S U C C E S S S T O R Y

ZUKEN®

E³ series®

E³.series is a scalable, easy-to-learn system for the design of wiring and control systems, hydraulics and pneumatics.

KRONE integrates ECAD, MCAD and ERP to enable integrated design and sourcing

KRONE
THE POWER OF GREEN

"Today, we have all mechanical, hydraulic and electrical assemblies available in one information source. This puts us in a position to build a number of robust downstream processes on them"

Stefan Thygs,
System Administrator,
Electrical Engineering
KRONE

ZUKEN®

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KRONE, a major brand in the agricultural machinery market, implemented an interdisciplinary product development process. Using Zuken's E³.series they linked ECAD, MCAD and ERP to develop an integrated digital engineering and sourcing process, achieving sizable benefits for both sourcing and service. With an integral representation of mechanical and electrical product information, KRONE was able to make solid progress in implementing its major business optimization strategies: Industry 4.0 and Farming 4.0.

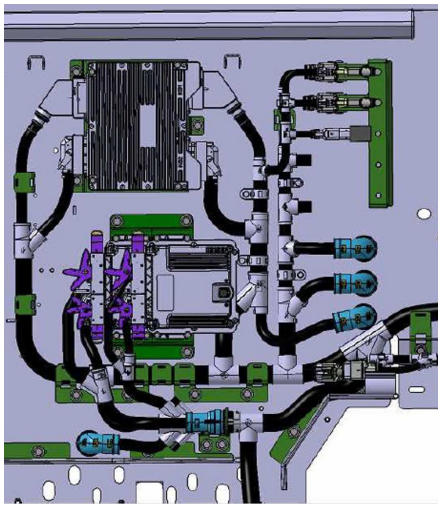
When KRONE introduced its latest compact forage harvester, the BiG X 480/580, it marked a milestone in the company's rich history of innovation in the area of agricultural machinery.

Not only was it a downsized version of the world's most powerful precision forage harvester, the KRONE BiG X 1100 with more than 1000 HP, it was in fact, the first of a new generation of products that was developed in an interdisciplinary process that brought together electrical and mechanical engineers to work in a harmonized environment. It was achieved by linking electrical CAD, mechanical CAD and ERP to enable an integrated digital engineering and sourcing processes based on a digital twin.

Like many machinery companies in Germany, KRONE is a privately-owned business that has evolved over time into a global manufacturing company with a strong tradition of craftsmanship, innovation and quality.

Founded by Bernhard Krone, and family owned over four generations, KRONE is organized in two divisions, KRONE Commercial Trailers and KRONE Agricultural machinery.

The agricultural operation, located in Spelle, Northern Germany, since 1906, specializes in high-tech forage harvesting machinery, such as disc mowers, rotor rakes and tedders, round balers and corn foragers.



Comparison of the 3D harness design in MCAD with a photograph of the physical product.

Results

- Generation of comprehensive wire harness manufacturing specifications for sourcing and contract manufacturing.
- Cost savings for cable harness manufacturing through comprehensive digital specifications and bills of materials.
- Improved fit and reduced lead times for cable harness sourcing thanks to ECAD/MCAD integration.
- E³.series data used in assembly, quality control, technical documentation, training and service.
- Best-in-class approach based on CATIA and E³.series.

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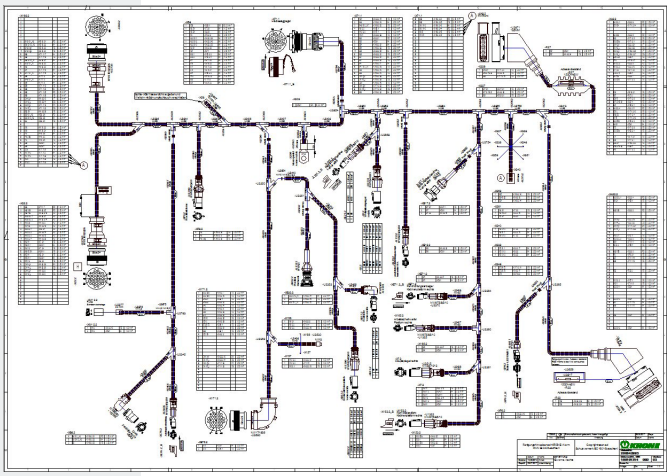
Maschinenfabrik Bernard Krone GmbH & Co. KG is one of Europe's foremost producers of agricultural machinery. The global company is headquartered in Spelle, Germany.

