CIQ software solutions leading to improved quality and productivity levels can generate serious gains in profitability

Manuel Felder, Wolfgang Klein

AESA Cortaillod

CH-2016 Colombier, Switzerland

+41-32-841-5177 - aesa@aesa-cortaillod.com

Abstract

Increasing needs for enhancing productivity and profitability, as well as demands for traceability, are requiring strict and efficient tools to monitor all kind of deviations during the manufacturing process. To cope with the needs of the wire & cable production environment, time and length stamped tracking as well as accurate management of all available data are essential.

Production plants are filled with sensors, measurement gauges and testing equipment. The generated data is enormous but their comparison and analysis is rendered difficult due to the various formats that must be handled. The CIQ (Computer Integrated Quality management system) software developed by AESA combines all those data into a single datapool under a unique format so that tracked values can be compared not only globally but also on a discrete level where the element or part of a cable that has been assembled and sheathed at a given moment can be traced.

Keywords: wire & cable; Industry 4.0; quality; tracking; cost control; continuous improvement; lean; six sigma; manufacturing; software; data; data management; productivity; data logging

1. Introduction

CIQ is a specific quality data management system especially developed with, and for, cable manufacturers. CIQ networks all measuring and testing devices into one common system and stores all the acquired data in a central datapool. This enables all the entities involved in managing the production to have direct and near real time access to process and testing data. The acquisition of time tracking and length-associated measurement values is of pivotal importance, as well as the management of all the available data. Tracked values shall be comparable not only on a global level but also on a discrete or individual level in order to allow for the checking of which segments of a wire or cable have been combined.

2. The manufacturing environment is rapidly changing

During the past 50 years, all manufacturing industries have been following the same trend towards efficiency improvement coupled with overall cost reduction, increase of productivity, and the introduction of quality management systems. Several concepts have been implemented for this purpose, such as the one promoted by Edward Deming. The main mottos are connected with continuous improvement, lean manufacturing, six sigma and/or other quality development strategies. What connects all those schemes is the need for accurately measuring and analysing data. How to implement a "Plan-Do-Check-Act" process, if no accurate data is available? How to evaluate the results of actions and implement improvements, without measurable feedback loops?

But this has only been the starting point. The pace of the changes in the production environment has increased by tenfold since the industry entered into the "digital age".

This new "period" is requiring and leading to the interconnection and integration of systems (production islands, quality islands), the evaluation of massive amounts of data, the optimization of the complete value chain by narrowing, or even merging, the interactions between producers, distributers, sellers and customers. The global life cycle of a product, including basic R&D and product development, is being shortened and made transparent to many internal and external stakeholders.

Industry 4.0 is today's buzzword. It includes the requirement derived by above trends along with the generation of additional indirect needs such as: security for employees or systems (IT), adaptability of the value chain and of production processes to address the specific needs of various customer segments.

All the requests for enhanced productivity, profitability and control and/or traceability, are requiring the use of efficient tools to monitor the fulfilment of product specifications and to track any deviations occurring during the manufacturing process. Multiple solutions are available but most of them are dedicated to the manufacturing of single or "countable" amounts or parts. Very few are able to cope with the specific needs of the wire & cable production environment with time and length stamped tracking coming along with an accurate and efficient management of a massive amount of data.

If the target is also to further improve the quality of the end product, it is essential that the tracked values can be compared not only on a global level but also on a discrete level where we can check which segment or portion of a wire has been assembled with another and later jacketed into a cable. If a product is found defective: on which line was each wire produced, when, what raw material, what batch number, what tolerances, what machine set-up parameters, what deviations during the manufacturing process,...? All those questions should find an answer in order to track down and fix the problem. Once the root cause has been corrected, here comes the next question: do I still have products containing the same issue within my stock? Do my customers have some of it waiting to be buried underground or to be installed within a building? How can I mitigate the risk of additional costs?

Today's production plants are filled with many sensors, measurement gauges and testing equipment using a wide range of inspection technologies. The generated data is enormous and their comparison and analysis is rendered difficult due to the various formats that can be found. The CIQ system enables to combine all data into a single datapool and format, providing consolidated reporting, traceability, including global evaluation functionalities. It meets the constant growing requirements needed by the digitalization of the cable manufacturing industry.

3. The place of CIQ within the IT environment and the management infrastructure of the production plant

CIQ is finding its place within a complete production environment. Often factories are already equipped with extensive ERP or MES resource planning systems. It was developed to close the missing link between ERP (Enterprise Resource Planning) / MES (Manufacturing Execution System) and the shop floor, thanks to its capability to handle:

1. Product traceability
2. Quality control
3. Data acquisition
4. Process Management
5. Performance Analysis

Those capabilities are traditionally part of normal MES functionalities but without the specificities of the wire and cable industry. Market is offering multiple IT solutions supporting the management of cable production processes. These solutions, often complex in structure, are based on standard modules developed for general purposes and are covering most of the central functions needed by ordinary manufacturing industries.

