

# Stick Fastener Feed System for Large Variety & Small Quantity

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## ABSTRACT

Electroimpact has developed a new Fastener Feed System which provides an automated solution for fasteners previously hand fed via drop tubes. The hardware is simple, compact, and is supplied a fraction of the cost of hoppers or cartridges. It can be used as a primary feed system or it can be used as an auxiliary feed system when combined with feed systems designed for high quantities of fasteners. We have installed this system on the A380 Stage 0 LVER lower panel wing machines and feed 5 diameters, 10 grips each, for a total of 50 different fastener types. This system moves 547 total fasteners per ship set from manual feed to automatic feed, saving considerable build time.

## INTRODUCTION

The A380 wing panel assembly cell in Broughton, Wales, fastens the stringers to skin panels for the upper and lower panels of the A380 aircraft. The cell is comprised of ten E4380 Low Voltage Electromagnetic Riveting machines that install thousands of titanium LGP lockbolts, ANSA threaded bolts, and steel slave bolts in diameters from 1/4" to 1/2" as well as 1/4" pan head bolts and 1/4" to 3/8" slug rivets.

The original fastener feed system consisted of a 96 slot cartridge based auto-feed rack and a set of manual drop tubes to feed the 34196 fasteners per lower panel ship set. There are over 150 different diameter/type/grip combinations making up this total. Although nearly 98% of the fasteners panels were auto-fed with the cartridge system, 677 fasteners per ship-set still required manual feeding.

An automated solution to feeding the remaining fasteners was called for to eliminate the increased build time and logistics problems incurred by storing and hand feeding these fasteners from the operator platform. The cost and extra space needed to increase the existing cartridge feed system to accommodate the drop fed

fasteners outweighed the benefit, so a more economical and compact solution was sought.

The solution came in the form of the new Small Quantity Automatic Fastener Feed System. This system was brought on-line at a fraction of the cost of the cartridge based rack and it fit in the existing envelope of the machine, automatically feeding nearly all of the remaining fasteners.

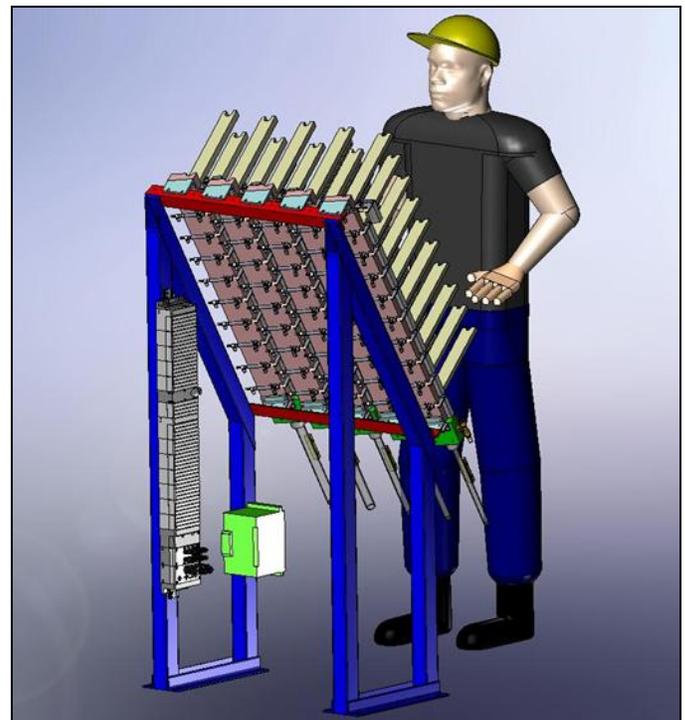


Figure 1. Complete System

## SYSTEM OVERVIEW

The system is made of four main components: The hanger, escapement, slide, and blast valve. The hanger is an aluminum channel with a T slot cut into the underside. The fasteners hang from their head and slide down the channel into the escapement as they are called for. The open design of this channel allows for

easy viewing of all the fasteners present in the system, making it easy for the support staff to monitor fill levels. One hanger is required for each fastener type/diameter.

The escapement is at the end of the hanger and is pneumatically actuated via an air cylinder. In its retracted position, the escapement prevents the fasteners in the hanger from entering the slide. When the escapement is actuated, it moves the last fastener in the hanger from the hanger and into the slide. The escapements are made from 1/8" stainless plate and are grip independent, so the same escapement and hanger combination can be used to feed any length fastener. This part commonality allows for lower manufacturing costs than systems with dedicated or adjustable escapements.