E³ series®

E³.series is a scalable, easy-to-learn system for the design of wiring and control systems, hydraulics and pneumatics. Its object-oriented system architecture, built on a central database, ensures the continuous synchronization of all engineering stages.



Manufacturing outputs for the wire harness are generated in E³.series.

Visible quality leap in harness design

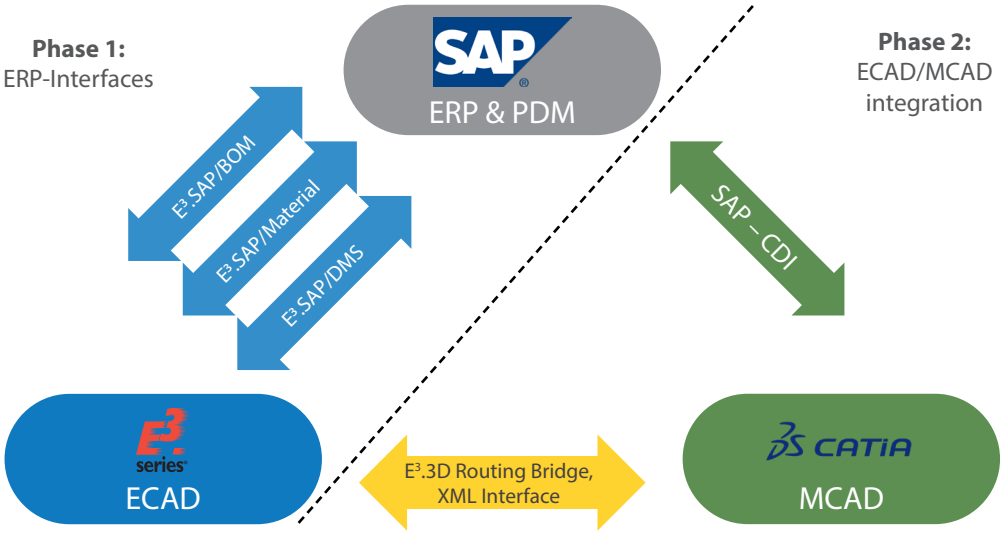
When the first pre-series BiG X 480 forage harvester rolled off the factory product line it was, as usual, closely inspected by the company's senior management team. The cable harness installation received favorable comments for being exceptionally clean and well executed, setting new standards for a company that makes top quality a hallmark of all its products.

"That was a remarkable accolade, because our senior management places prime importance on quality. Although it had not been pointed out to them, the quality leap of the harness design was immediately noted," says Dr.-Ing. Goy Hinrich Korn, CIO of the KRONE Group. "Since the cable harness takes a long time to source, we sometimes had to build in 'safety margins' into our harnesses that we used to conceal in the pre-series products by applying the odd extra loop during the assembly process. This time, no masking was necessary since it was a perfect fit."

The positive comments of the management team proved the success of a process re-engineering initiative that had been initiated by KRONE's electrical engineering team: "We had been using Zuken's E³.series electrical design tools since 2006, but mainly for documentation purposes," recalls Dr. Korn. "The integration and process support capabilities provided by E³.series were largely unused during the initial years. It was my colleagues Stefan Thygs and Michael Blume from our electrical engineering and technical IT departments who promoted E³.series and its integration into our sourcing and mechanical engineering processes. Up to that time, the cable harness was more or less an afterthought, which was designed after the mechanical design was close to completion."

"We started from a list of requirements and decided to divide the project into two distinct stages," explains Thygs, leader of the E³.series integration project. "The first stage was focused on the implementation of the available interfaces from E³.series into the KRONE SAP environment, so that electrical engineers could directly access material master data and generate bills-of-material and specifications that could be seamlessly transferred and reused in the SAP sourcing processes. The second phase was aimed at establishing a close coordination and parallelization of mechanical and electrical design work."

"The cable harness installation set new standards for a company that makes top quality a hallmark of all its products."



