Payload Integration
For Commercial Space Vehicles

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Paying customers will no doubt be the driving force behind the commercialization of space. These customers will come in two primary forms, first will be "Payloads" which will require Integration into the Space Vehicle, and second will be "Tourist" which will require some level of technical and physical training much like todays astronauts. This paper will focus on both the "why" and the "how" of commercial payload integration.

First let us investigate the "WHY" side of the equation. The answer is quite simple, "To Identify and Minimize Risk". In other words, payload integration is about identifying and minimizing risk to the space vehicle, its crew, and its mission. In general, payloads will fall into two distinct categories, powered and unpowered. Both require integration into the vehicle to assure first that the vehicle can provide the appropriate environment and resources required by the payload, and second and more importantly, that the payload does not expose the vehicle or crew to an unacceptable level of risk. This leads us to the "HOW" side of the equation, which includes both "physical" and "functional" integration into the platform.

Physical integration of a payload is primarily accomplished via an Interface Control Document (ICD), which identifies everything from utility connections such as power and thermal, to physical connections such as rack attach point locations and fastener requirements. In many cases, such mass, volume, and power requirements form the basis of first order cost estimates associated with flying a payload. The bigger and more complex the payload the more it cost to fly, and in most cases, the bigger and more complex the payload the greater the risk is to the vehicle and crew should the payload behave in an anomalous way. While this is not always the case, it does make for a good general rule. Preventing and/or containing anomalous behavior before it presents a risk to the vehicle or crew is the final piece of "Functional" payload integration.

Functional integration of the payload is generally accomplished via a set design standards, guidelines, and requirements tailored specifically for the vehicle architecture and environment in order to minimize risk to the crew and vehicle. One of J&P's more challenging tasks has been to provide assurance that our Nation's Astronauts and Critical Space Assets (i.e. the International Space Station, Space Shuttle, etc.) are not exposed to an unacceptable level of Risk. To achieve this we use tools such as Hazard Analysis (HR), Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects, and Criticality Analysis (FMECA), Reliability Block Diagram Analysis (RBDA), Criticality Assessments (CA), Fault Tree Analysis (FTA), and even Probabilistic Risk Analysis (PRA) to name just a few. And yes we use them on payloads also, especially since some of the payloads contain enough potential energy to cause significant, if not catastrophic damage to the host vehicle.

When considering a "new payload for spaceflight" J&P recommends performing a Hazard Analysis (HA), with the primary objective of identify potential hazards in both the design and operation of the payload. In addition, when the payload is a consumer of "utilities" such as power, data, or thermal resources, it is recommended to also perform a Failure Modes and Effects Analysis to assure that a failure in the payload will not be propagated. Finally we suggest the formation of a review panel (either formal or informal) where the analyses can be presented and the payloads suitability for flight determined.

J&P is ready to apply our exceptional payload integration engineering services to assist the Spacecraft Developers in maximizing their potential for commercial success by minimizing the risk to their vehicle.