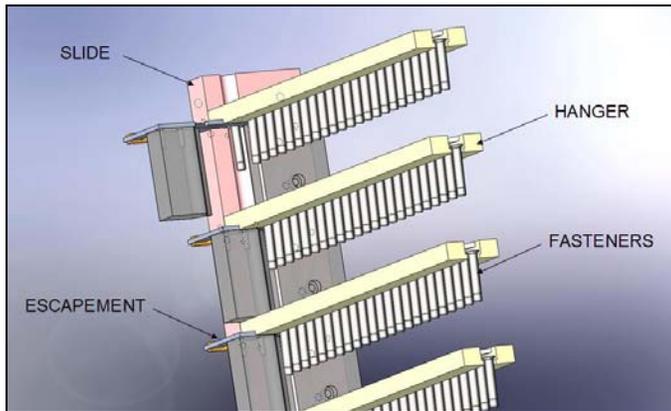


Figure 2. System Overview

The slide provides the path the selected fastener takes from the hanger to the blast valve. It also acts as the base plate for the system which the air cylinders, escapements, and hangers attach to. The same basic design is used for all diameters, with only the part thickness and the fastener path dimensions changing between sizes. The limit to how many grip lengths one slide can handle is simply dictated by the length of slide.

The blast valve sits at the bottom of the slide and sends the fastener to the tool point after it is escaped. It has a spool which allows the fastener to pass through, then, when the tube sensor sees the fastener, the spool is shuttled over closing the upstream path and sends an air blast downstream behind the fastener, blowing the fastener to the tool point.

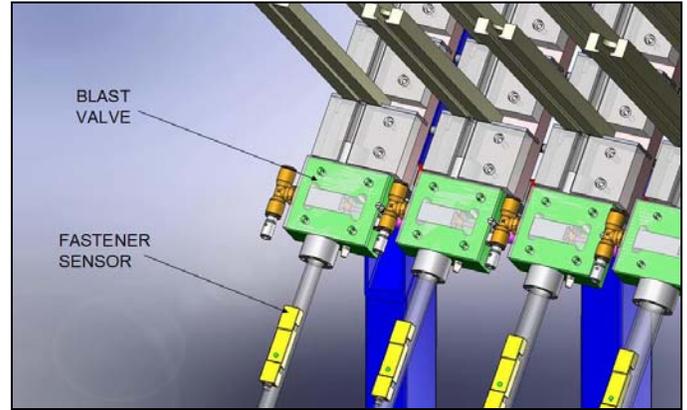


Figure 3. Blast Valves

## THE ESCAPEMENT PROCESS

The automatic fastener escapement process is as shown in the figures below.

Step 1: The machine calls for a fastener and the CNC or PLC selects which escapement to feed from.

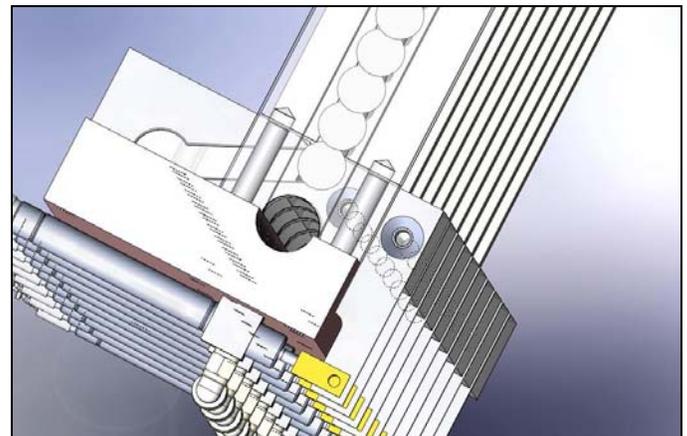


Figure 4. Step 1

Step 2: The escapement air cylinder begins to extend, removing the bottom fastener from the hanger and moving it toward the feed path in the slide.

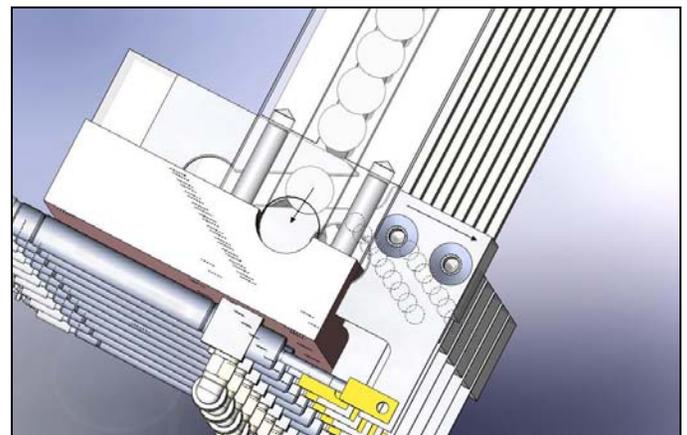


Figure 5. Step 2

Step 3: The escapement continues to move the fastener into position. Just prior to the end of the cylinder stroke, the fastener finds itself positioned above a keyhole in the escapement that will allow it to fall through.