The first stage (upper left) focused the integration of E³.series with KRONE's ERP system. The second phase was aimed at the coordination of mechanical and electrical design work.

"Today, we are in a position to produce detailed cable harness drawings and bill of materials that the supplier can directly use for harness manufacturing"

Michael Blume
KRONE

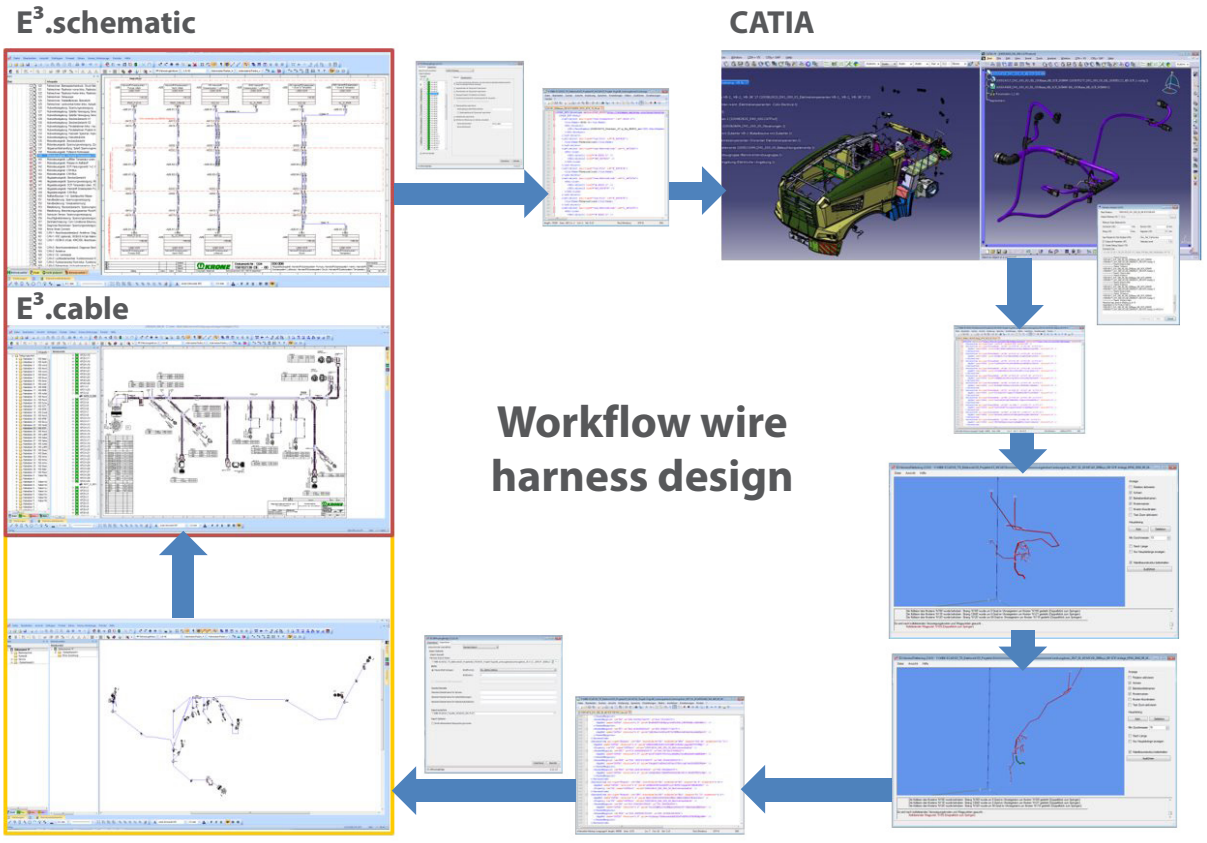
Comprehensive sourcing documentation

During the first phase, a unified company-specific design methodology was developed which involved the creation of company-specific templates for E³.series schematic and cabling designs. In addition, material master data records were cleaned up in KRONE's SAP-system and a new classification scheme for the electrical components was introduced. This provided the basis for the definition of automated E³.series reports to generate digital bills-of-material and connection tables that could be transferred directly to be reused in sourcing and production.

