School of Aeronautics and Astronautics

SYMPOSIUM

The 2014 Research Symposium Series

* Free Pizza *

Monday, March 24, 2014

4:30 pm in ARMS 1021

Reducing Velocity Pointing Errors for Spinning, Thrusting Spacecraft via Heuristic Thrust Profiles

Kaela Martin

When a spacecraft performs an engine burn, the thruster misalignment (a consequence of assembly) causes the spacecraft to deviate from its desired trajectory. The majority of the velocity pointing error is produced by the step-function-like behavior of the thruster which almost instantaneously jumps from zero to its maximum value. Instead by ramping-up the thruster, the velocity pointing error is greatly reduced.

Historically, the velocity pointing error has been reduced by spinning at a high rate (similar to a bullet). By reducing the pointing errors, the spacecraft saves fuel and lengthen its lifetime in one of two ways. The spacecraft has a smaller spin rate for the same pointing error of a typical thruster profile or has fewer in-course corrections with a smaller pointing error.

Previously it was shown that the velocity pointing error can be reduced by linearly ramping-up a thruster from zero to its maximum value. The question is: what is the optimal profile that minimizes the velocity pointing error? Heuristic ramp-up models such as exponential, parabolic, cubic, and cosine are considered. These profiles reduce the velocity pointing error beyond the linear profile to nearly zero and hence qualify as optimal solutions.

Analysis of Bi-material "Thermostat" Strip Specimen for Predicting Cure Induced Shrinkage

Oleksandr Kravchenko

A new experimental technique and data reduction method based on the bi-material "thermostat" strip is proposed to estimate the magnitude of the cure induced shrinkage in the constrained polymer during a prescribed, but arbitrary cure cycle. The bi-material "thermostat" configuration consisted of a layer of liquid thermoset, placed on the surface of the fully cured, unidirectional composite lamina of carbon fiber/epoxy composite. The proposed data reduction method includes the self-weight of the strip and requires knowledge about the polymer properties undergoing cure that can be obtained from the molecular modeling simulations (elastic modulus, coefficient of thermal expansion and glass transition temperature as functions of degree of cure). The cure kinetic properties are determined with the conventional differential scanning calorimeter measurements. The proposed model allows separation of strains in the polymer due to cure shrinkage and thermal expansion. It also represents a multi-scale modeling approach that allows validation of the polymer properties obtained using molecular dynamics simulations. Furthermore, the described bi-material strip configuration provides a vehicle to develop the cure cycles to determine the optimum cure cycles for minimum cure shrinkage.

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