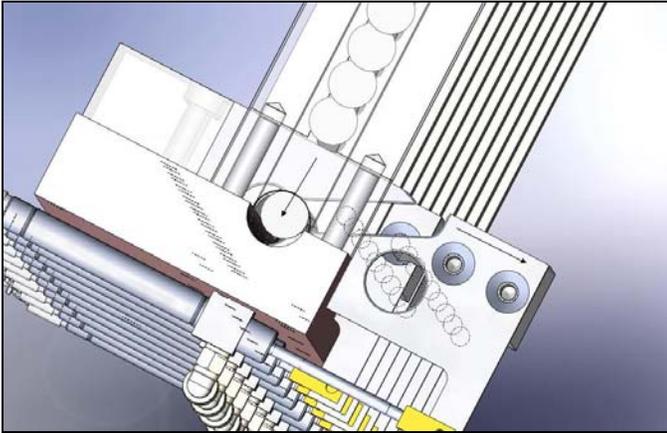


Figure 6. Step 3

Step 4: The escapement process is completed and the fastener falls vertically down the slide through the blast valve.

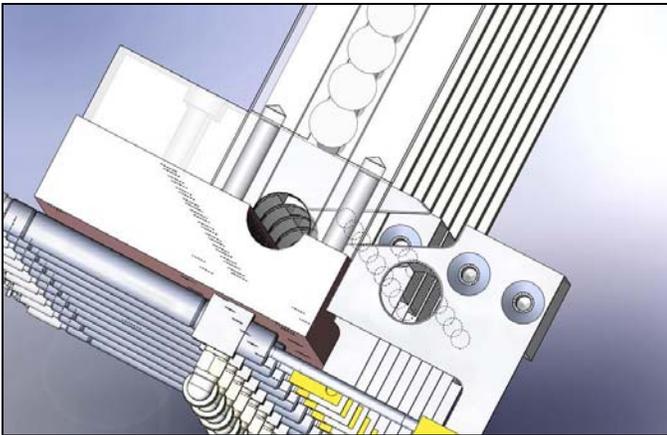


Figure 7. Step 4

Step 5: The escapement returns and the next fastener in line falls into place, ready for the next cycle.

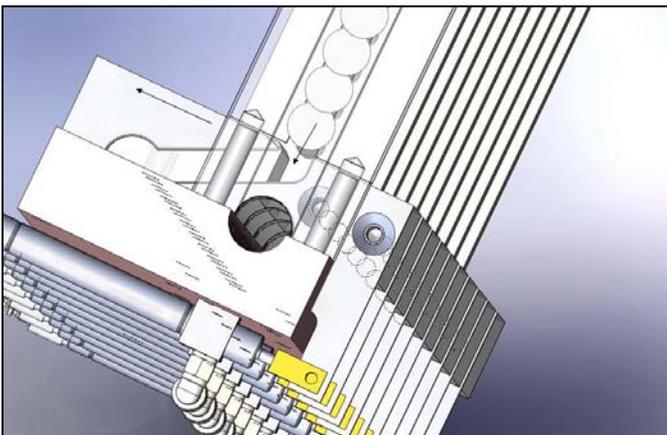


Figure 8. Step 5

## INTEGRATION

The new system was integrated into the existing production machine by modifying the fastener feed code, wiring and plumbing in the new hardware, and connecting the new feed tubes to the existing feed system.

The fastener feed code on an A380 LVER machine resides on a PLC. When the CNC determines which fastener is to be installed, it requests the fastener from the PLC which knows if it is to be auto fed from the rack, or hand fed from the drop tubes. Changes were made to the code so that the PLC can now select fasteners from the new Small Quantity Automatic Fastener Feed System as well.



Figure 9. System Integration

The new system required only two valve manifolds to operate the fifty escapements and 5 blast valves. The blast valves are actuated using 18mm Festo CPV valves as used on the cartridge feed system, while the escapements are actuated via a new 52 valve CPX manifold with an integrated input module to handle the fastener sensors. Using a single CPX manifold vs the 7 CPV manifolds it would previously take to work the escapements also contributed to the low cost of the system. Both manifolds were connected to the existing Profibus network.

