Pegasus: Precise flying effects
for stage and show technology

Flying by Foy
lets the stars fly

The entertainment industry is always growing, and with it the demand for surprising and ever newer special effects with which to astound the public. Flying sequences in film and live events are a main element in the director's bag of tricks. For over 50 years, Flying by Foy, a company based in Las Vegas, USA, has specialized in flight effects for performers. Even though the equipment is hidden behind the scenes as much as possible, automation of flight simulation requires a sophisticated control system, which Flying by Foy has implemented based on PC Control and EtherCAT from Beckhoff.

Over the years Flying by Foy has provided flight effects for over 50 Broadway shows, live events for the Smithsonian Museum in Washington D.C., for the Olympics in 2004 and other sporting events, as well as for numerous live entertainment events, theater, films etc. "We provide intuitive and easy to use controls so the operator can easily create dynamic and breathtaking flying performances without requiring knowledge of the automation's inner workings," explained Matt Bevacqua, Technical Designer at Flying by Foy.

EtherCAT sets no limits on Motion Control

In mid-2008, Flying by Foy decided to launch a major upgrade of their Pegasus Automation control products, to improve coordinated positioning and enhance the safety functionality. "In contrast to a crane moving containers at a shipyard where the system is continuously trying to avoid swinging, for example, Flying by Foy uses dramatic swinging and dynamic motion to produce exciting flying effects," Matt Bevacqua said. Free-form flying techniques require

considerable pendulum effects and significant swinging actions that cannot be easily duplicated by a gantry or a four point system with tight load control.

The new Motion Control and automation system for Pegasus must take this into account and provides the ability to safely implement dynamic, interpolated motion profiles. The previous generation of Pegasus Automation utilized a motion controller and inverter in one package, i.e. the drive with integrated intelligence, handled the positioning tasks and velocity control itself. "That worked fairly well, but we were limited by the legacy fieldbus infrastructure when communicating with the equipment," reported Matt Bevacqua. "This severely limited our applications since our systems often require multiple master controllers. It necessitated a level of coordination that was not possible with a standard fieldbus. We required a solution that would essentially allow us to write our own communication protocol."

Integrated control platform for all product lines

Flying by Foy currently offers three products lines: the DW-V3 performer flying winch, the IW-V winch that is built into a standard 12" box truss and is a useful solution for rock & roll touring productions and for quick load-in requirements at arenas, and the BR-X units with wireless control units that are pods which can traverse wirelessly along I-beams and can lift and rotate to maneuver. Windows-based Pegasus Automation Software acts as a traffic controller for all three controller platforms offering a user-friendly interface for writing, editing and saving data.

All three Flying by Foy product lines use a Beckhoff C6515 Industrial PC with Intel® Celeron® M processor, TwinCAT NC PTP Software and EtherCAT I/O Terminals. "The C6515 form factor works extremely well for fitting inside the rack while allowing internal heat to ventilate harmlessly out of the rack," said Matt Bevacqua. "A typical implementation may have five or six racks all together, so keeping the hardware well-ventilated is a must. Flying by Foy used the Industrial PC from Beckhoff in summer 2010 in an outdoor production of Tarzan located in the desert in Ivins, Utah where it was routinely well over 100° F (38° C).

Alternatively, Flying by Foy uses the CX9010 Embedded PC instead of the C6515. "Since TwinCAT is the integrated software platform for all Beckhoff controllers, all we need to do is transfer our control software from one Beckhoff hardware type to the other," explained Matt Bevacqua and continued: "Another benefit of using TwinCAT is that it allows us to write our own applications in the same Windows CE operating environment as many of our other system tools. We also take advantage of TwinCAT's impressive adaptability, I/O linking features and motion control function blocks."

Flying by Foy programs the majority of their drivers and user interfaces using Microsoft Visual Studio®. "We're looking forward to working with the newest software generation from Beckhoff, TwinCAT 3 which is integrated in Visual Studio®," said Matt Bevacqua. "TwinCAT already gives us limitless flexibility to implement our own custom drivers into the Beckhoff system and adapt to constantly changing project requirements. Today we're not locked into any specific hard-

Celine Dion, "A New Day": Show at Caesars Palace in Las Vegas. Flying by Foy has been producing flight effects on the stage and screen for over 50 years and giving film and music stars their wings.

"We deliver intuitive and easy to handle controls, with which the operators can produce dynamic and breath-taking flight scenes," Matt Bevacqua, Technical Designer, Flying by Foy.

ware so we can easily change over time if needed. In our business this is very important because our application demands are always evolving and lead times are usually extremely short."

EtherCAT – speaking the language of entertainment engineering

For the Pegasus Automation System's communication, Flying by Foy has taken a big step forward by using EtherCAT. "EtherCAT allows us to seamlessly communicate with nearly any available fieldbus," Bevacqua explained. "With the EL6751 CANopen Master Terminal, for example, we have a fully functioning CANopen master that's easily and cost-effectively implemented into the EtherCAT system. Even better, we can just as easily integrate other masters for PROFIBUS or DeviceNet, for example, to operate over EtherCAT."

Flying by Foy also utilizes the EL6851 DMX master/slave terminal for lighting control. "The ability to synchronize DMX lighting and Motion Control with EtherCAT greatly enhances our flexibility," explained Matt Bevacqua.

