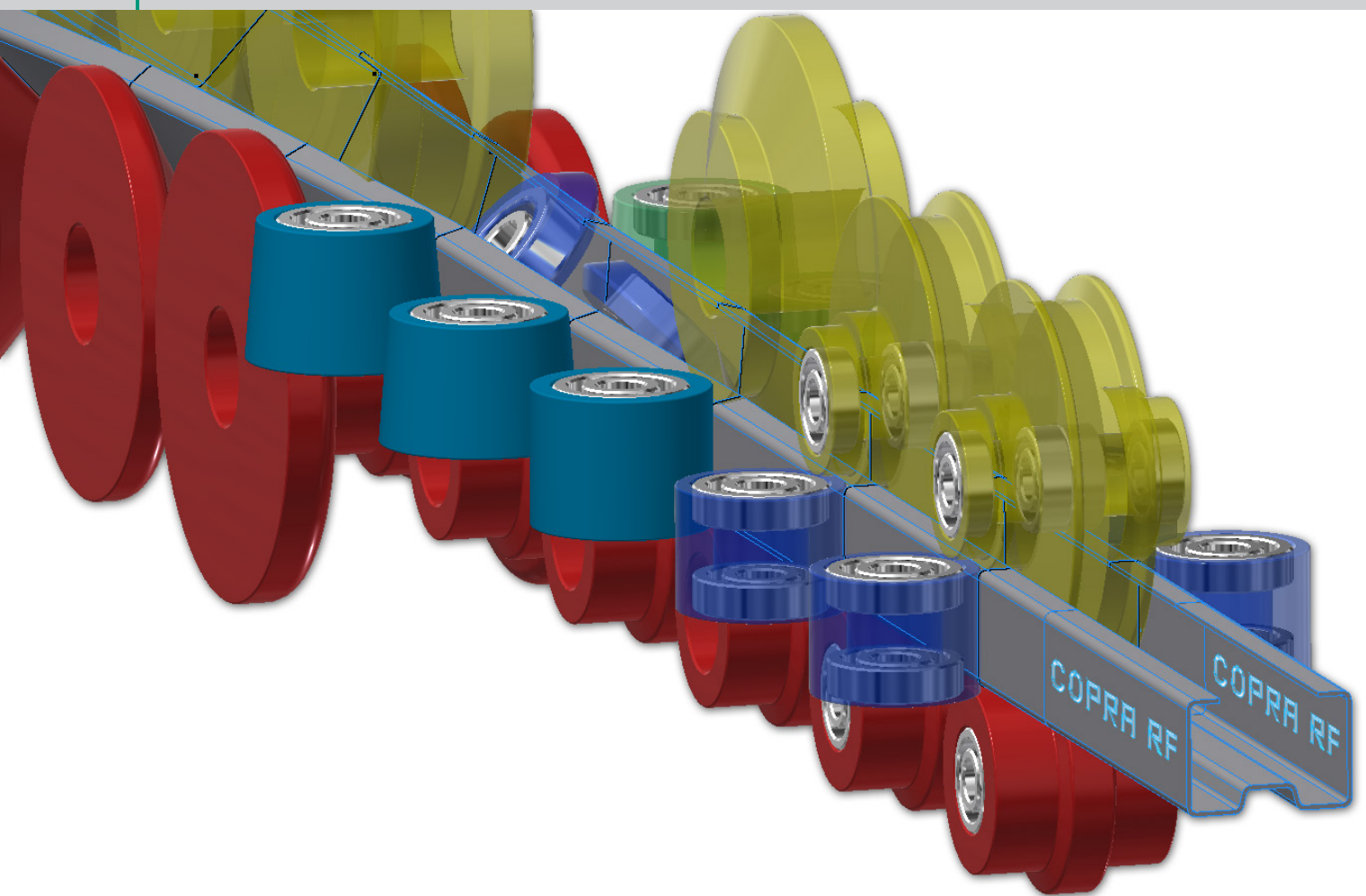


COPRA® RF Sections

Our software module COPRA® RF Sections is tailor-made for the design and development of open as well as closed profile cross sections. It's equally suited for simple as well as complex profiles. Together with the optional analysis modules and COPRA® RF Roll Design, roll formers have everything they need for consistent processing of high quality roll formed sections.