In order to get the fasteners fed from the small quantity automatic feed system into the same feed tubes as the rack and drop fed fasteners, a new 3 into 1 selector was added to the machine. The selector manifold has three rows of incoming lines. One from the rack, one from the drop tubes, and one from the new feed system. A pneumatically actuated shuttle containing the outgoing feed tubes is lined up with the active system when a fastener is requested. The feed tubes, when aligned, provide a continuous path from the active system to the tool point

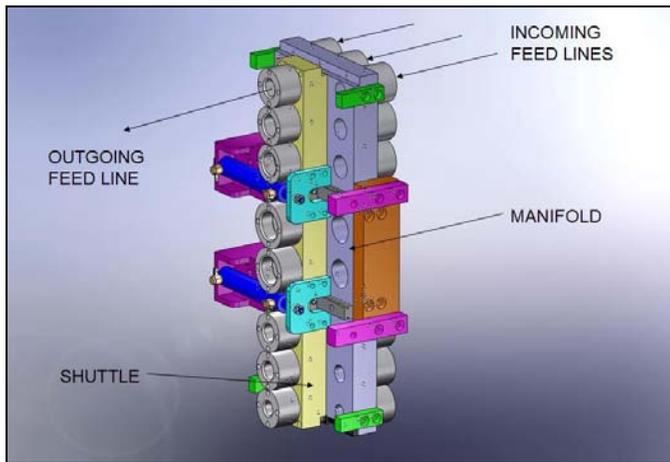


Figure 10. Selector

## PERFORMANCE GAINS

Any time the machine has to stop putting in fasteners automatically and request a hand fed fastener, makes a negative impact to the build time of one of these panels. Assuming it takes the operator (when present) a conservative average of 30 seconds to locate a requested manual fed fastener and hand feed it, moving nearly 550 fasteners to the Small Quantity Automatic Feed System saves nearly five hours per ship set.

Also, since the fastener fill levels are easy to monitor, even from outside the operating envelope of the machine, the system can be kept fully loaded by factory support staff which eliminates extra down time associated with running out of a required fastener when the machine is waiting to install it.

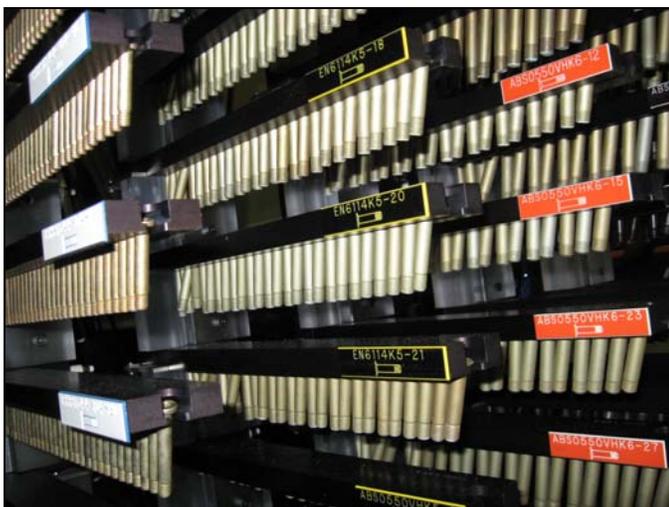


Figure 11. Fastener Visibility

## GOING FORWARD

We already have another machine in production which will be using this type of assembly as its primary feed system for bolts. This decision was based on the low cost, compact design, and the low required fastener count the project required, all of which are attributes for this new system.

This new project requires 1/4" slave bolts only and so it will have only one side. Since it is the primary feed system, and to expand the length of time between refills, this new system will have detachable hanger extensions. The extension can be manually or automatically filled off-line and then, attached to the end of the hanger, increasing its capacity. Once the extension is empty, it can be replaced while the machine is still operating with the fasteners currently in the hanger.

## CONCLUSION

Automating fastener installations was an expensive and hardware intensive process. Typically, only fasteners fed in very large quantities justify the use of a fully automated system. The new Small Quantity Automated Fastener Feed System gives the advantages of automatic feeding at a fraction of the cost.

In the case of the A380 LVER stage 0 machines, considerable production time has been saved with the addition of this new hardware making it a very cost effective upgrade. And since the new systems flexibility allow it to be used either as an auxiliary feed system or a primary one, depending on the machine requirements; it should have a bright future in the industry.

## REFERENCES

1. New Generation Automated Fastener Feed Systems by Philip Rink, Gregory Givler, Blake R. Stancik and William J. Nary II, SAE 1995
2. Flexibility in Fastener Feeding by Blake R. Stancik and Carter L. Boad, SAE 1999

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