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Bruce Claremont, February, 2008

PDP-11 Replacement Keeps the Navy's MSDD Spinning

Back in the late 1970's the U.S. Navy and American Airlines teamed up to build a simulator designed to introduce aspiring pilots and flight crew to the wonders of motion related spatial illusions. The device recreates the physical sensations experienced in an aircraft when no reliable external points of reference are available, such as flying over water, in clouds, or in the dark. The purpose of the device is to show trainees that what they feel often has no relation to what is actually happening to an aircraft. Relying on physical sensations in flight can be deadly. The simulator helps air crew identify the onset of disorientation.

With typical military brevity, the device was named the Multi-station Spatial Disorientation Device. To its keepers and victims, it's knows as the MSDD. The MSDD became operational in the early 80's and has introduced thousands of Navy and Marine personnel to the visual and vestibular physio-dynamics encountered during flight. In other words, it tricks the eye and inner ear. The device is currently maintained by the Naval Operational Medical Institute (NOMI) and is part of a suite of training apparatus used in preliminary flight training. Two of the MSDD's more famous companions are the dunk tank and altitude chamber.

MSDD platform, capsules, and capsule interior.

The MSDD apparatus is substantial. Think of a whirling amusement park ride carrying 10 fully enclosed capsules around its perimeter. Each capsule is an oversized drum containing a single seat, a rudimentary instrument panel, and a large, shuttered window. Capsule safety equipment includes a seat belt and air sickness bag. Trainees are encouraged to avoid air sickness with the knowledge that they have to clean up their own mess.

Controlling the MSDD was a Digital Equipment Corporation PDP-11/34 mini-computer. In 2007 this Unibus-based machine would be considered a museum piece, but it continued to do its job, running sophisticated FORTRAN programs that control the MSDD *flight profiles*. Trainees complete simple assignments during each *flight* as the simulator employs rotation, capsule orientation changes, and optical illusions to generate varying physical sensations. While the MSDD may appear primitive compared to today's CG driven simulators, I can affirm from

personal experience that it is entirely effective. There is no substitute for real physical sensations. It has been estimated that recreating the MSDD using modern technology would cost tens of millions of dollars, and that's before any military contractor markup!

Anyway, reliable as the old PDP-11 had been, it was finally wearing out. Within the Unibus backplane resided two very special cards: a custom controller unique to the simulator developed by American Airlines (AA) and a Real Time Processing (RTP) card. Investigation into replacing the PDP-11 and re-developing these two cards lead to that multi-million dollar estimate I mentioned. Everyone knows military budgets are tight, so an alternative solution was sought. That's when Migration Specialties got involved.

AA Unibus card

The MSDD is proactively maintained and modified by one Walter Alexander. By proactive I mean Walter is a hands on guy that sweats the details. He lines up adequate spares and knows how to fix virtually every system incorporated into the MSDD. We're talking everything from hydraulics' to wire-wrapped circuits. Recognizing certified PDP parts were becoming almost impossible to obtain and of doubtful reliability, Walter sought a direct PDP-11 replacement. He was looking for something that could support the unique Unibus cards and RSX-based PDP-11 software in a modern form factor.

Walter initiated a small business solicitation for this replacement system. Long story short, four companies bid on the replacement, Migration Specialties won. Each company submitted essentially the same solution, a Strobe Data Osprey emulator.

The Strobe Data Osprey is a PCI-based card that emulates almost any PDP-11 system. Coupled with a Microsoft Windows O/S and an Osprey Unibus chassis, the solution supports the PDP-11 environment and legacy Unibus cards. The Osprey provides a binary compatible PDP-11 platform. No code changes or recompilation is required. Likewise, the Unibus is the genuine article. The cards are simply transferred from the PDP-11 to the Osprey chassis. Communication is handled via a special Osprey Legacy Interface Card (LIC) and FireWire connection.

All of this sounds almost too good to be true and Walter is paid to be skeptical. Walter's skepticism is understandable and Migration Specialties addressed it by offering a no work, no pay guarantee. If the Osprey replacement system failed to fulfill the Navy requirements, the Navy would only be liable for travel expenses. The guarantee demonstrates Migration Specialties confidence in the Osprey solution and commitment to customer satisfaction.

Old and new. The Osprey system on the left serves double duty as a printer stand as the stalwart PDP-11 prepares to retire.

December is a pleasant time to visit the Naval Air Station at Pensacola, although the weather is irrelevant when you are working inside the chilly MSDD building. It seems some of the MSDD components work best at about 68°F (20°C). Other than a physical fitment problem requiring a chassis swap, the

installation and testing went smoothly. The CPU, memory, serial interfaces, parallel interfaces, and disk components of the PDP-11 system were virtualized on the Osprey system. The Unibus AA and RTP cards moved directly into the Osprey chassis. We followed an integration test plan developed by Walter and I to ensure that components worked as expected before and after virtualization.

The final test was a ride in the MSDD by yours truly along with the first batch of trainees. Valuing Navy personnel highly, the Navy elected to field test with one contractor and nine Marines. The Osprey performed flawlessly. I found the 15 minute mission fascinating. Using acceleration and rotation in a single plane, the MSDD creates physical sensations in three dimensions. The device tricks the inner ear into perceiving things like climbs, turns, and tumbles while fooling the eyes into perceiving motion when there isn't any and vice versa. It is a tribute to the brilliance of the people that created it that the technology continues to serve the Navy well as it trains crew much younger than the device itself.

Walter sits at the MSDD master console putting the Osprey through its paces.

The MSDD is legacy technology that works. The Osprey PDP-11 emulator and Migration Specialties know how allowed this important device to be upgraded at minimal cost in a very short period of time. The MSDD is a prime example of emulation technology used to preserve valuable assets, rather than re-inventing them. Migration Specialties is proud to have helped the U.S. Navy keep the MSDD spinning.