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Section design with COPRA® RF Sections

COPRA® RF Sections provides several convenient possibilities for the design of the final profile. The user either draws the contour, extracts geometry from a 2D customer drawing, uses a 3D CAD model or generates elements from predefined section components. If it's a punched section, even the punch hole pattern from the 3D model will be adapted. The position of the punch holes on a flat strip will be automatically adjusted, with the calculated material neutral line considered.

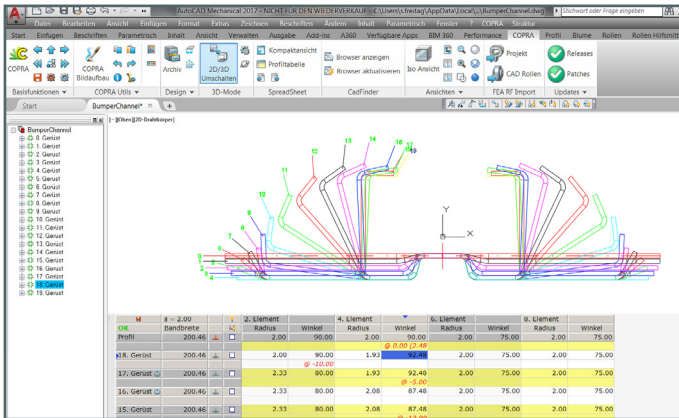


Fig. 1: Easy and quick section design with COPRA® RF Sections

COPRA® RF SpreadSheet and COPRA® RF Trapeze/Corrugated

COPRA® RF Spreadsheet is a very powerful tool for quick and easy parametric flower design in table form. The program automatically updates any changes across the whole flower pattern, without additional input from the user. You can not only modify any geometric data of the final cross section, but even the type of strip width calculation or the calibration method. COPRA® RF SpreadSheet calculates the new flower and also automatically adjusts the bending angles in case a station has been modified in the meantime.

COPRA® RF Trapeze / Corrugated is another technology module that provides special functions for trapezoidal- or corrugated sheet metal. It calculates the optimal bending pattern for trapeze-like sections by (dependent on the bending angle) making sure a constant transverse material flow for a minimum necking in the bends.

Furthermore, there is also the option for automatic roll design, whereby the feature "clone rolls" will be applied efficiently.

COPRA® RF Flower Technology and COPRA® RF DTM – Simulation- and analytics modules for the optimal flower

In addition to the basic functionality of COPRA® RF Sections, data M offers other optional program components for analysing and optimizing the roll forming process.

COPRA® RF Flower Technology incorporates technical calculations like the determination of the theoretical elastic recovery or down-hill-forming with minimal elongations. It also allows the sequential depiction of the individual bending pattern after input of the necessary parameters. Furthermore, different forming curves can be selected for the calculation of the strains.

The "real-time" monitoring of longitudinal strains feature, allows the designer to directly track the influences of a modification, in a separate window or on a second monitor. Modifications to the forming flower in the COPRA Spreadsheet project are also displayed in real-time in the DTM window.

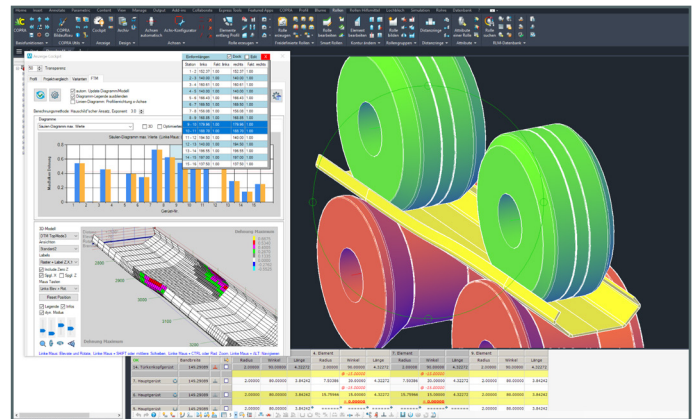


Fig. 2: COPRA® RF shows values and positions of longitudinal elongations

Unwanted plastic longitudinal elongations across the strip edges are an unavoidable side effect in roll forming. Usual consequences are various defects across the profile like twist, bow or end flare. To prevent this, the module COPRA® RF DTM provides calculation of the theoretical elongations. Because a three dimensional visualization of the forming process not only exposes the path of the strip edge from different perspectives, but also other parts of the section that more importantly are quickly calculated and visualized.