Up to that time, the detailing of the harness designs was largely done by the contract manufacturer, who typically received an annotated schematic drawing, which had to be comprehensively remastered by the contract manufacturer. This included the allocation of wires, connectors, pins and splices and the compilation of a detailed bill of materials.

"Today, with the full harness layout detailed in-house in E³.series, we are in a position to produce detailed cable harness drawings and bill of materials documentation in a format that the supplier can directly use for harness manufacturing," summarizes Michael Blume, Head of Technical Applications in KRONE's IT department. "This puts us in a much better buying position, and we expect to see the cost reductions reflected in our tenders."

With the specification and sourcing processes of the cable harness in place, the project was ready to progress into its second phase, the coordination of mechanical and electrical design. "In the past, the mechanical engineering teams clearly set the pace in the product development process. With no mature 3D model available as a reference, the design of the electrical harness chronically lagged behind the physical model, requiring substantial overheads for coordination and change management," says Thygs.



Workflow wire harness design with electrical design in E³.series and 3D physical layout in CATIA®

"The interface between E³.series and CATIA® brought our cable harness design much closer to the physical design world"

Stefan Thygs
KRONE

Best-in-class electromechanical harness design

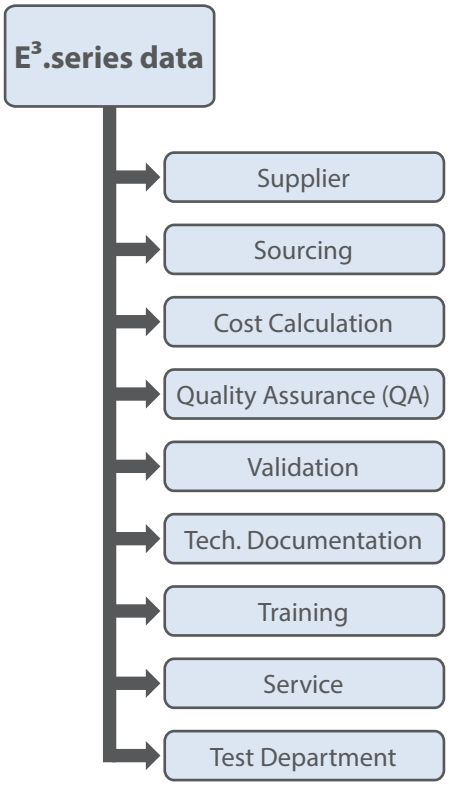
As both CATIA V5 and E³.series were established technologies in mechanical and electrical engineering respectively, it was a logical step to think about ways of combining them so that key parameters could be exchanged and modifications carried out on both ends in a coordinated manner. "It would of course have been an option to transfer the electrical design from E³.series to CATIA and finalize the complete layout of the cable harness in the MCAD environment, but we decided not to pursue this path for the simple reason that we had E³.series in place, and E³.series is the expert system that controls all electrical design objects and metadata," says Thygs.

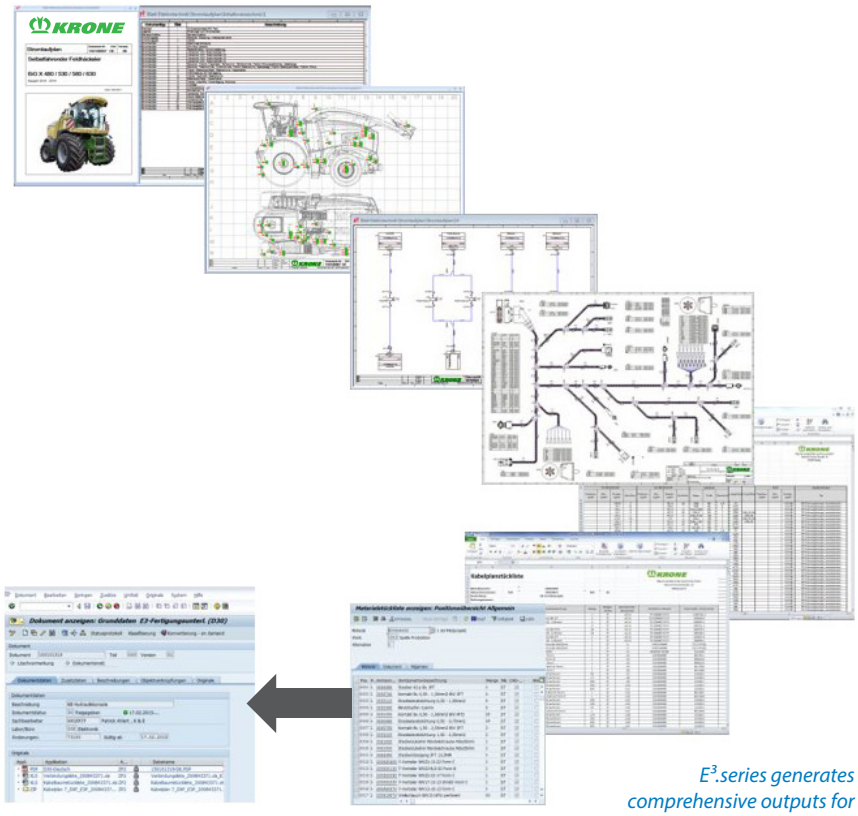
The solution was built using the E³.series product option E³.3D Routing Bridge that enables a bidirectional exchange of schematic and connection information between E³.series to CATIA, Creo and other leading 3rd party MCAD systems.

