SUSTAINABLE ROLL FORMING

ISMR SAYS: *"DREISTERN, who celebrated its 75th anniversary in 2024, is introducing a new system that makes it possible to detect profile straightness on the roll forming machine."*

Sustainable roll forming processes are possible through intelligent scrap avoidance. Planned scrap rates of significantly less than 1% of the material used are already within the realms of feasibility in roll forming today, DREISTERN told ISMR.

By Dr. Tilman Traub, *Professor of Automation Technology, Aalen University,* and Frank Gremmelspacher, *Senior Marketing Manager, DREISTERN.*

With the 'Green Deal', the European Commission is obliging industry to become greenhouse gas-neutral by 2050. However, the gradual reduction in available emission allowances envisaged for this will pose challenges for manufacturing companies in the foreseeable future. To avoid falling into a cost trap, emissions must be reduced as much as possible and the use of CO_2-intensive raw and auxiliary materials must be organised as efficiently as possible.

In terms of the carbon footprint of entire industrial sectors, the production and processing of steel has the largest industrial carbon footprint to date (ahead of cement product production[1]). New ways of producing crude steel, which are being promoted by well-known major steel manufacturers under the banner of 'green steel', offer the potential to significantly reduce the CO_2 footprint.

However, a closer look at the material flows within the life cycle of steel reveals another challenge: a good fifth of the steel in circulation is in an endless loop between melting furnace, processing and scrap container and is never used as a final product in this cycle[2].

1. Allwood, J: M.; Cullen, J. M.: Sustainable Materials With Both Eyes Open. UIT Cambridge, Cambridge, 2012.


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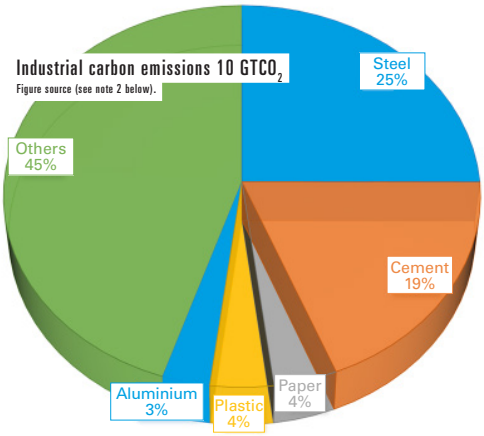
About the Authors

Dr.-Ing. Tilman Traub completed his doctorate at PtU between 2014 and 2019 and was a chief engineer at the institute from 2015. In his doctoral thesis, Dr. Traub "revolutionised" the roll-forming process, defining measures to increase forming efficiency by up to 89%. He was awarded the Otto Kienzle Commemorative Medal on 4 November 2021 and is Professor of Automation Technology at Aalen University.

Frank Gremmelspacher is senior marketing manager at roll-forming specialist, DREISTERN. He is also a certified project management specialist, with many years of management experience.