COPRA® RF DTM uses a plain geometric approach based on the theory of thin shells. The module determines the highest occurring values of longitudinal

deformations. Due to a minimum of processing time, it is particularly helpful for initial evaluation of the feasibility of a project. With COPRA® RF DTM, you can pre-optimize an entire roll set prior to conducting a subsequent FEA simulation.

Essentially all that is required is data such as roll diameter and horizontal centers as well as the section flower. Until today, COPRA® RF DTM is the only software solution available worldwide that can calculate the strip strain that is inherent to roll forming. By doing so, it considers the important influence of the forming roll tool diameter. Above that, the module calculates the influence of further factors like material thickness and shows the distribution of longitudinal deformations in areas of compression as well as the occurring material curvatures in the forming areas.

COPRA® RF Roll Design

After completion of the flower design, the associated roll tools must be designed. An accurate roll design is eminent for the quality and the manufacturing cost for the final product. COPRA® RF Roll Design provides several section specific functionalities that no other software solution can offer. Particularly noteworthy is the „SmartRolls“ functionality. It allows the accomplishment of the whole roll design without further construction lines. The number of required clicks can thus be reduced to a minimum. Following profile and flower optimization, the first roll contour will be generated. The available contours of the flower pattern itself serve as respective starting points.

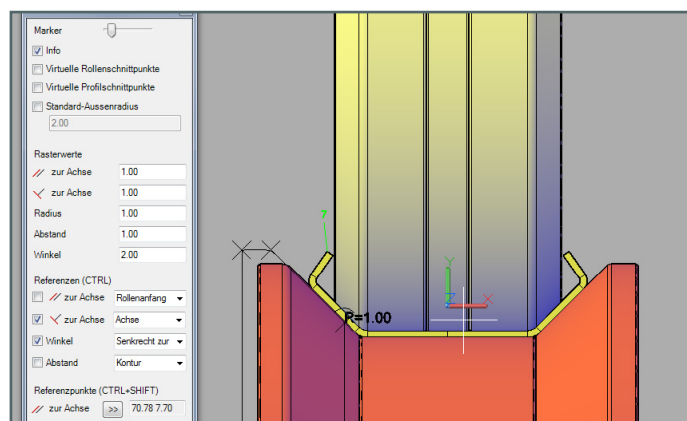


Fig. 3: Dynamic modification of roll design with COPRA® RF SmartRolls

Also, the designed cross sections can be laid out automatically as a rough draft and will be ready for completion with targeted graphical functions quickly and safely. Following completion of the roll design, both the individual roll as well as the assembly plan dimensioning will be conducted automatically by COPRA® RF.

Additionally, your engineers can rely on pre-made roll design functions for many standard sections like U-, C-channel or top hat profiles. For this, the software calculates the roll contours including all details and not only the rough contours. In order to conduct a precise cost calculation, COPRA® RF Roll Design furthermore works out the weights of the finished tools, reduced by the mass of the boreholes.