TwinSAFE ensures safety for operators and performers

Flying by Foy also guarantees operator and performer safety with the integration of TwinSAFE in the Pegasus system. "TwinSAFE has empowered us with an easy to implement safety solution by connecting the intelligent Safety I/O terminals on the same fieldbus and with the same cabling as our Motion Control," said Matt Bevacqua. "With TwinCAT, all motion limits are monitored. TwinSAFE is the

safety controller that monitors all safety-relevant subsystems for our full line of hoists. As safety and motion data are transmitted over the same fieldbus, this eliminates additional cable runs. Also extending the safety controller is easily possible: With EtherCAT, if there is a need to add a safety function that wasn't originally planned, you only need to add a distributed TwinSAFE terminal and install an EL6900 Safety PLC terminal at the local control station."

XFC: Increased performance, decreased costs

XFC technology (eXtreme Fast Control), which is based on EtherCAT and PC Control, brings a further performance boost to Flying by Foy. With the ability to achieve I/O response times < 100 µs, EL1262 and EL2262 XFC terminals with oversampling from Beckhoff also play a role in the Pegasus Automation System. "XFC terminals are useful for replicating encoder signals for our flight simulation systems," explained Matt Bevacqua. With the Beckhoff standard encoder terminals it is possible to record positions in various different locations and to synchronize them using the distributed clock functionality. "Pegasus is able to read in an encoder position at one winch and, using XFC terminals, replicate that high frequency signal at a local station with an accuracy of about 10 µs and a delay of about 1 ms. XFC Terminals help us replicate these signals without having to run dedicated control lines, which results in considerable wiring and cabling savings."

Retrofitting made easy

"With one standard Ethernet cable run, we can bring essentially any type of data from any point in the venue back to our local Pegasus controllers," Bevacqua explained. "This simply wouldn't be possible with any other fieldbus system without a far more complicated wiring scheme and higher costs. With the EtherCAT bridge terminals, Flying
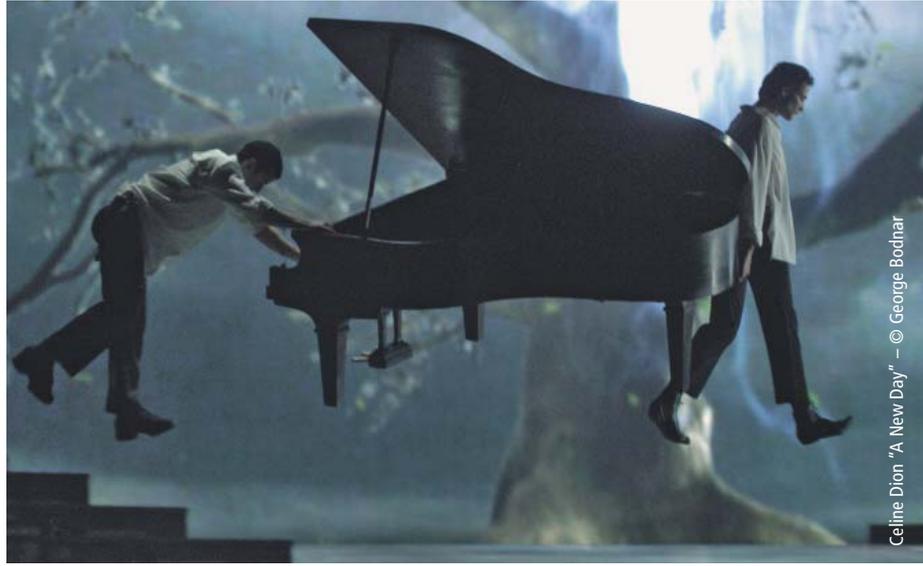
Flying by Foy's control solution is mounted in a 3.5" rack using a Beckhoff C6515 Industrial PC.

Test of a Pegasus automation system for simulating flight motion: Operator and performer safety are guaranteed by the integration of TwinSAFE in the controller.

Celine Dion "A New Day" – © George Bodnar

Celine Dion "A New Day" – Piano Movers

by Foy can easily take I/O points from one system and transfer them over to another TwinCAT master so we can easily share motion axes with different masters. With TwinCAT, we have a completely software-based motion control platform, which means significant savings since we must constantly retool and change our equipment to suit our clients' wide range of artistic requirements."

Open for future developments

The 3rd generation of the Pegasus Automation System is flying to a great start, having been placed in over 100 axes of motion in the field. However, the Pegasus technology advancement to bring artistic concepts to life is by no means finished. Matt Bevacqua's upcoming

plans for Flying by Foy include developments around the AX5000 EtherCAT Servo Drives. "Incorporating the AX5000 drives will give us a comprehensive, high performance solution that unifies the Pegasus controls under one advanced system architecture," Bevacqua explained. "With Beckhoff as our technology partner, Flying by Foy will continue to make creators' and directors' visions a reality – while ultimately, and most importantly, capturing the imaginations of their audiences."

Flying by Foy   www.flybyfoy.com
Beckhoff USA   www.beckhoffautomation.com

The housing design of the Beckhoff C6515 Industrial PC allows Flying by Foy to develop compact and, in regards to heat dissipation, efficient racks so that the heat is quickly dissipated when several of them are stacked on top of each other.

The Pegasus automation software serves as the traffic controller for all platforms, in that it coordinates the functions of the various winches, hoists and wireless control units. TwinCAT NC PTP from Beckhoff controls the automation and motion requirements.