



## 2007 United Kingdom Space Design Competition

### **HISTORY OF NORTHDONNING HEEDWELL the simulated company-**

**Northdonning Heedwell** is one of the four major aerospace contractors remaining in the United States in 2067. The company has been involved in every major U.S. government space project for the past 100 years and has contributed in some way to every major commercial space venture during that time. The company in its present form resulted from a merger between Northdonning Aviation and Heedwell Grummietta in 2002.

Before the merger, Northdonning Aviation was the world's most prolific supplier of fighter aircraft for the U.S. Air Force and foreign allies. Heedwell Grummietta had a wide variety of product lines in various industries, although it was most recognized in the aerospace industry for being a major producer of expendable launch vehicles (ELV), and for building one-of-a-kind scientific satellites. The company had a modest subcontract for Space Shuttle operations, and built two modules for the International Space Station. The merged Northdonning Heedwell retained these areas of expertise, and added capability for production automation with acquisition of Alliance Electronics in 2008.

After the merger, the company infused some of its experience with efficient military aircraft operations into the space sector of its business, and a search for new product areas quickly turned up candidate projects. Within months, company management made a commitment to invest in commercial development of a new launch vehicle, a two-stage-to-orbit design that would reduce launch costs to \$1000 per pound, long considered a maximum launch cost for profitable commercial operations. Within four years, Northdonning Heedwell based a prototype Space Tug at the International Space Station, and initiated a profitable business moving existing vehicles and satellites to and from orbits as high as GEO.

Like other aerospace firms, the company participated in and benefited greatly from the Foundation Society's construction of the Alexandriat space settlement and its solar shield. Northdonning Heedwell's early investment in developing a new launch vehicle design enabled it to go into production in 2012, and the first of the new vehicles flew late in 2017. During the latter phases of Alexandriat construction, the company's fleet of Percheron vehicles literally became the "workhorse" transportation system for equipment launched from Earth to the three full-service LEO spaceports that grew from the original International Space Station. A derived design, the Palomino, carried most of the passengers who became Alexandriat residents. The company's small fleet of space tugs grew, too; Northdonning Heedwell became the leading supplier of transfer vehicles capable of travel between the LEO spaceports, the Earth-Moon L5 libration point, and lunar orbit.

Northdonning Heedwell's leadership in commercial launch services enabled it to establish the standard for capabilities and operations costs of new reusable launch vehicles. Third-Generation Percherons are capable of flying 60,000 lbs. of payload to 160-mile LEO orbits, and 38,000 lbs. to existing spaceports at 260 miles, for \$600 per pound. The payloads are carried in standardized containers that allow a 15 foot diameter by 60 foot long payload envelope, and new payloads can usually fly within two months of requesting a flight. The vehicles are 220 feet long, with 35-foot diameter fuselages, 94-foot wingspans, and tails 30 feet

tall. The Palomino vehicles are configured for carrying 90 passengers; each individual's \$250,000 fare to a spaceport includes a 250 lb. weight allowance for person and possessions.

The Alliance Automation Division is the recognized leader in development of automated systems for space applications. It supplied robots to construct and maintain the first Solar Power Satellite (which began operations in 2017), automated systems for several on-orbit materials processing applications, and automated zero-gravity factories for various small high-profit products. This Division also has a fine reputation with the Foundation Society, having supplied robots that automated much of the lunar operation for Alexandriat construction materials, and other robots that maintain the exteriors of Foundation Society settlements.

Northdonning Heedwell utilized expertise from several divisions to develop an automated manufacturing facility on a ferro-nickel asteroid that it placed in orbit around the Earth-moon L4 libration point. Originally built to provide materials for construction of Belvestat, the facility now supplies raw materials for many of the manufacturing projects at that settlement. This factory produces triangular trusses to customer-specified dimensions, at the rate of 600 feet per hour. Customers are required to provide their own transportation of these structures, although some limited assembly is permitted in the vicinity of this operation. The company's standard triangular truss with 12-foot sections, suitable for zero-g installations, sells for \$900 per linear foot.

