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FEELING FIDELITY

Developments in Control Loading

(Source: FCS)

Although many would argue that it is the visual system that determines the overall fidelity of the simulator, others claim it is the feel of the device that generates the realistic immersion factor. Poor handling means poor acceptance. ***Trevor Nash*** **investigates current developments in the field of control loading.**

One of the major technology transitions to hit the military training and simulation market over recent years has been the demise of hydraulic actuation and the arrival of electric systems. Increasingly, digital electric motion and control loading systems are replacing hydraulic systems.

Both systems were viewed with conservative scepticism during their inception phase but increasingly, the benefits of such systems are being seen positively by both system integrators and users alike.

As well as the benefits of electric control loading – ease of maintenance, the safety aspects associated with a lack of hydraulic pipes, easier installation, reduced power requirements and the problems of variable performance caused by oil quality and temperature – the continuing improvements to design of electric actuators has led to higher fidelity. In the case of electric motion platforms, this performance improvement has also been mirrored in increased payload capacities although some industry engineers still highlight the problem of noise.

Although there are some electric actuator detractors out there, most believe that the military sector is sold on the concept and is leading the way in the adoption of both electric motion and control loading. The same is not the case in the commercial airline training market which seems to have a much more conservative view towards any change in accepted and proven technology.

Ron Janzen is the Head of Engineering for FlightSafety International's Simulator Systems Division (SSD) and believes that electric control loading systems have now reached a level of maturity such that they have become the de facto standard for SSD.

"Three years ago, FlightSafety International decided that electric motion and control loading was coming of age and we needed to move forwards with the technology," explains Janzen. "As a company we had historical links with Moog for hydraulic systems and so we decided to talk to them about our future all-electric requirements which will form that standard for the future. We believe that the reticence towards electric actuation has disappeared in the military but the

commercial sector still has this, 'I don't want to be first attitude.'"

FSI SSD's strategy is leading to some major benefits. "FSI has re-written the tool set for motion and control loading. With many hardware components and software programmes the same for the motion and control loading we have achieved a COTS approach which sees control loading/motion modules easily integrated into the overall simulator design."

In describing Moog's latest generation control loading systems, the company's Head of Engineering, Dan Foster says design work only commenced after exhaustive discussions with the user community and examining the results of a trade study. "Our aim was to get a high torque force with low friction and all control loaders being managed by a single server".

"The benefits of this approach, which sees actuators linked to the servers via firewire, are high transfer rates and little latency – we're currently running at 2000 Hz but will shortly move to 4000 Hz. The single server route also means that everything is plug-and-play and that the actuator simply becomes a line replaceable unit."

Foster tells *MT&SN* that the company has 200 control loaders on order of which around 70 have already been delivered. These systems are being devoured by FSI SSD for use on programmes such as the C-17, V-22, TH-67, UH-60, CH-47, AH-1 and UH-1.

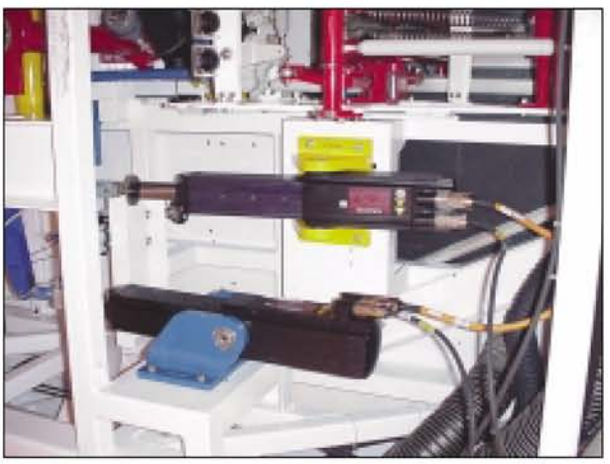
"In our early discussions with Moog we wanted to achieve a design which could be used for retrofit upgrades," explains FSI SSD's Janzen.

"The motor ball screw linear actuator design that Moog came up with featured trunnion mounts which provided the same form and fit as Moog's older hydraulic actuators."

This approach has meant that FSI has been able to switch the control loading from hydraulic to electric on the USAF's C-17 programme.

The USAF has now completed the first acceptance of C-17 electric control loading on a simulator at March AFB whilst work on the V-22 programme continues.

FSI is using the new control loading actuators on the FlightSchool XXI programme (TH-57, UH-60 and CH-47) as well as with Bell Helicopter on its UH-1 and AH-1 programmes.