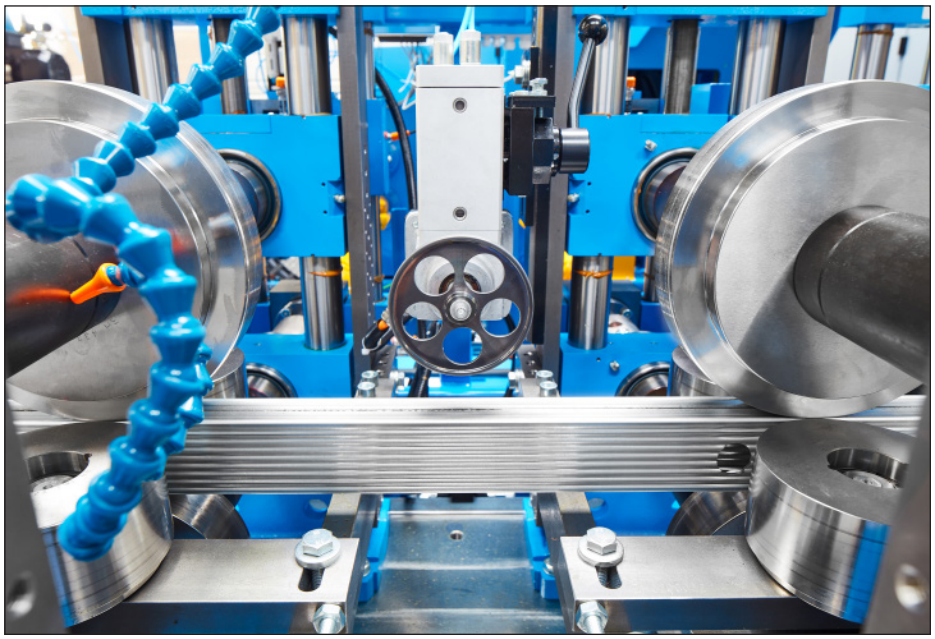


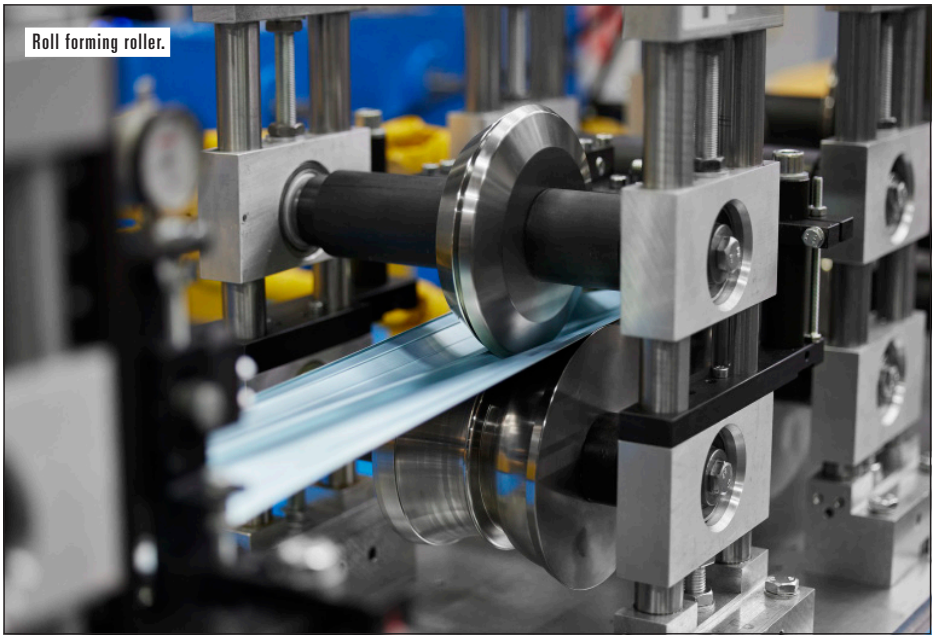
There are many reasons for this 'scrap cycle': rejects during the production of semi-finished products, (planned) offcuts in the processes or rejects from the finishing processes.

Sustainability benefits

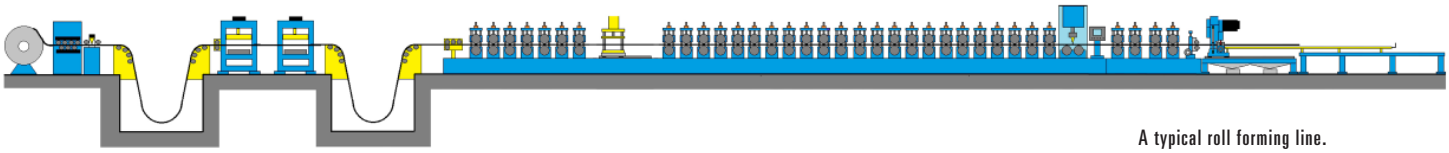
Leaving the production of semi-finished products aside for a moment, there are two main challenges for production processes. On the one hand, it is important to reduce planned waste and therefore the amount of material used. Secondly, the process must be controlled in such a way that rejects are avoided or at least recognised at an early stage before entire batches are declared as rejects. Roll forming is a manufacturing process that meets both these challenges.