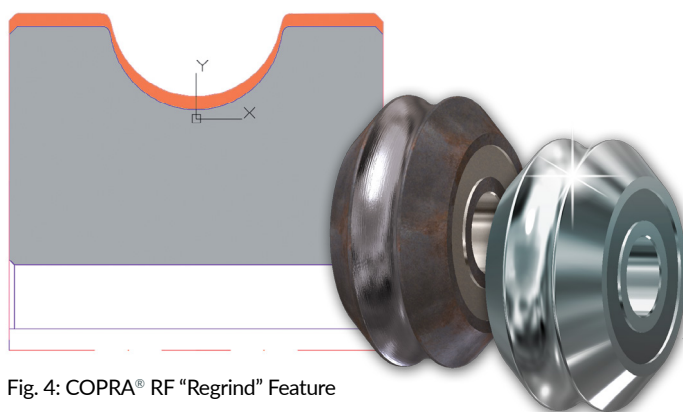


Fig. 4: COPRA® RF "Regrind" Feature

AssemblyCheck – Implementation of Roll Forming system without mishaps

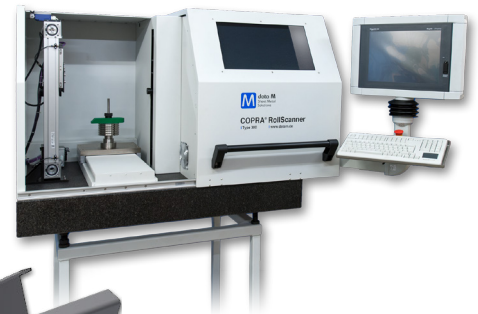
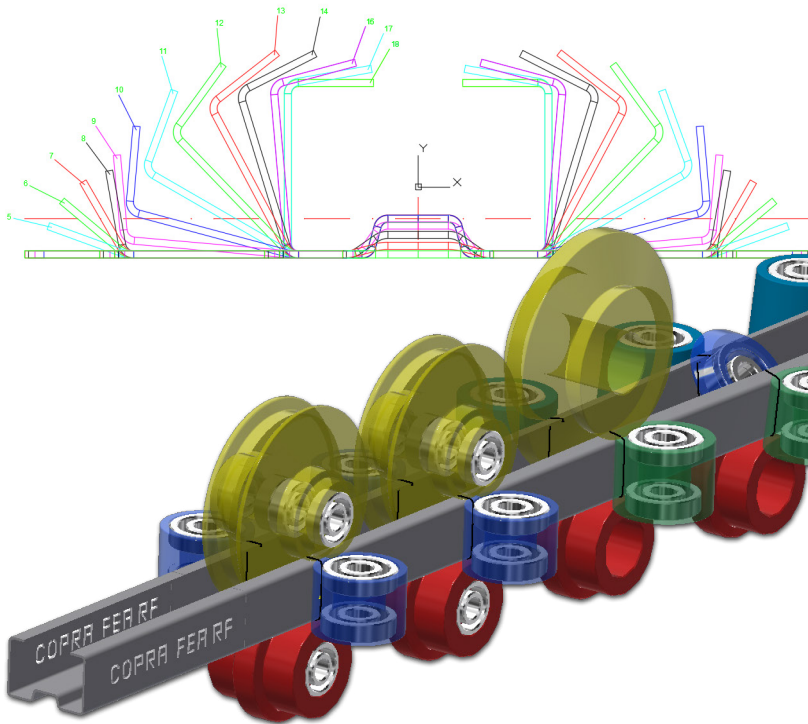
The function AssemblyCheck helps your technicians significantly with the start-up of a roll formed product. After design of the required roll set, the delivered rolls need to be measured with the COPRA® RollScanner. Following the transfer of the contours to the data base COPRA® RLM, the designed and scanned rolls will be overlapped and compared in COPRA® RF. Thus, all deviations regarding roll widths or radii will be exposed instantly. They would have otherwise caused incorrect positioning in the bending area. The first roll will be aligned with the machine side, all further rolls along their respective predecessor. If the rolls need to be adjusted during implementation, the whole design will be updated straight away. AssemblyCheck also provides detailed information regarding roll positions. Displacements of single rolls due to faulty roll widths are also easily identified.

Design of combination roll tooling

Due to greater variety of section forms and rising tool cost, manufacturers increasingly exploit combination roll tooling, thus enhancing the tooling utilization rate significantly. COPRA® RF for sections offers various applications for different scenarios. For instance, should identical section forms with varying measurements have to be produced, COPRA® RF adjusts the available flower automatically to the newly required dimensions. Hence, sections of similar shape only

need to be handled once. Due to the overlay of the modified cross sections with the related roll tooling, the designer can then easily determine which rolls only need repositioning, width or diameter adjustments or where spacer rings might have to be inserted. Should it be desired, both the repositioning of the rolls as well as the width adjustments can be done automatically by COPRA® RF, the designer only needs to adjust the necessary roll diameters.

