatory CFNs was also called for such as upon egress at the beginning of an EVA (summary of the station's geologic setting, including sampling strategy and rationale) and prior to ingress at the end of an EVA (synthesis of major station observations/features). Also, a CFN was needed for each collected sample. In addition to describing the sample's salient characteristics, this sample-CFN had to include a still image of the geologic context prior to any sample-handling, and a close up view/still image of the sample after collection; the continuous video stream was to allow for stereographic viewing of the undisturbed sample "in situ", and was to illustrate the sample collection bag number for archiving purposes. Obviously, this sampling protocol was analogous to that of Apollo. Examples of discretionary CFN's relate to geologic observations while driving, to syntheses of all rocks collected at a given station, and additional station summaries following ingress as detailed in a number of companion abstracts (4, 5, 6).

**Lessons Learned:** The CFN concept was developed during DRATS 2009 for rover-based IVA activities; it was recognized immediately, that it should be extended to EVAs, the reason why backpack mounted EVA cameras and their wrist-control were specifically designed and built for DRATS 2010. While some of the

hardware and software was experimental, the basic concept worked well for DRATS 2010. The CFNs contributed measurably to the real time comprehension of the geologic context and sample characteristics by both tactical and strategic science teams; indeed, they were the only information available to the entire science team when ground-to-surface communications were down, which was purposefully planned for 6 of the 12 traverse days [1, 3]. CFNs also seemed beneficial to the crews themselves, as CFNs demand rigor and discipline to compose, thus sharpening the crews' perception of critical observations. Despite high data density, the total volume of CFNs is relatively small and amenable to rapid downloading, typically in the first hour after the end of a traverse. Transmission rates are prohibitive to download the running comments and multiple, continuous video streams on similar timescales. Nevertheless, it is important to note that the latter constitute the primary surface information in the long run; the CFN's merely augment this information and represent useful tools to manage the real-time conduct of a mission.

While the CFNs of DRATS 2010 were obviously a success, the concept needs refinement. Data management on board the rover and on-the-ground servers needs improvement to assure timely downloading and access to the CFNs. The ergonomics of the wrist control could possibly be improved. Also, some image display (either on wrist control or in-helmet device) should be included as the crews had to compose their 2010 images by estimating the location of the field of view of a camera that was mounted at some fixed position (=shoulder-height) on their backpacks. Also, CFNs require substantial practice and rigor by the crews to become ideally short and concise. These issues and other suggestions for improvement are being addressed in more detail in companion abstracts by the geologist crews [4, 5, 6].

**References:** [1] Eppler, D. *et al.*, 2011a (this volume); [2] Eppler, D. *et al.*, 2011b (this volume); [3] Hörz, F. *et al.*, 2011 (this volume); [4] Bleacher, J. *et al.*, 2011 (this volume); [5] Young, K. *et al.*, 2011 (this volume); [6] Hurtado, J. *et al.*, 2011 (this volume).