

## QUALITY-DATA-MANAGEMENT IN WIRE HANDLING

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*Abstract: In many segments of today's industry, process monitoring and traceability are essential if the stringent requirements demanded in many standards are to be met. In conjunction with STEINEL's piezoelectric force sensors and a high sophisticated measuring system the evaluation software PiezoWin2 is available. This software gives the user a modern data monitoring and statistics program that is designed to simplify and enhance reliability in process monitoring. PiezoWin2 is used in the automotive and aircraft wiring industries as well as in the telecommunication. In this industries crimp connections are used on electrical wires, to ensure economical production for the fastening of electrical wires to their respective wire contacts.*

*PiezoWin2, a Quality Data Management software program based on the QS9000 standard, allows the user to monitor and control interfaced devices in real time. The capability of up to 124 individual devices are monitored and controlled by one central point via CAN network. In order to provide a clear picture of all measuring equipment involved in the production process, STEINEL has selected the Microsoft Windows<sup>®</sup> Explorer, a user interface nowadays familiar to every PC user.*

*Keywords: Quality Management, PiezoWin Explorer, Cable Confection*

### **1 HOW SIGNIFICANT IS CABLE CONFECTION FOR CAR INDUSTRY?**

If an electrical wire is connected conductive and stable with a terminal contact, than it is spoken of a crimp connection. Crimp connections are used on electrical wires for ensuring economical production in fastening electrical wires to their respective wire contacts.

The Quality Assurance Method based on QS9000, grants a quality product referring compact, gas tighten, conductive, wear well and stable formed. In the car industry the 100% monitoring of crimp connections is precondition unrenounceable for avoiding waste of each and all single electrical contacts. Consequences can be failure of ABS-function or Airbag-function as well as different control commands for necessary driving functions. Also creeping, slowly oxidised contacts are to avoid. All such faults can lead to injury and harm on life and to inevitable compensation due to warranty . Crimpcontrol monitoring takes precautions against such fault influences That is the reason the car industry had established quality standard for cable confection.

### **2 WHICH TEST EQUIPMENT IS QUALIFIED FOR CABLE CONFECTION?**

Monitoring sudden strokes of the press in manufacturing stable conductive connections between electrical wire and the terminal contact a robust and reliable industrial proved measurement system is required.

This features are achieved by a piezo electric measuring system. The measuring system uses a quartz crystal sensor built in on a holder mounted above or underneath the crimp tool. Measured is the force profile of each crimp.

Typical crimp forces within a range of some few 1000 N to about 40 kN change rapidly in time of 20 to 70ms. The cycle for the crimps goes up to 7000 crimps per hour.

Piezo-electric quartz-crystal force sensors are very well suited to register these forces, because their speciality is the measurement of dynamic and quasi-static loads. Quartz sensors are robust, rigid, in long life term and in very small dimensions available.

The evaluation is referring to a teach-in force profile, called reference, of the same crimp composition and compares with each individual crimp. With each evaluation the applied measuring system from Steinel AG delivers the sort decisions for production output. Immediately the crimping's are sorted as "accepted" or "rejected". This failure prevention strive for is a future oriented production strategy. It is achieved by 100% monitoring to immediately avoid potential permanent defects.

Close proximity to each other of the individual curves in the force profile indicates that the production process has a narrow spread and that process monitoring can be meaningful and admissible. Following the principle of continuous quality improvement, a minimum requirement in a statistical process analysis is established: the spread must be within the specifications. The 'Process Capability' is one essential (eminent) parameter for quality describing in production, it is the gauge for long-term influences within the specifications.

Faulty crimp connections are eliminated from the production process as soon as they are detected. Most possible faulty crimp connections on electrical wires are:

- missing strands from numerous individual strands
- individual strands outside the contact
- insulating material caught in the crimp connection
- wire stripped too long
- faulty supply lead to the contact
- insulating claw folded towards inside
- wrong wire size for crimp connection
- crimp height irregular or modified
- inlet funnel different
- waste strips crimped
- missing contact and/or wire
- unsatisfactory tool operation
- forewarning of tool failure

### **3 WHICH DATA OF QUALITY ARE SIGNIFICANT FOR CAR MANUFACTURES?**

The most important objective is to get comprehensive parameters for quality. The evaluation is based on statistics due to QS9000-Standard for car industry.