In roll forming, an initially flat metal strip is gradually formed between forming rollers into an open or closed finished profile. Forming




Roll forming roller.

2. Allwood, J: M.; Cullen, J. M.: Sustainable Materials With Both Eyes Open. UIT Cambridge, Cambridge, 2012.



A typical roll forming line.

usually takes place at room temperature so that no additional energy is required for heating. For efficient operation, further processing steps (such as the insertion of holes and embossing, the closing of closed profiles and cutting to the final profile length) can be integrated into the system

Cutting to the final profile length means that no further cutting, which in turn causes scrap, is required when the profiles are assembled. Furthermore, as the fed strip usually has exactly the strip width required for the finished end product, there is no planned waste apart from the cutting slugs when the punched holes are inserted and any cutting waste (e.g. for mitre cuts). Planned waste is therefore only produced when a new coil is applied.

Planned scrap rates of significantly less than 1% of the material used are therefore already within the realms of feasibility in roll-forming today. There are also robust approaches in roll forming for the second challenge, the minimisation of unplanned scrap.

Minimising scrap

The illustration above shows a typical roll-forming line.

From left to right, a coil is first unwound and the sheet is straightened. An optional processing station enables the end of one coil to be joined to the start of the new coil. This minimises the planned scrap when changing coils. Appropriate markings on the strip also allow the weld seam produced to be tracked as it passes through the system, so that the component with the transverse seam can be specifically ejected at the end. When using a coil that is several kilometres long, the scrap can be limited to just a few centimetres.

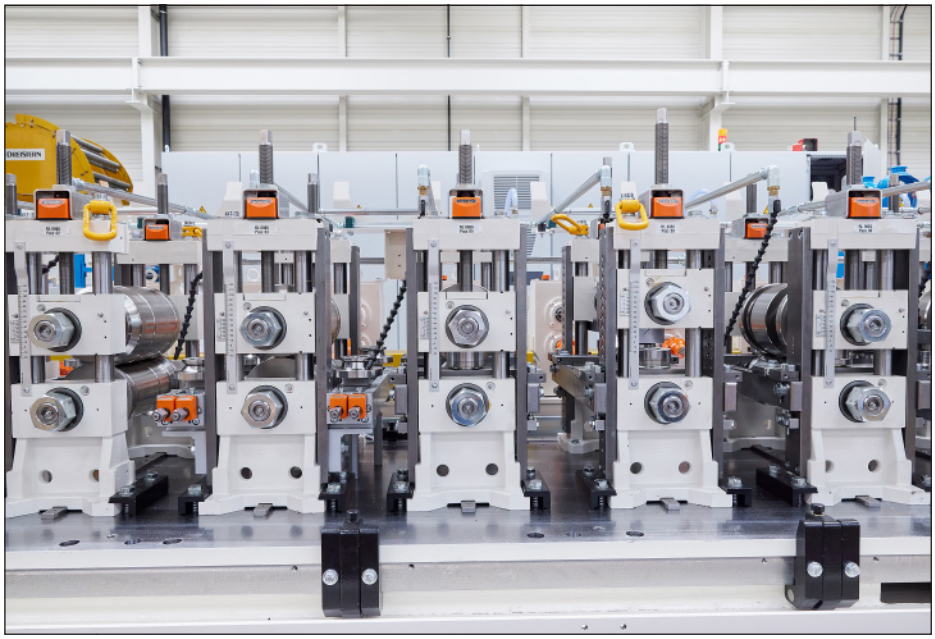
In the second processing station, the holes required for the profile are punched into the still flat belt. Camera systems at the outlet of the press continuously monitor the resulting punching pattern. If, for example, some of the holes are missing due to a broken punch, the machine can be stopped immediately without producing any more scrap. The quality of the weld seam created during the welding process can also be continuously monitored using camera systems in conjunction with image analysis.

