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A SOFTWARE TOOL TO SUPPORT CONCURRENT ENGINEERING IMPLEMENTED IN  
PROJECT OF HYBRID ROCKET FLIGHT TEST

**Abstract**

With the emergence of sub-orbital spaceplanes as an application for hybrid rocket, the interest about this kind of rocket was generated in recent years. Typical example of hybrid rocket is SpaceShipTwo developed by Virgin Galactic. On 29 April 2013, after nearly three years unpowered testing, the spacecraft successfully performed its first powered test flight. Hybrid rocket propulsion technology has been researched for nearly ten years in Beihang University. From theory analysis, numerical simulation of combustion, to ground performance experiment, several key technologies of hybrid rocket had been broken. A sounding rocket powered by hybrid rocket was successfully launched on 25 November 2011 in the northwest desert of China. A new project of hybrid rocket flight test is been undertaking. Compared with former sounding rocket without control, the new flight test vehicle will be controlled to fly a scheduled trajectory. More disciplines will be involved, and more challenges will have to face. A multidisciplinary research team is organized in School of Astronautics, Beihang University, include propulsion, aerodynamics, structure, control, electronics, launch equipment, and even electromagnetic compatibility also is considered. Manufacture of parts is contracted with some companies of aerospace industries in China. Research and development process follow the pattern of Concurrent Engineering. Regular meetings were hold and heads of each discipline attended to discuss and exchange design or analysis results. To support concurrent engineering implemented in the project, a software tool was developed in the programming language of Python. The basis of the software tool is An Integrated Data Model of hybrid rocket flight test vehicle. Each discipline provide design or analysis data to this Data Model, such as structure detail design result and aerodynamic simulation data. Because all discipline orient the common data model, conflicts could be avoided. All data is stored in the format of XML, and easily to extract and display useful information. The core of the software tool is to perform a 6-DoF flight simulation with aim to examine design whether satisfy requirements of flight mission. Uncertainties, such as thrust misalignment, aerodynamics error, irregular gusts, etc., are also qualified and involved in 6-DoF flight simulation using Monte Carlo method. Development of hybrid rocket flight test vehicle is a coupled and interacted process between disciplines. The software tool helped the research team to implement Concurrent Engineering efficiently and effectively.