The following data are available:

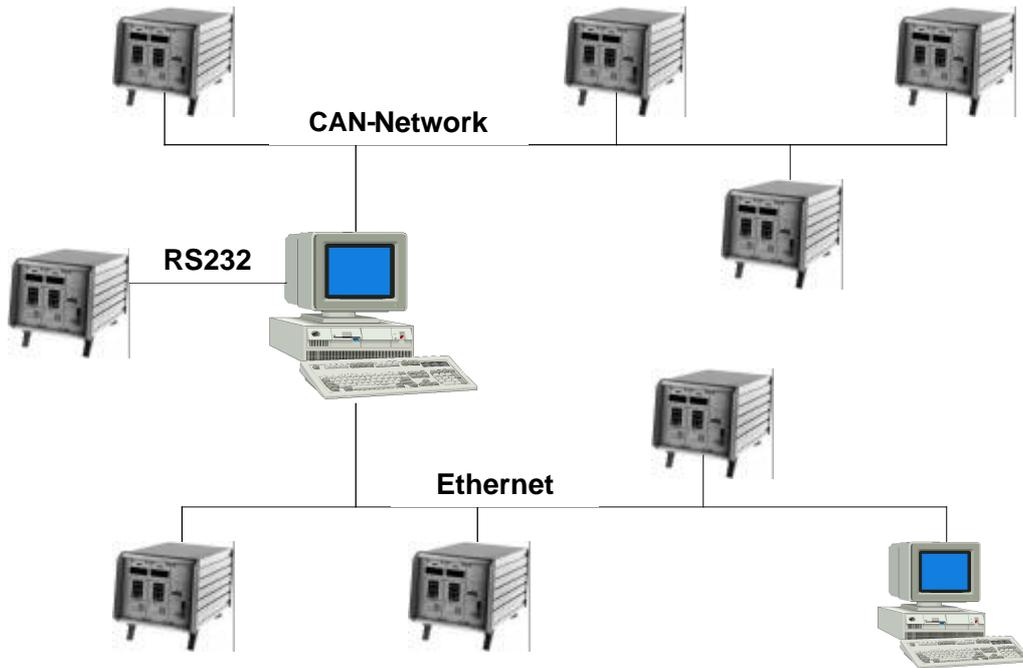
- value of deviation in % between reference force profile and individual force profile
- value of max.force from each individual force profile in kN
- graphic display of force profile for reference and current curves
- graphic display of process variables the histogram of deviation
- sample analysis of both values, deviation and peak force as mean value and standard deviation
- graphic display of sample analysis
- total number of all crimps
- total number of rejected crimps per batch and per shift
- total number of references per shift
- process capability

The evaluation program PIEZOWIN2 from Steinel AG supplies all these process data. Especially the process capability, based on a predetermined quality standard, can be reduced while production is in progress. Improvement of the process is reflected by an increase in this index value.

### **4 EFFIZIENCY QS LEADS TO QUALITY-DATA MANAGEMENT QDM**

The only way for getting immediately transparency and essential parameters of the process leads to QDM. For crimp monitoring during production there is an evaluation program available, running under Windows NT or Windows 98. Connecting all automates and presses to one evaluation a network realised by CAN is applied. Bi-directional interfaces not only mean it is possible to read data but also alter settings as and when required on individual measuring devices. Using CAN networks to link individual devices provides the capability of monitoring a maximum of 124 devices from a central point. In turn, each individual device can monitor up to 8 channels ( sensors), depending on configuration.

The evaluation analysis not only crimp connections but also using common statistical methods; the measurement data of the production batches can be handled comfortable. The applied evaluation program lean all measured data to an efficient handling program, the quality management software PIEZOWIN2 . In order to provide a clear picture of all measuring equipment involved in the production process, Steinel has selected the Microsoft Windows® Explorer, a user interface nowadays familiar to every PC operator. In the quality management software PiezoWin2 this display format is known as Piezo-Explorer. Piezo-Explorer always displays current production quality, thus permitting real-time production monitoring.



**Figure 1.** Overview of the network for crimp quality monitoring

Procedural control of the crimping process ensures timely detection of faulty crimp connections. The sorting decision for each individual crimp connection is made during the production process and the crimping are sorted immediately. This ensures efficient production.

Within the evaluation software a quality attest document including process capability is available for each batch, which is necessary for purposes of product liability. During time the request of more transparency of the process quality was growing.

Long-standing experiences have brought the necessity to divide / split the monitoring process of crimp quality in two evaluation parts. One part describes the current quality monitoring on all connected CrimpControl Monitors. The basic request was to indicate the current / actual production state at a glance from all connected monitors. The result is the Piezo-Explorer.