- | CAD Finder Project- and document-management
- | SpreadSheet – parametric flower design
- | Punch Hole Editor: modification of 2/3D model
- | Analytic simulation with COPRA® RF FTM
- | Effective roll design with SmartRolls
- | Automatic generation of drawings
- | Direct link to COPRA® FEA RF
- | RLM – data base powered Roll Lifecycle Management

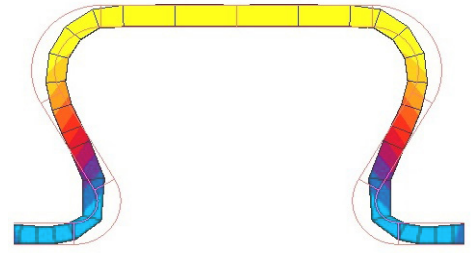


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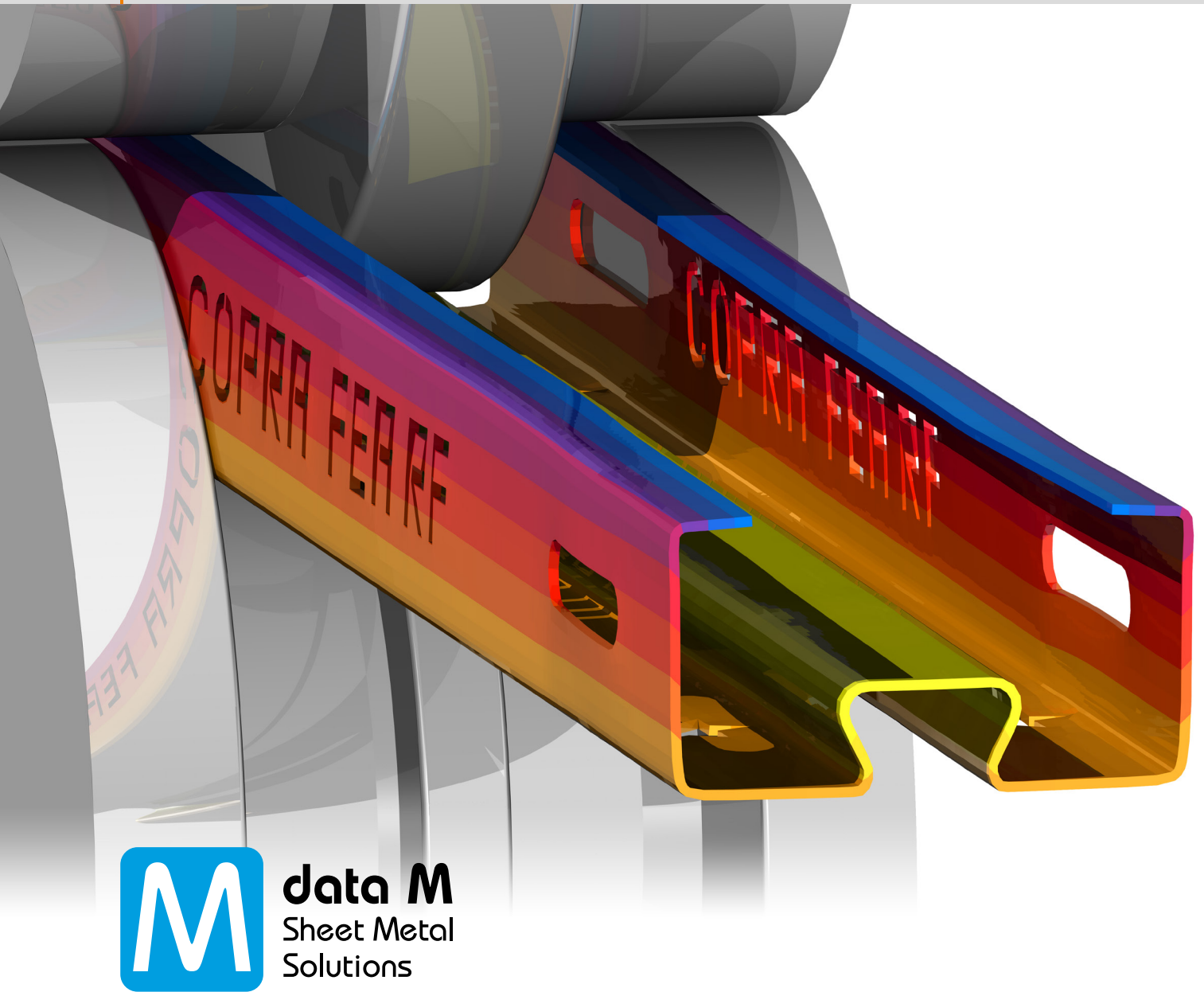
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COPRA® FEA RF



Our Simulation Module COPRA® FEARF is the world leading software solution for the simulation of Roll Forming processes. The program calculates the entire process including pre and post operations and screens for possible design errors. Through the intelligent interconnectedness of our COPRA® products, simulation results will be available for design review immediately. Due to our intelligent menus there is no need for a dedicated FEA specialist.