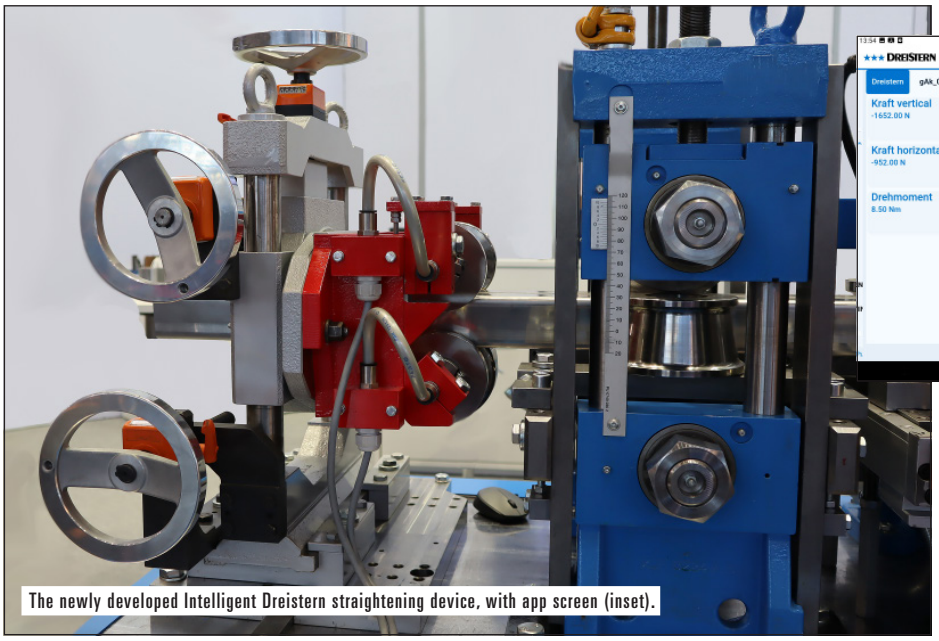
The profile geometry, in turn, can be monitored using profile scanners, while the component length can be monitored by comparing the signal from a measuring wheel with the cut-off signal from the cut-to-length unit. This allows most of the quality-relevant component parameters to be continuously monitored and a corresponding alarm to be triggered immediately if permissible tolerances are exceeded. This enables an immediate response to changes in the process, even before large quantities of rejects are produced.

Detecting profile straightness

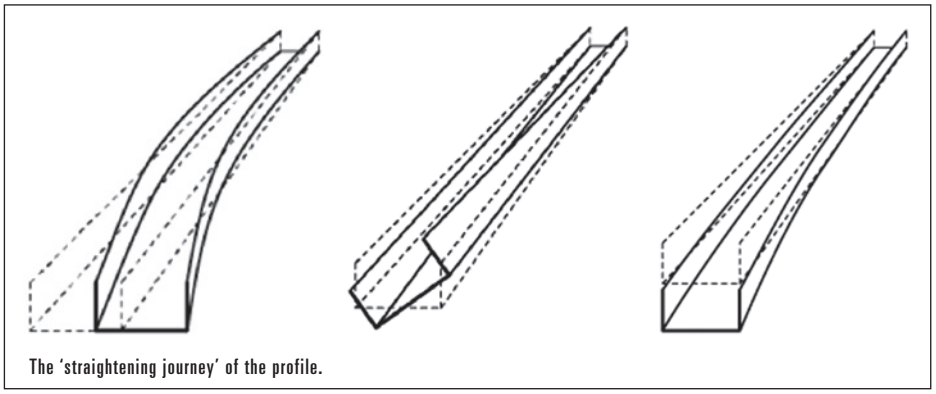
However, there is one quality feature that has not yet been systematically monitored inline; the straightness of the profiles in the longitudinal direction. During the process, multidimensional stress states occur during roll forming which, in the worst case, lead to partial elongation of individual sections in the profile cross-section. This inhomogeneous longitudinal strain distribution leads to a curvature or twisting of the profile along the longitudinal axis, particularly for asymmetrical profiles.