The company developed a system for zero-g manufacturing of solar cells from materials available in silicate asteroids. Each unit costs \$40 million, not including transportation to deposit it on an appropriate asteroid, where it produces 1 x 2 foot solar panels at the rate of 10,000 per day, each of which is capable of generating 40 watts of power in Earth orbit and weigh two pounds, at a cost of \$55 per kW. Solar power continues to be the primary source of electricity in space, despite numerous attempts by Northdonning Heedwell and other companies to create a fusion reactor that can be launched to or built in space. Fusion technology in use on Earth requires a reaction volume too large and too heavy for launch by a practical vehicle, and manufacturing processes for critical components require large quantities of water and power. Even the smallest such installations, 10 MW reactors appropriate for non-industrial communities of about 5000 people, cannot be transported to space.

Northdonning Heedwell was a leader in establishing corporate partnerships with the Foundation Society to develop new products and capabilities in space. This program started soon after Alexandriat became operational; Foundation Society personnel were preoccupied with their commitment to build the solar shield, and welcomed corporate initiatives to identify businesses to operate in the settlement after solar shield construction. The focus of these partnerships was to figure out how to make things in microgravity and perfect vacuum that were difficult or impossible to make on Earth's surface. The most profitable of the products developed under this program were nanobots, microscopic robots programmed to perform tasks at the molecular level. Although envisioned for decades, they were impractical until an Alexandriat lab figured out how to grow them in space. Nanobot designs and uses are not the universal fabrication technique envisioned by some late-20th-century science fiction writers, but they do enable more efficient processes to make an airtight seal on the inside of superdome structures, place solar cell materials on SPS array surfaces, add filtering materials to windows of spacecraft, and assemble the interiors of circuit components.

Although it did not win the Foundation Society contract to build Belvestat, the company had a major subcontract to design the manufacturing areas that are the reason for the settlement's existence. These facilities can be adapted to build a wide range of products; the most well-known are space vehicles, lunar landing vehicles, robots for various applications, and airlocks that operate with almost no loss of atmosphere for each opening to space. Almost any large product that must be made of metal and is intended for use in space is built in Belvestat's manufacturing facilities. Two major customer groups are operators of orbital hotels and moderate-sized space settlements developed by organizations other than the Foundation Society.

The company builds wingless versions of the Palomino spacecraft on-orbit at Bellevistat, through a cooperative agreement with the Foundation Society. These vehicles provide transportation for cargo and passengers from orbital facilities to the lunar surface and other Earth-orbit space destinations. Rates average \$9000 per person per day of travel, and \$45 per pound of cargo per day of travel.

Northdonning Heedwell did win the contract for building the Columbiat space settlement, which serves as the financial and commerce center of space. The company's successful proposal for this project included extensive use of robots for all phases of construction, which greatly reduced the costs of housing workers, especially during the early phases of the construction process. The company also earned praise from the Foundation Society for the amenities that were designed into the public areas of this settlement; it is the first space community to prominently feature large public artworks and promenades that serve aesthetic needs beyond the utilitarian design of existing settlements.

When the Foundation Society began development of the Argonom settlement in orbit around Mars, Northdonning Heedwell built two large cyclers spacecraft, in elliptical solar orbits crossing the orbits of Earth and Mars when the planets are relatively close by. Transfer ships based at Aresam rendezvous with the cyclers to load and offload cargo and personnel; \$1500 per pound delivers cargo from Bellevistat to Mars orbit. Landing vehicles charge \$50 per pound for transportation to the Martian surface, and \$300 per pound for the return trip. Although development of a practical fusion propulsion system enabled another company to develop a ship offering regularly-scheduled 80-day flights between Earth and Mars, the high cost of this service (\$4000 per pound) limits its use to passengers and high-priority cargo; the cyclers continue to do a brisk business in transporting bulk cargo.