The second part describes the long time crimp quality, it records and documents all necessary information about the past. The basic request for was apart from the common standard statistics like histogram and sample analysis additionally two subjects. One subject is to indicate the history of rejected crimps connections as well as made references in the past production. Another subject it records and documents production history

This new advanced functionality as above described is applied and fulfilled in the new software of quality data management PiezoWin2.

## 5 PRESENTATIONS OF THE SELECTED QM - DATA

### 5.1 Current production quality

The current (actual) production quality reflected by the Piezo-Explorer shows a coloured icon for each channel. The colour includes the information about the current (actual) production quality. We distinguish between four different production states with the assigned colours

Production state	Assigned colour
No production	Gray
Good production quality	Green
Satisfactory production quality	Yellow
Bad production quality	Red

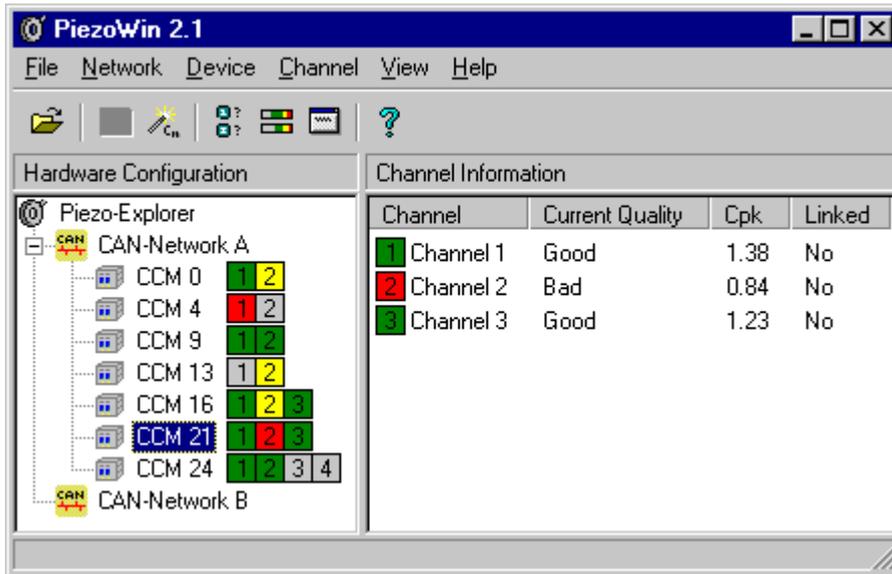


Figure 2. Piezo Explorer

The advantage of the Piezo Explorer with the indication of the current production quality is the possibility to survey the entire production at a quick look. As soon as an icon turns red the observer will immediately notice the outstanding alert sign. It's up to the observer to react on this event. The window of the Piezo-Explorer presents visible the status of each connected crimp monitor. The current process capability (Cpk, see figure 3) is displayed.

Another example of the benefits is the recognition of standstill production. As the pressure on costs increases today it is necessary to reduce the non-productive time of the manufacturing equipment. The Piezo-Explorer gives you the tool to identify those non-productive states in the complete production.

The great advantage of this concept is the simplicity of visualising the actual production state of nearly as many channels as you like. As any simplification of a complex process there are also limits in our case. As we always display the actual production quality in the explorer presentation we do not have any information about the past.

Because of this we provide long time information by the additional subject called production history. The production history summarises the duration of the different production states during a specific period of time. For instance this period could be a shift or a week. After finishing the shift the software shows for the shift period how long it was produced in the different states.

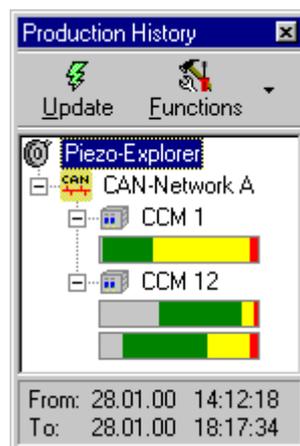


Figure 3. Production History

## 5.2 Rejects/References Accumulation

Industry applications have shown another problem. The best measurement equipment is useless when it is not turned to good account. This may sound strange but experience has proven the problem. Some companies have achievement wage which is why the operator tries to produce as

many good crimps as possible. What the operators did to increase his wage was to put the cables rejected by the measurement system into the container with the good crimps. There you are, the powerful control equipment is worth nothing when the operator evades it. That was the source for an additional quality management function of the PiezoWin software called the accumulation function.

