Paper ID: 30048
oral

13th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Space Elevator Tether and Space Mineral Resources (3)

Author: Prof. Alex Ellery
Carleton University, Space Exploration and Engineering Group, Canada

PROGRESS TOWARDS A LUNAR SELF-REPLICATING MACHINE – THE 3D-PRINTABLE ELECTRIC MOTOR IS THE KEY

Abstract

A 3D printable electric motor has been under development as the linchpin of a self-replicating 3D printer. A number of prototype motors are presented but a traditional universal electromagnetic motor has been the primary focus of development. It is a modular design with the module constituting a laminated iron core around which is an insulating bobbin to mount the laminated wires of the coil. This constitutes both the rotor and the stator poles. It is envisaged that a lunar version would be entirely constructed from readily extracted lunar material - conducting wires of fernico, insulating material of silicone plastic and core of silicon steel. A mu-metal mesh structure acts as an electromagnetic shield to prevent electromagnetic induction outside the motor (to which fernico wiring is more susceptible than copper or aluminium). Electric motors are also limited by temperature and so require thermal control considerations – fernico is ideal for thermal straps while metal oxides (such as titania) are ideal for thermal insulation. These raw materials are available on the Moon either indigenous (such as iron, titanium and oxygen) or imported by meteorites (such as nickel-iron-cobalt) or solar wind (such as hydrogen, carbon and oxygen). The electric motor and its associated electronics introduce actuator components to the 3D printing repertoire beyond mere structures. Furthermore, a 3D-printable electric motor demonstrates that 3D printing may constitute a universal constructor. This is consistent with theoretical models of self-replicating systems that are based on robotic manipulation of the environment. A robot is in essence a specific configuration of actuators, be it in a Cartesian arrangement such as a 3D printer for parts manufacture, revolute arrangement such as a manipulator for assembly of parts, or other kinematic arrangement such as a mobile vehicle, drill, etc required for mining of raw materials. Similarly, chemical processing plant structures and piping require actuators for valves and pumps to maintain reagent-product throughput. The implications of self-replicating machines for space exploration are immense – it makes possible the development of a robotic manufacturing infrastructure on the Moon. Potential applications include space-based geoengineering and solar power satellite manufacture at low cost.