

HONG KONG MICRO END EFFECTORS AND RIND GRINDERS

DR. T.C. NG*, DR. K.L. YUNG, MR. C.H. YU**, MR. C.C CHAN***.**

*** Dentist, ** Hong Kong Polytechnic University, *** Solidworks Corporation, HK**

ESA's Mars Express Mission, scheduled for launch in June 2003 consists of an orbiter with appropriate instrumentation and a lander. The lander, provided by the United Kingdom, is named Beagle 2 and is dedicated to astrobiology. It seeks a full geological, mineralogical and geochemical investigation programme to characterise the landing site. The Beagle 2 team, under the leadership of Prof. C.T. Pillinger, has appointed a team of Hong Kong scientists to undertake the design of all the micro sampling tools onboard the lander. "

About 11 years ago, Dr T C Ng first conceived of the Space Holinser concept from the dental forceps he designed for handling inlays. With the help of Dr K L Yung, Dept of Manufacturing Engineering the PolyU, the belief that tweezers, the most common hand instrument used in the laboratory, when properly designed can greatly extend the functionality of the human hands, was then realized into the Space Holinser Forceps System designed to help astronauts working under zero or micro gravity. In 1994, the PolyU Industrial Center began to participate jointly in the manufacture of the forceps, using its advanced manufacturing and testing facilities such as CAD/CAM, LASER, EDM, CMM and precision machine tools.

After years of research by the Hong Kong team over 140 presentations to space agencies all over the world, a forceps system containing more than 70 interchangeable components and giving over 100 combinations has been developed. This system was found suitable for gripping objects of any shape and up to 20cm in size under zero and micro gravity environment. On 15 th Dec 1995, 4 pairs of custom designed forceps developed by the Hong Kong team were delivered by the replenishing rocket Progress to the Russian space station MIR and have been used since then by the Russian astronaut. Other space agencies are also considering to use some of the Hong Kong 's inventions for the International Space Station and Shuttles in the future.

Based on the experience gained from the Space Holinser Forceps System the Hong Kong team applied the knowhow to the design and development of micro end effectors [MEE]s for planetary sampling and return. Shifting its focus to the tip of the forceps, the team has successfully developed the MEE Corer and MEE Penetrator for the retrieval of soil or rock samples on planetary explorations for insitu or return to earth analysis.

After the Vikings and Pathfinder missions, scientists concluded that the secrets of Mars must be hidden under the rind of its rocks or beneath its soil, hence where the search for life should begin. The prototypes developed by the Hong Kong Mars Team are the lightest multi functional tools that can retrieve rock samples, grind off up to 2mm of rind to expose the bare rock for surface spectrometer examination as well as collect subsoil samples for insitu analysis of rock and soil composition in the oven of the lander. These prototypes are currently being tested and modified according to the criteria of the lander. Up to now, there are 15 MEEs and Rind Grinders developed for surface/ subsoil sampling and coring. Latest development from the team for planetary micro sampling tools that not exposed to ESA.

1/ MANTA MICRO SAMPLER AND ANALYSER-developed for Astrium of Germany. The tool is supposed to be fit at the leg of the small lander. The mechanism can able to retrieve sample, mini oven to burn and analyse by mini spectrometer.

2/ DRILL IN DRILL-developed for VTT of Finland. The mini drill is supposed to fit inside a large drill for subsurface coring. The mechanism can able to core a mini rock sample when the drills hit underground rocks.

3/ MOLE CORER-developed for DLR of Germany.The corer is supposed to fit at the tip of the Russian mole for subsurface coring.The mechanism can able to core a mini rock sample when the mole hits underground rocks.

4/ROCK CORER+RIND GRINDER-developed for 2003 Mars Beagle 2 lander of UK.The latest design has to incorporate a X,Y linear movements mechanism to push the micro end effectors of the Rock Corer to grind a surface area of 30 mm square/2mm deep.The net weight is 350 gm as ultimate target.

Please visit the website <http://158.132.65.249> for more details of the planetary micro sampling tools.