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McDonnell Douglas Space Systems Company

6 October 1989

Mr. Robert Fullerton
Fullerton Design
4635 Rio Encantado
Reno, NV

Dear Mr. Fullerton:

NASA currently has contracts with four prime contractors to develop system, operational, performance, and assembly requirements for the Space Station Freedom. McDonnell Douglas is prime contractor under Johnson Space Center in Houston, Texas and is responsible in part for the Space Station structural design and on-orbit assembly. All on-orbit assembly must be designed to minimize astronaut or robot time. Activities to complete assembly and disassembly must be uncomplicated and minimize the use of non-standard tools.

The Zip-Nut concept offered by Fullerton Design is a good example of on-orbit compatible hardware. The component has been visually examined by various technologies at both NASA-JSC AND MDC with favorable response. However, for such a component to be qualified for use on a NASA man-rated space vehicle such as Space Station extensive testing will be required. Since the product has no past usage on space vehicles, full qualification is the only method by which it can be considered for use on the Station. It must be pointed out that even with extensive qualification testing, there is no guarantee that the Zip-Nut will be used. Once all test data has been thoroughly examined by both NASA and MDC, a decision will be made. At that time, if the product is acceptable, drawings for the part could be added to the WP-2 Space Station Mechanical Parts Standards Manual which is used by designers on the program. This process is time consuming and will involve considerable coordination between NASA, MDC, and your company.

I hope this information provides you with an accurate assessment of the MDC position on the Zip-Nut. Please do not hesitate to contact me should you require additional information. My number is (714) 896-3311, Extension 9688.

Very truly yours,

Raymond H. Anderson
Senior Engineering Specialist
Space Station Division

RHA:dkr

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ABSTRACT

PATHFINDER
IN-SPACE ASSEMBLY and CONSTRUCTION
MECHANICAL JOINTS and LARGE COMPONENTS

Frank Thomas and Jeff Finckenor
NASA/Marshall Space Flight Center
Structural Development Branch

The Pathfinder Project was conceived to develop the technology that would be required for future generic space flight missions, such as establishing a permanent moon base or a manned mission to Mars. A key area is In-Space Assembly and Construction, and this report will focus on the development of a mechanical joint and the definition of several large components in this area. A 120 foot diameter aerobrake vehicle, with a 300 ft nose radius and supported by a transition truss, was chosen as a focus problem.

Using previous mission study data, a 3-G centerline deceleration with a 1-G transverse loading was baselined. A 3-D finite element model of a generic structure established the axial loads on the elements. Ninety-five percent of the elements were loaded under 100,000 lb, with the remaining elements being at the aerobrake interface points.

The mechanical joints must be able to carry the 100,000 lb loading, be robot operable with few specialized end effectors, have a high reliability, be low in mass, and correct an assembly tolerance build up of up to ± 0.020 inches.

A mechanical joint, called the Grip Joint, was designed, is being fabricated and will soon be tested. Another application for high strength joints would be building lightly loaded structures

with fewer members. The Grip Joint concept is also easily scaled to both larger and smaller loads.

The joint is made of Aluminum 2219-T87 and uses inclined planes in the form of axisymmetric grooves to provide the tolerance build up correction. A self aligning fastening screw joins two half cylinder gripper sections. The screw is fed by the robot into a "Zip Nut" as a temporary alignment, then tightened to provide the fixed position. The "Zip Nut" is an independently invented and patented nut that uses spring loaded thread sections to allow a bolt to be pushed through easily, then given less than a single turn to tighten. The Grip Joint is strong, simple, small, requires a minimum of robot activity, and corrects large tolerance build ups.

The types of large components that would be required for interplanetary missions were researched. The most general were pressurized habitat modules, fuel/oxidizer tanks, and planetary descent vehicles. Models of a pressurized module and an oxidizer tank were built to determine loads on the component support members. The tank was a spherical LOX tank with a 15.15 foot diameter and weighing 130,000 pounds. The pressurized module was a Space Station Freedom laboratory module with a 14.5 foot diameter, a length of 42 feet, and a weight of 64,000 pounds. The tank member loads ranged from -36,000 pounds to 214,000 pounds, and the module loads ranged from -30,000 pounds to 58,000 pounds.

The Grip Joint and the definition of necessary large components are integral to Project Pathfinder. In turn Pathfinder is vital to continuing efforts in space, including the recent

initiatives proposed by the President.

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