PERCUSSIVE ROTARY MULTI-PURPOSE TOOL (PROMPT) S.L. Schmidt[1] , D.S. Boucher[1], and J. Richard [1]Deltion Innovations Ltd, 26 Meehan St., Capreol, ON P0M 1H0 Canada, sschmidt@deltion.ca, dboucher@deltion.ca, jrichard@deltion.ca

Introduction: Deltion Innovations has developed a small, light, low power multipurpose tool. The Percussive and ROtary Multi-Purpose Tool (PROMPT) prototype includes a set of bits and bit handling and change out mechanism (TBMM) suitable for operations in moon and Mars analogue environments. PROMPT is intended to be used on the end of a manipulator arm and is functional in any orientation. The Tool Bit Management Module (TBMM) is a storage unit for a variety of tools that will store and present a suite of tools for PROMPT use during any of its various work cycles. The TBMM is a passive device and is typically installed on a rover chassis.

Figure 1 PROMPT on a static arm (left), TBMM (right)

PROMPT is a tool used primarily for drilling into consolidated and unconsolidated material to extract a core sample. It can also chisel consolidated material or scoop unconsolidated material. PROMPT also provides the capability to attach or remove threaded fasteners such as nuts or bolts and operate other rotary interfacing mechanisms in lunar or Martian analogue environments. PROMPT is capable of drilling and tapping (threading) a hole in sheet metal such as aluminum plate for the purpose of installing a fastener.

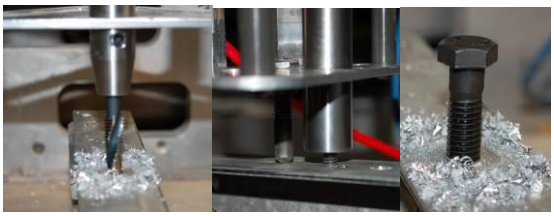

Figure 2 left to right – drill and tap, bolt tightening, installed bolt

Operations: PROMPT operations rely upon a manipulator arm for placement at a working surface, such as a rock face or metal construct. The manipulator arm must also hold PROMPT in place using a nominal 100 Newtons force in any axis, during operations. PROMPT is capable of safely withstanding up to 300 Newtons force from the arm in any axis.PROMPT manages all rotary, linear travel, thrust and hammer required to complete its tasks, thereby alleviating these tasks from the arm.

Operations are highly automated. Rotation, thrust and percussion rate are user selectable. Once initiated, the desired operation (drill a core, drill and tap metal, fasten a bolt, etc) is completed with no additional user input. The system will also tolerate communications interuptions.

Specifications: The PROMPT drill unit mass is <5kg. It is less than 28cm tall and fits within a 7200cm^3 envelope. The TBMM mass is just over 1kg and fits within a 2100cm^3 envelope. The unit holds up to six tools and is compliant to allow misalignment of the drill for tool exchange. The misalignment tolerance is dictated by typical positional accuracy that can be achieved by a manipulator arm. Misalignment can be any combination of 5mm radial offset, 5° radial angle and 5° approach angle.

Captured cores are nominally 50mm length x10mm diameter. Holes of 50mm length x 5mm diameter can also be augered.

The average power consumption is from 30-70W depending on the tool and the user selected operational parameters.

The system was successfully tested at temperatures ranging from -10C to +40C and storage at temperatures from -20C to +51C. The unit was subjected to various levels of humidity, water spray, dust and mud during operations. Testing confirmed that the unit could withstand the range of environmental conditions expected at Lunar and Martian analogue sites.

With the push tube installed, PROMPT can penetrate CHENOBI lunar simulant containing <+2% moisture, to depth (5cm) in less than 60 seconds. Sample capture is nearly 80% of theoretical by weight. Similarly, it can penetrate Maritan simulant (Hawaiian tephra) in less than 60 seconds. Sample capture in this instance is <60%. The rounded nature of the tephra particles means they do not interlock to the same extent as CHENOBI particles so sample retention is affected. The diameter and length of the push tube may be approaching the lower end of diameters capable of sam-

ple collection. The next smallest push tube developed by Deltion was for the Minicorer drill; at 12mm diameter and 10cm length, it was able to capture >80% sample.

The scoop tool was capable of collecting shallow surface samples, and may be a better choice of tool for unconsolidated materials. A chisel edge is incorporated into the scoop to enable fracturing of surface features. The chisel successfully chiseled a trough in sandstone.

Figure 3 PROMPT chisel in sandstone

The auger tool penetrated 5% moisture frozen compacted CHENOBI, sandstone and basalt to depth (5 cm)

The coring auger penetrated 5% moisture frozen compacted CHENOBI, sandstone and basalt to depth and captured sample.

Figure 4 Sandstone core drilled by PROMPT

The arbitrary limits on reaction forces imposed by a conceptual manipulator arm, affects the penetration rate in consolidated materials, varying primarily with friability and unconfined compressive strength.

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