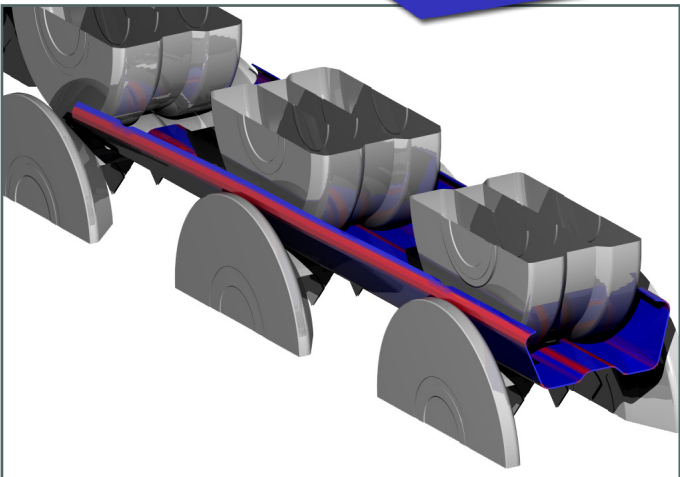
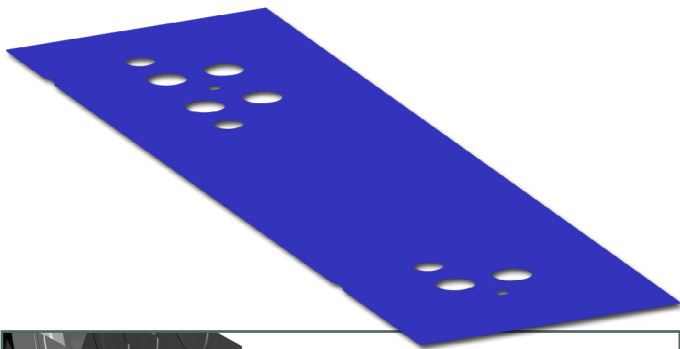


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Prevent trial and error by simulation of the manufacturing process

More often than not, roll formers operate along the lines of trial and error. After production of the entire roll set, the machine is activated in order to find mistakes or weaknesses during the roll forming process or even to test the feasibility of the entire project. Naturally, this method often causes high expenses. To prevent scenarios of this kind, companies of various manufacturing branches conduct process simulations. With methods like these, producers predict results of planned manufacturing processes by reference to virtual models. data M has been developing and enhancing COPRA® FEA RF for 20 years. The software computes the roll forming process with the so called non-linear elastoplastic calculation method.

With this approach, even the most complex production processes can be verified and the results thus be predicted with sufficient accuracy. COPRA® FEA RF imports the required data directly from the design module COPRA® RF. The results in turn will be available for design optimisations right after simulation. All the important information like forming forces, driving torque, elongations etc. can be viewed and applied accordingly.



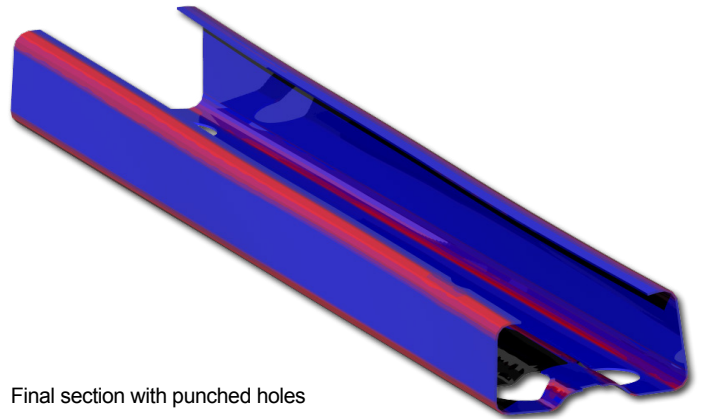
Pre- punched material and roll forming process

However, preventing defects and bad product quality with consistent simulation is only the most straight-forward advantage of COPRA® FEA RF. Product development and the design process can be optimised and thus also profit hugely from verification. One also shouldn't underestimate the increased know-how within the company through testing of various forming strategies within a virtual roll forming machine. We must remember a "classic" trial and error approach generates high cost only by testing a single strategy.

