Moon Orbiter, Propulsion Issues. Gianmarco Mengaldo[1], Valerio Moro[2], Luca Rossettini[3], A. Bandera, F. Maggi [1] Politecnico di Milano, Via La Masa 34, 20156 Milano, Italy, gianmarco.mengaldo@mail.polimi.it, [2] Politecnico di Milano, Via La Masa 34, 20156 Milano, Italy, valerio.moro@mail.polimi.it, [3]Politecnico di Milano, Via La Masa 34, 20156 Milano, Italy, luca.rossettini@polimi.it)

Introduction: In the recent years a renovated interest on Moon missions has been growing. The objective to send again men on the Moon, the commercial projects about space hotels and Moon tourism, and the necessity of acquiring more information about the Earth satellite are pushing the study and development of many new lunar missions. At academic level both NASA and ESA are helping student to design and realize an orbiter which should reach the Moon in the next four years: ESMO and ASMO missions.

In this scenario, the choice of the propulsion system become critical for the success of the mission. Both chemical and electrical propulsion systems compete for advantages and disadvantages; however, for short-term missions, chemical propulsion seems to be most reliable solution. Traditionally the choice for chemical propulsion system has been liquid propellant, but hybrid motors, still under development, seems to offer the best competitive solution for short and middle range space applications.

In this article a comparison between the two philosophies and a trade-off for a moon orbiter are proposed. It is then discussed the main characteristics, requirements and implementation of the propulsion system simulator, which has been of fundamental importance on the whole orbiter design.

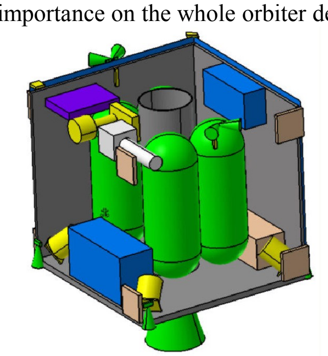

Fig. 1: Hybrid Propulsion Moon Orbiter, CatiA model produced by the ESMO Structure & Configuration team M_STRU_A1

Propulsion systems trade-off: Orbital maneuvers are usually performed using electric or chemical propulsion. The first one produces a very small thrust, usually in the order of mNewton, but with a very high specific impulse, usually in the order of thousands of seconds, while the other produces a much higher thrust but with low specific impulse. For a mission to the Moon, both the time and propellant mass variables, together with costs implications, are taking into consideration. On the chemical propulsion side, both hybrid and liquid propulsion are discussed: a solid fuel enriched with aluminum hydride and liquid oxidizer hybrid engine is compared with a commercial MMH-MON liquid bipropellant thruster.

Hybrid propulsion (Fig. 1) is known to be the best compromise between solid and liquid systems, joining advantages of both configurations: higher specific impulse compared to solid propellant, thrust control and re-ignition possibility, simpler architecture than liquid systems. The most critical disadvantage of hybrid propellant thruster is the lack of heritage: it has never flown before. On the other side the bipropellant liquid thruster system is very reliable, with a good heritage, but it implies more weight.

Propulsion simulation system: A propulsion simulation tool is proposed to monitor the state variable such as temperature, pressure and mass and predict their variation during mission operations.

The simulator replicates the engine and its main components working conditions (Fig. 2), giving maximum flexibility for the performances analysis of the chemical propulsion system in order to accomplish all the maneuvers required by the moon orbiter mission.

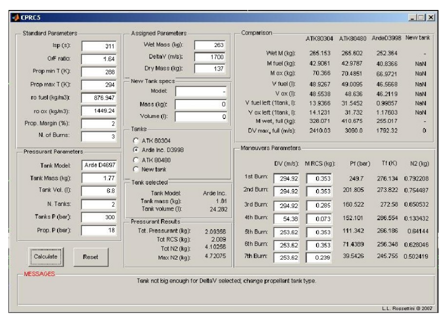

Fig. 2: Propulsion simulation tool graphical interface

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