E³.3D Routing Bridge transfers electrical entities such as wire lists, wire diameters and colors as well as connectors, pins and splices can to the MCAD environment. These can then be used in the MCAD system to perform collision checks, band radius checks and calculations of wire and segment lengths. The comprehensive parameters resulting from these operations are then transferred back to E³.series, where accurate manufacturing drawings and documents are generated and handed over to the sourcing process in SAP.

"This brought our cable harness design much closer to real manufacturing conditions," summarizes Thygs. "In the past, we always needed a prototype to measure up and determine the bundle lengths and diameters, but that implied that the harness design came in at a very late stage in the development process. As production deadlines are typically tight, we were frequently forced to add extra lengths to our pre-series cable harnesses, which meant that we had to run an extra loop to tidy things up."

Use of E³.series data





E³.series generates comprehensive outputs for cable harness manufacturing

"It was a deliberate decision to rely on a best-in-class solution that combines two specialized toolsets"

Dr. Goy Hinrich Korn
KRONE

The proof of the pudding came, as mentioned earlier, when the first pre-series model of the KRONE's BiG X 480 compact forage harvester was rolled out of the factory, and senior management was positively surprised by the quality standards of the harness design.

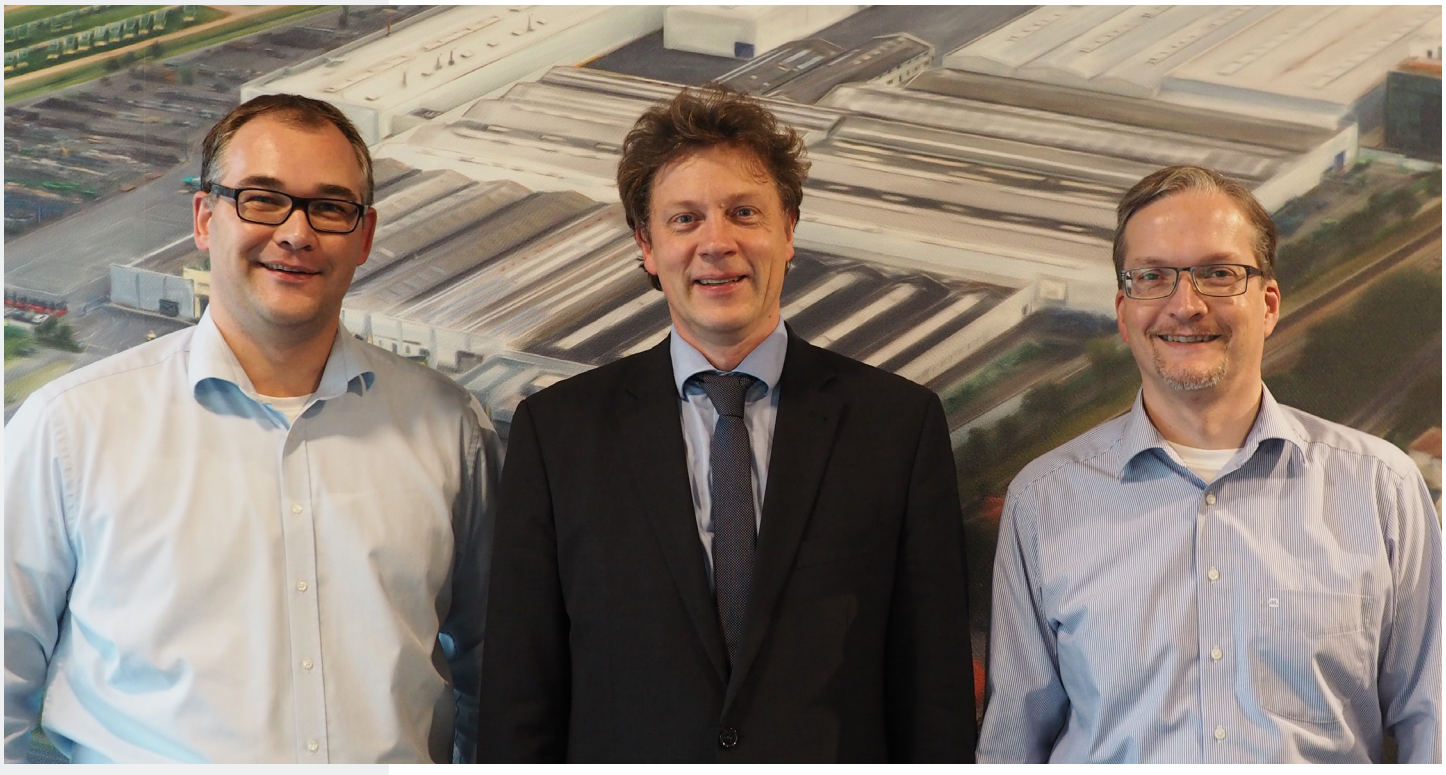
Although the adaption of the data exchange functionality between E³.series and CATIA required a good deal of tenacity, the result clearly speaks for itself. "From a project management point of view, it was a difficult and arduous journey," confirm both Thygs and Blume. A number of functions needed to be reworked to meet the requirements of our processes and available reference projects were rare. The mission was complicated by the fact that parameters had to be adjusted both on the CATIA and the E³.series side. "But thanks to the commitment and excellent working relationship with Zuken and our CATIA service partner we pulled through and are now seeing the benefits of our approach."

"It was a deliberate decision to rely on a best-in-class solution that combines two specialized toolsets," confirms Dr. Korn.