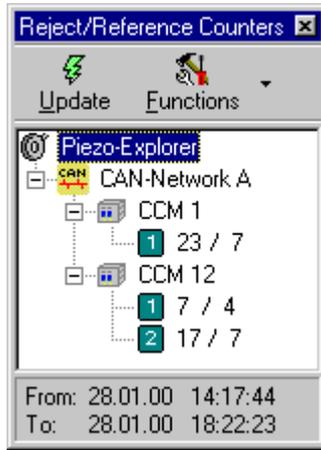


Figure 4. Accumulation of Rejects and References

The accumulation function is basically a counter which adds up the rejected crimps. This counter is only visible for the PiezoWin user which allows a hidden observation of the operators.

An example of use would be the reset of all counters at the start of a shift. Each rejected crimp will then increase the value of the counter. At the end of the shift the observer using PiezoWin sees the total amount of rejected crimps for each connected channel. The observer picks out some operators to check the correct handling of the quality orders. The tested operator should be able to show the correct amount of crimps rejected by the Control-Monitor.

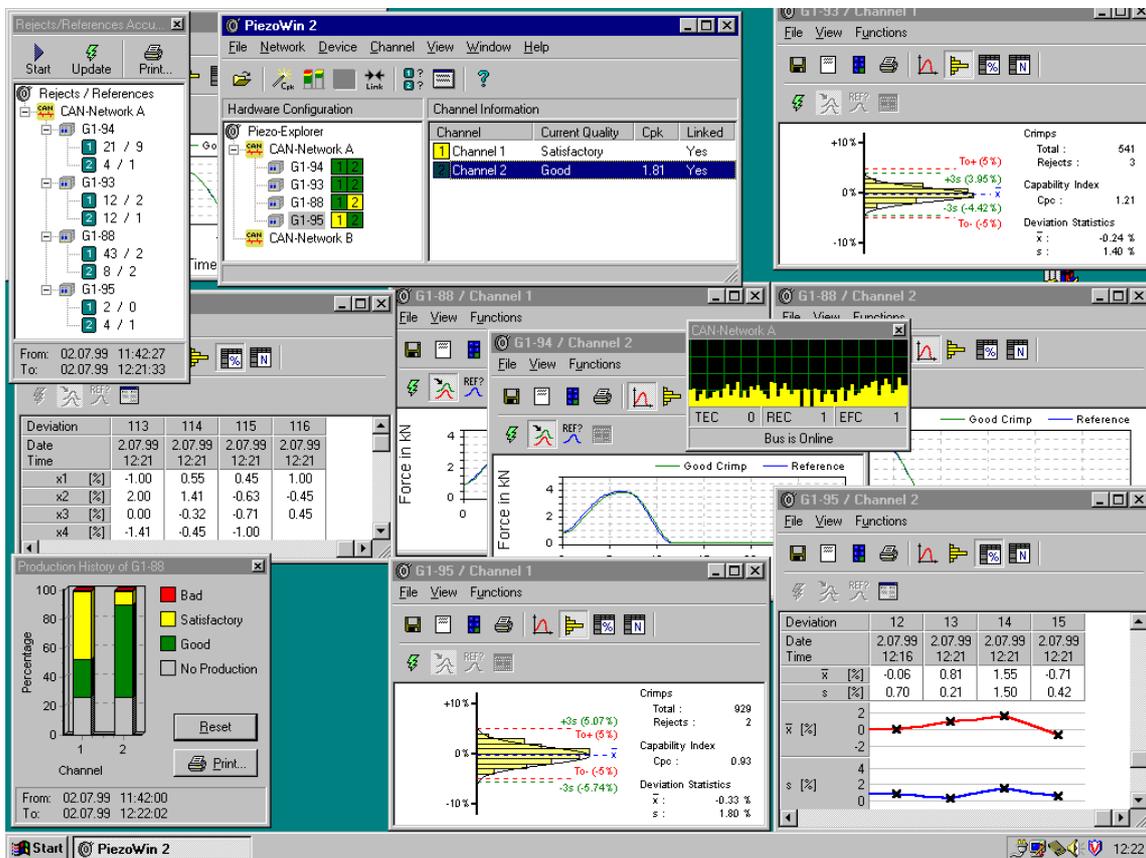


Figure 5. Overview of PiezoWin2 displaying cable confection production process

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This precaution helps increase the quality of the product significantly by improve the factor of human inaccuracy and greed. Quality can not only be made by measuring. Every member of the whole has to be convinced or even be forced by the need for a good quality.

The paper has shown detailed the results of an advanced evaluation program for managing quality data in an industrial application. All collected quality data reflect the transparency of the process which is handled not only by one quality monitor device but by using a CAN-network application with several devices focusing on Quality Assurance due to QS9000 from March 1998.

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