COPRA® FEA RF – The virtual Roll Forming Machine

In order to understand the functionality of COPRA® FEA RF, it is helpful to imagine the program as a virtual roll forming line since our software enables you to test new roll designs at will before the actual roll manufacturing process. Sometimes even more important: It is particularly suited to test if complex projects are feasible after all.

All of our customers were able to achieve significant cost reductions by consistent utilisation of our simulation tools. Nevertheless, there is still persistent reservation towards FEA simulation among some roll formers.



Final section with punched holes

Contrary to a common believe, manufacturers don't need a dedicated FEA specialist. Rather, any designer with experience in the field of roll forming can operate the software because COPRA® FEA RF automatically generates the FE model out of the design data. There is also the assumption that processing would take as long as simple test procedures. This may have been true circa ten years ago. Nowadays even desktop CPUs provide enough performance to simulate even complex roll forming processes including pre and post operations in only a few hours.

Our simulation tools have convinced a lot of project managers, even those that initially believed the investments wouldn't be "worth it".

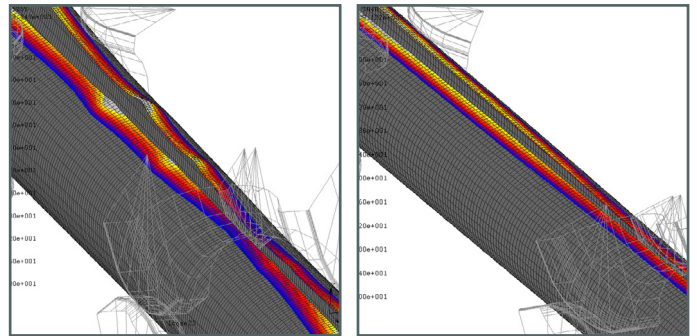
Provided a complete roll set costs circa 30 000 € and the ability to reduce tool wearout to a minimum through consistent simulation will alone recover the capital expenditure for the software, even in the mid-term. Additionally, machine down times as well as the required times for equipping and implementing will also be reduced, thus the machine can actually be used for bread and butter production with the time saved.

Increased product quality through non-linear Finite Element Simulation

Material alterations that occur during manufacturing processes frequently present producers with huge challenges. COPRA® FEA RF simulates these changes reliably and quickly. Also the usual defects like strip edge waviness, twist or bow can be prevented beforehand by verification of the design. After the simulation, COPRA® FEA RF provides a dynamic animation of the roll forming process as well as a graphic depiction of the results.

You can follow how the material is behaving during the actual manufacturing process. Furthermore, the software provides important information of the applied forces, torsional moments, pressure and tension values as well as lastly a complete 3D-visualization of the finished (virtual) product. Of course, the applied pressures can also be broken down by the respective axis.

The consistently enhanced user interface allows your designers to navigate naturally through the forming stations. After output of the simulation results, the respective positions of the relevant cross sections will be identified by "Roll-Planes" and compared to the required cross section. You can of course export the data for further use with other CAD programs. Your designers will then be able to test new roll tools or complete sets for the effects on the manufacturing process. Like all COPRA® products, the simulation methods are tailored to the roll forming process – and for highest efficiency.