"Obviously, we don't have everything in one single system – but is that really required?" summarizes Dr. Korn: "Typically you have several different authoring systems and each one is optimized for its particular purpose. I believe there will always be specialized tools for specialized tasks and I also believe there will never be one single source of truth for all data of different types. There are so many different formats out there and the Internet is the best example that data that are generated locally can be brought together in a new layer."

Anticipating the digital twin

Although the solution was initially designed and driven by KRONE's electrical engineering department, it now provides tangible benefits for a number of downstream operations: "When we started the project, we simply wanted to reduce the change and communication overhead between electrical and mechanical engineering," recalls Blume.



Stefan Thygs, Dr. Goy Hinrich Korn and Michael Blume (from left to right).

"Our colleagues at the assembly lines have access to a digital model of the machine that includes a detailed representation of the cable harness and its assembly."

"We are now finding ourselves in the middle of a discussion about Industry 4.0 and digitization, and we are finding that our integrated data model combining digital mechanical and electrical data is bringing us close to what is today referred to as the digital twin."

"Today, we have all mechanical, hydraulic and electrical assemblies available in one information source, and that puts us in a position to build a number of robust downstream processes on them," confirms Thygs. "Today the colleagues at the assembly lines have access to a digital model of the machine that includes a detailed representation of the cable harness and its assembly. This is an essential aspect, as the cable harness can't simply be bolted on to the finished machine. It needs to be wired up step-by-step together with the mechanical assembly."

In addition to souring and assembly, many applications benefit from the digital twin: from cost calculation, quality assurance to technical documentation, training and service.

"We are well under way towards the digital twin and the digitization of our business processes," concludes CIO Dr. Korn. "But the most important aspect is that we are in a position to develop a harmonized electromechanical product in which the electronic equipment is an integral part – not an afterthought."