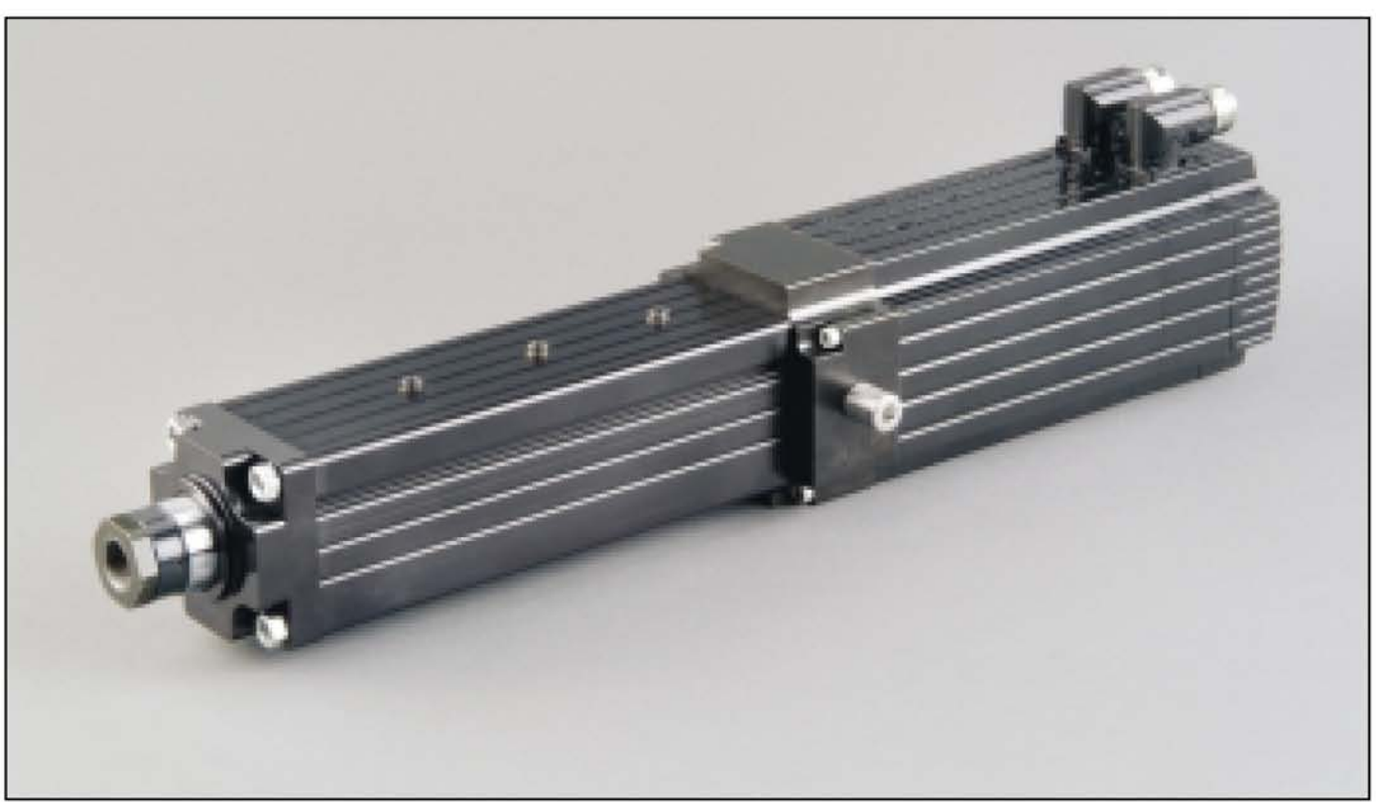


FSI's Simulator Systems Division (SSD) is now using a wide range of electric control loading systems from Moog.

(Source: FSI SSD)

BIG COMPETITION

Like most aspects of the military training and simulation market, the control loading sector is not without competition. Conklin, New York-based Simulation and Control Technologies Inc (SCT) started building control loaders in 1992 since when they have fielded over 500 channels. The company's Frank Fuller tells *MT&SN* about the current market.



Moog range of electric actuators have been designed as COTS products which can be easilly mounted and serviced. The product is in use on a number of programmes including the C-17, V-22 and will be used as part of the FlightSchool XXI programme.

(Source: Moog)

"There is no doubt that electric control loading is accepted by the military and that the technology continues to improve," he says. "Competitively though, it's a very tough market with new players appearing every year."

SCT believes that the only way to stay ahead of the competition is to innovate and add product discriminators. An example of this innovation has seen the company move its software away from the DOS to the real-time LINUX environment. According to Fuller, LINUX provides, "a better graphical user interface as well as enabling development tools to help the user build better simulators."