Because of the clamping of the profile in the roll forming machine, these geometric defects are usually only recognisable after cutting. At this point in the production process,





The newly developed Intelligent Dreistern straightening device, with app screen (inset).



The 'straightening journey' of the profile.

automatic quality detection is usually no longer possible, as the profiles are packaged directly. Dreistern is therefore now introducing a new system that makes it possible to detect profile straightness on the roll forming machine.

The patented system in the straightening device is based on the fundamental idea that although the profile straightness cannot be geometrically detected due to the clamping of the profile in the roll forming machine, the reaction forces required to hold the profile in its constrained position can. For this purpose, the presented straightening device has integrated various force sensors that detect the reaction forces that the profile exerts on the leveller. The sensors are integrated into the axes of the leveller so that they are protected against damage in everyday industrial use.

The measured forces can be taken? once for a straight profile. If the straightness of the profile (and therefore the required reaction forces) change during the next process, the associated application can immediately trigger an alarm and alert operating personnel to the impending quality problem. In this way, the last gap in the closed quality control loop can be closed.

The system works independently of the existing system control and can therefore be integrated into existing roll forming processes. A connection to the system control is possible in individual cases, so that production can also be interrupted automatically in the event of an alarm. The system is operated via an app that runs on a supplied tablet. Installation on other end devices, such as the system operator's mobile phone, is also possible if required.

The next step

Initial applications of the new system in industrial processes have demonstrated the efficiency of the new concept.

The illustration (top right) shows that a change in profile straightness in the vertical direction (green curve) leads to a significant change in a load component (blue columns). This is impressive as the amount of bowing is still within the permissible product tolerance. The other load components (red columns), which correlate with horizontal curvature (purple curve), remain virtually unchanged.

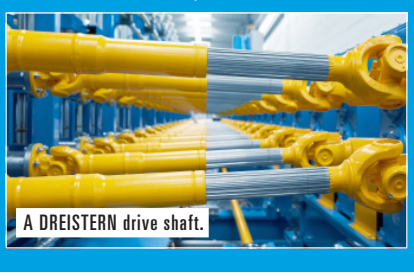
This is not the end of the development process. In the next step, DREISTERN is working intensively on further developing the existing alarm function so that operating personnel are made aware of the impending error. This includes diagnosing the cause and guiding them through the solution process. ■

About DREISTERN GmbH & Co. KG

Since its foundation in 1949, DREISTERN GmbH & Co. KG has been setting new benchmarks in global roll forming for a wide range of roll formed products. Now in its third generation, and celebrating its 75th anniversary in 2024, the family company specialises in roll forming technologies, machines and process execution.

"Thanks to our intelligent technologies (Roll Forming 4.0 or RF4.0), the forming process is controlled in such a way that the required geometry and dimensional accuracy of the product is achieved. Only the exact forces and torques that are required to achieve the best result are applied. In addition to product quality, this also increases energy efficiency," it told *ISMR*.

"We use modern drive and control technology, as well as servo technology, to increase the energy-efficiency of roll forming production. Functions such as residual strip processing, automatic good and bad part recognition, scrap-optimised cutting or waste-free part changing reduce the proportion of scrap to a minimum. Additional energy-saving functions include intelligent switch-on/switch-off functions or reversing optimisation for our flying cut-off machines. Intelligent retrofitting solutions, such as adding a skin-pass-station, also make a decisive contribution to increasing the degree of material utilisation," it added.



A DREISTERN drive shaft.

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