**Motion Control Solutions**
Success Story

**Flying shears for high-strength steel plate**

**Motion control: Open, standard solution replaces "black box" synchronization – high energy efficiency, straightforward service**

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Low system complexity – low lifecycle costs. This combination also applies to systems for processing strip steel. The integration of synchronous functions – previously provided separately – in a motion control-based overall automation environment simplifies the implementation, maintenance, service and spare part procurement – and allows energy usage to be significantly reduced.

"Heavy gauge, high strength" – with the best quality

Heavy gauge, high-strength steel plate is used when constructing ships, offshore platforms, high-pressure tanks, high-rise buildings and bridges. The starting material is supplied from the steelworks as coil. Longitudinal and/or transverse cutting/slitting systems prepare it for sector-typical metal-forming processes to obtain flat, rigid plate steel in the appropriate format and without any distortion. The Italian Fimi Group has established itself as a leading manufacturer of "cut to length" and "slitting" systems for high quality "heavy gauge, high-strength" steel plate. Their cutting and slitting systems can also handle coils with steel plate thicknesses of 25 mm.

Fimi's new "Flytronic" flying shears are also designed for high strength steel plates with these gauges. Depending on the particular version, they can cut through metal up to 10, 16 and even 25 mm thick – at material speeds of 65 m/min. The knife beams are moved in synchronism with the moving steel plate during the cut. This ensures that even at these high speeds and thicknesses, a precisely vertical cut is made through the plate. The knife beam and its drive are mounted on a trolley, powered by servomotors, which, depending on the version, can weigh up to 35 tons.

**Open, standard solution replaces "black box" synchronization – service from a single source**

Up until now, for flying shears in the steel industry, the individual sub elements of the automation were implemented in separate modules. Especially the externally purchased synchronization of the traversing trolley with the moving steel plate repeatedly crystallized out to be a block box that was not particularly service friendly. Machine OEMs and operating companies were only able to influence this black box to a low extent, which was a limiting factor when it came to further developing their machines.

When developing the new flying shears, the Fimi Company used the Simotion motion control system from Siemens AG. This open automation system offers state-of-the-art motion control as well as extensive technology functions to address the widest range of applications. Further, it addresses tasks, which in classic applications are handled by a PLC. Simotion is admirably suited to combine automation structures that have grown over time, and simplify them in an optimized, overall system.

**Overall system optimization possible for the first time by simply emulating previous sequences in the motion control system**

Based on the experience gained with dedicated systems for the individual automation tasks, it was simple for Fimi development engineers to simply transfer the control of the flying shears into the Siemens system. The open, standard "flying shears" application was used from the Simotion toolbox, replacing the motion synchronization, previously purchased as non-transparent subcomponents. This toolbox is a collection of standard applications – with secured quality – for typical motion control tasks in a wide range of sectors.

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and industries. Its behavior can be parameterized to address all of the process-relevant details. Further, when required, its program can be adapted to comply with specific requirements.

Contrary to the previous situation, machine OEMs now have full control over the system behavior. What is especially important is that the Fimi experts can incorporate their process-related skill sets in the details of the motion control, which was not simply possible beforehand.

As is the case in most of the applications, Fimi was able to use the standard “flying shears” Simotion block without having to make any changes – in spite of the requirements placed on the dynamic performance of the closed-loop control and the extremely high process forces.

**Perfect vertical cuts even at plate speeds of 65 m/min**

When moving forward, the huge trolley is accelerated along a distance of just a few decimeters, and synchronized with the steel plate. And precisely so that the cutting position of the moving knife beam corresponds to the cutting position on the moving steel plate. As soon as the synchronous speed and synchronous position have been reached, an eccentric mechanism activates the knife beam and drives the cutting-edge through the steel plate. The steel plate and trolley move in precise synchronism for the duration of the cut. This means that even at high plate speeds and gauges, there is sufficient time for a perfect vertical cut through the steel plate.

A huge amount of energy is required for the cut itself. This is stored in a flywheel, and at the right instant this is transferred to the knife beam by coupling to an eccentric mechanism. The fundamental advantage of the solution: Before each cut, the energy lost as a result of the previous cut must be fed back to the flywheel, and to do this, the complete process cycle time is available. This significantly reduces the load peaks on the power supply. For the “Flytronic”, the flywheel drive – a servomotor – is now integrated into the motion control, both from the control side as well as from the energy side. This means that the braking energy of the trolley can be directly used to accelerate the flywheel. Further, the motion control system ensures that at the instant of the cut the setpoint speed of the flywheel as well as the phase position of the eccentric mechanism correspond to the cutting position. This is necessary, so that the cut can be executed without any delay as soon as the trolley and the moving steel plate are in synchronism. This is necessary because the traversing range of the trolley is limited to 1350 mm, and the speed of the steel plate is comparatively high with 65 m/min – and part of this distance is also required to reverse the trolley which weighs many tons.

However, before it reverses, the trolley moves out of synchronism with the moving steel plate and accelerates a small amount past it in order to move the knife away from the steel plate. This avoids any friction between the knife edge and steel plate when the knife beam is lifted. This has a positive impact on the cut quality as well as the knife lifetime.

As soon as the knife has been lifted from the moving steel plate, the trolley is braked and traversed to the starting position of the cyclic process.

**Common DC link for all drives – significant energy-saving through energy equalization**

All of the drives of the flying shears represent a single synchronous group. This means that they can all be connected with one another through a common DC link. When it comes to cyclic motion sequences, this saves a significant amount of energy. As a consequence, not only can the braking energy, which is generated each time the trolley reverses, be used to bring the flywheel of the knife beam up to its setpoint speed, it is also possible to store the excess energy, and use this to accelerate the trolley the next time. Load peaks are reduced or even avoided altogether as a result of this energy equalization between the individual drives. The power drawn by a Fimi “Flytronic” is therefore significantly lower than for previous models with comparable cutting performance. The DC bus, supplied from several sources, also improves the provision of energy in critical process phases. This not only enhances the efficiency, but also improves the control quality.
Increase technological lead: More influence on the process – new knowledge gained

Fimi plans to transfer its good experience gained with its "Flytronic" to other stations of the cut-to-length and slitting systems. The strategic approach goes far beyond the advantages of an automation solution based on motion control, as Managing Directive Rovelli Giuseppe explains: "The flying shears represent well proven technology, and in this particular version, is a very attractive solution for many users. Current orders in-house for "Cut to Length Lines" (CTL lines) with the "Flytronic" clearly verify this. Further, with this open automation solution, we have a better insight into the process itself, therefore providing us with more options of influencing it. This allows us and our end users to have a better understanding of the plastic deformation process in the steel plate. As a consequence, we can prepare our machines more simply and flexibly to address new materials that are still not available today. For end-users, this technological flexibility represents a real competitive advantage as well as a high security of investment."

The well-proven flying shears concept becomes even more attractive with a motion control-based automation solution: The main advantages include simpler service, lower energy costs and improved process monitoring