SCT's latest innovation sees the launch of a new self-contained control loading package for throttle and control stick. Housed in a 12 x 12 x12 inch box, the customer simply provides SCT with the design specification of the throttle or stick. Like Moog, SCT also believes that control loading is becoming more modularised and this new product is designed to capture a share of this market.

"Although we work in both the commercial airline training and military training sectors, the former is currently suffering very badly," explains Fuller. "We did not take a single order in 2004 within this sector but the military side of the business is really very buoyant." Current programmes in the military market involving SCT include ongoing work on the F-15 DMT programme for Boeing where the company builds self-contained base frames with integrated control loaders as well as long terms work on the MH-60R/S programme.

In Europe, the leaders in control loading are FCS Simulator Systems. Based in Schipol near Amsterdam, FCS started building control loaders back in 1979 when they were part of Fokker. Today, around 70% of the company's control loading output is used by the military sector. In late 2004, FCS launched its new ECoL Q-Line range of control loaders. Referred to by FCS as their 6th Generation control loaders, Q-Line follows on from the C-Line loaders launched a year earlier.

The ECoL C-Line range was designed to provide, "cost-effective, medium-fidelity control loading" which offers a choice of three actuators, depending on the simulation task.

Although designed for the commercial Flight Training Device (FTD) market (US FAA AC 120-45), the company says C-Line products are well suited to secondary controls on more advanced simulators. These include items such as nose wheel steering, throttles and toe brakes.

INDUSTRY INNOVATION

The company has developed generic control loading modules integrated with a common base frame. Using C-Line modules, this base frame has been sold to Quality Research Inc for use on a US Army programme. This approach is explained by FCS's Sales and Marketing Manager for Control Loaders, Ton Stam, "based on the new Q and C lines, FCS is offering highly cost-effective control loading modules for both fixed- and rotary-wing aircraft."

SCT's new self-contained control loading products are already selling well.
(Source: SCT)

"The range currently comprises a rudder pedal module, a pitch/roll cyclic module and a throttle/collective module. The modularity and versatility of the FCS generic modules allows the incremental addition of features such as seat shakers as well as options of quick change or even reconfigurability."

A new range of high-fidelity control loaders, the ECoL Q-Line range, was demonstrated for the first time last December at I/ITSEC. Based on brushless, direct-drive actuators, the system architecture is based on digital amplifiers connected to the control loading server via a high-speed digital interface known as FCS Net. According to sources at FCS, the new devices have already been shipped to NLX, JF Taylor and Mechtronix.

As well as new-build simulators, control loaders are often key components during the upgrade of simulation devices. One company heavily involved in this sector is Clearwater, Florida-based Opinicus Corporation. The company's electric control loading products are referred to as the REALFeel product range.

"Being involved in both the new-build and upgrade markets means that we have lots of installation opportunities for REALFeel," explains Jim Takats, President of Opinicus Corporation. "Over the years we have installed these devices on programmes as varied as the CH-46E, CH-53E, EA-6, C-130H. C-130E, EA-6B, MV-22, EH101 and AH-1W."

One programme currently underway at the company's Clearwater facility features a C-130H Weapon System Trainer (WST) for the USAF Special Operations Forces (SOF). Under contract to Lockheed Martin Simulation Training Systems (LMSTS), Opinicus is to integrate six channels of REALFeel control loading into the device prior to its installation at Hurlburt Field, Florida.

As a simulator manufacturer, Opinicus is not unusual in manufacturing its own control loading systems; the same is true of Frasca and CAE. The latter is currently installing its own control loading as part of the US Navy's P-3C Orion upgrade. "We are replacing the current hydraulic control loading with our latest generation electric load units," explains Alex Petrilli, CAE's Group Leader – Mechanical Simulation Control Loading.

"These are the same load units that are being used on the US Air Force C-130J Maintenance and Aircrew Training System (MATS) programme."

In terms of the control loading work being undertaken by CAE on the P-3C programme, Petrilli says the company is, "replacing the primary controls (aileron, elevator, and rudder) along with the toe brakes and nose wheel steering. In addition, we are putting in new load units for the throttles that incorporate an electric 'Beta' range gate."

CAE's Petrilli says "the CAE design will provides FAA Level D equivalent enhanced qualification. The smoothness of the system is the key to enhanced qualification as per the US Navy requirements for the P-3C simulator upgrades."

It is clear that control loading has come a long way since the earliest spring loaded pulleys. Digital electric control loaders are now replacing hydraulic systems throughout the military training environment although the commercial airline training sector is yet to make a move in this direction of any significance.

As this review of control loaders has shown, improvements to the technology continue apace with industry investing with their customers to provide them with high-fidelity solutions.

The trend here seems to be that the simulator integrators are looking for COTS solutions that are easily supported by common servers/processors and software.