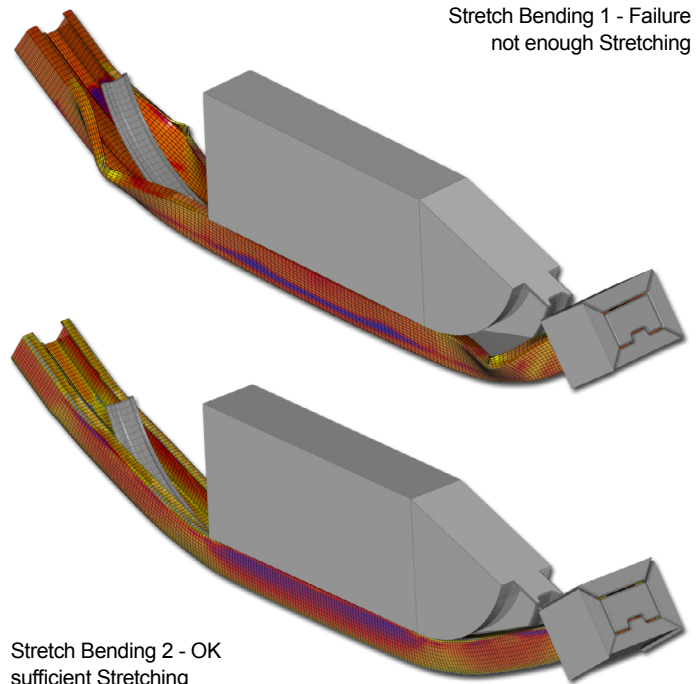


Strip edge waviness, optimized design

COPRA® FEA RF as a fundamental element of the process chain

COPRA® FEA RF not only simulates the roll forming process, but is furthermore able to calculate all common pre and post-operational manufacturing steps including stretch-bending. The software is thus a central part of our integrated solution concept for roll formers. Repeated verification through FEA simulation is inevitable for subsequent calculations.

Particularly stresses and tensions caused by roll forming influence the calculation results significantly. In case of a car bumper for instance, all process steps will be simulated reliably, so that the roll set can be adjusted quickly and easily as required.



Stretch Bending 1 - Failure not enough Stretching

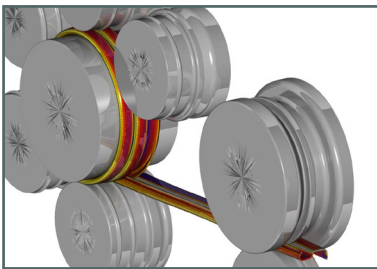
Stretch Bending 2 - OK sufficient Stretching

Why COPRA® FEA RF?

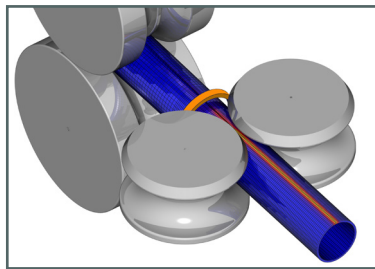
COPRA® FEA RF is a software solution for the simulation of roll forming processes as well as pre and post-operational manufacturing steps. However, roll formers profit in multiple ways: Additionally to reduced machine- and tool-cost as well as the avoidance of total losses, COPRA® FEA RF generates genuine innovation within companies.

Various forming strategies can be tested within virtual roll forming machines and thus optimise the production process in the mid- and long-term. Stay competitive with software verification instead of expensive trial and error.

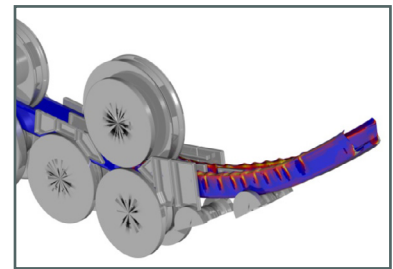
- | FE-Model generation within seconds
- | Easy and quick optimization of roll set
- | Virtual implementing of roll designs
- | Advanced Restart – adaption of grid at any time during simulation
- | Scaffolding stiffness – calculates alteration of roll gap by forming forces



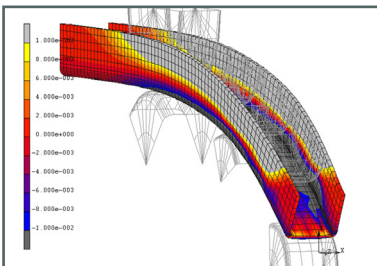
| Winding



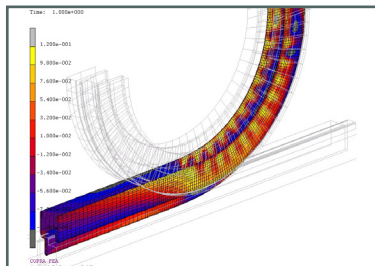
| High-frequency welding



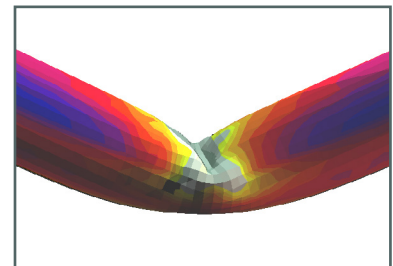
| Inline-Bending



| Sweeping



| Stretch Bending



| Crash Simulation



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