Figure 1. Position of the CIQ system within a "smart" factory environment

For the manufacturing of any goods produced on a length basis, the situation is somewhat specific: most of the data to be processed is not related to discrete quantities, but to length and/or packages (reels, coils, boxes,…). Additionally, accurate time stamping is needed for the optimal traceability of each segment of length. This specific type of data is not handled by traditional ERPs. This means that for cable manufacturing, specialized functional modules are required to complete the quality and performance management toolbox.

CIQ 3.0 has been developed in a modular way in order to be adaptable to producer's needs. Drivers and interfaces for a wide range of measuring systems and most common ERPs have been developed. Thus, a simple, efficient, and cost effective integration within any existing production plant is possible.

CIQ has an open architecture enabling data exchange with other systems and databases as well as the import and/or export of data in commonly used formats (see Figure 2).

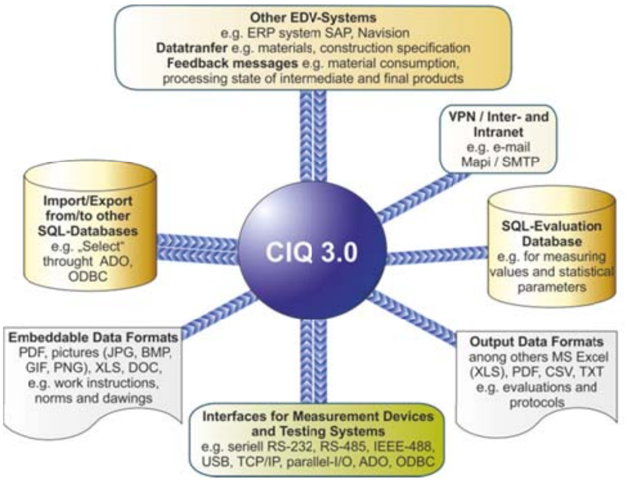


Figure 2. Interfacing and integration of the CIQ within IT infrastructure

The possible interfaces with existing EDP (Electronic Data Processing) structures include:

1. **Measuring and inspection systems**
2. **Other EDP (Electronic Data Processing) systems** (SAP, MS Dynamics or self-made ERP systems using Oracle or MS SQL-Server, …)
   At any manufacturing or testing stage, data can be loaded from other EDP systems such as material data or design values (tolerances). Reciprocally, it is possible to upload control data, for example about production status of intermediate and final products or about material consumption.
3. **Creation of outputs in different file formats** (.xls, .txt, .csv, xml, …)
   Multiple reporting features enabling the generation of reports and evaluations in different file formats for further processing by other software.
4. **Integration of existing documents and files**
   Existing documents (work instructions, standards, drawings) can be integrated and displayed by the system. Documents (such as Excel files) can be read and their content processed.
5. **Data exchange**
   CIQ features flexible import and export functions. User defined data can be transferred in customizable forms and exchanged with various other databases.
6. **Communication via VPN / Internet and Intranet**
   Alarm messages can be transmitted via e-mails. If VPN network connections are available, all evaluation features and supervision systems are remotely accessible.

A seamless integration of production and quality data within the ERP is more and more required by industries having deep traceability needs such as in the aerospace or the automotive industry. And Industry 4.0 will only accelerate the pace of this transformation.

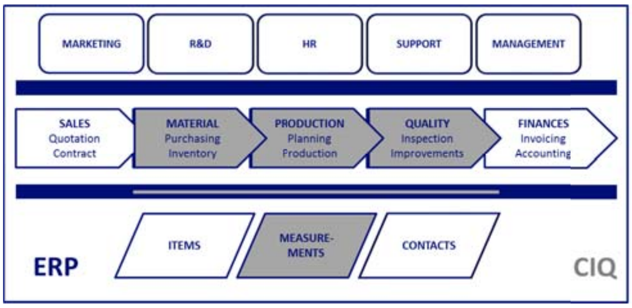


Figure 3. General interface of CIQ within the ERP dataflow with a focus on manufacturing data

CIQ eliminates the limitations of the ERP and MES in term of CAQ (Computer Aided Quality) by interconnecting all the enterprise resources and allowing to regroup, centralize and synchronize with each produced cable segments all the process and quality data generated during manufacturing.

4. CIQ 3.0 in the production floor

CIQ has been specifically designed for length and time associated measurement and value acquisition. The interfaces of the system have been adapted to accommodate most commonly used measurement and testing instruments (see Table 1) used in the cable industry. It also integrates a great variety of electrical and mechanical testing procedures in accordance to most of the applicable standards and test specifications.

In order to allow for a complete traceability, it is important to establish a link between process and testing data. Hence, it is recommended to capture the online data at all the steps of the production chain, i.e. from the reception of raw materials and the semi-finished stages until the shipment of the finished products (see Figure 4).

Data exchange with the supply chain monitoring systems shall be integrated into all processes taking place on the shopfloor. This is the prerequisite for an optimized use and traceability of the ingoing materials towards high quality for the outgoing products.

However, testing and measurement instruments are often specific to one particular machine or device and are using their own incorporated data acquisition tools which performance and standards are supplier-related. This means that measurements are made in disconnected individual "quality islands".

Maximum benefit from the data generated by all these devices is achievable only if those "black boxes" are connected together through the entire company network, thus allowing for a global overview of the situation and corresponding production performance.

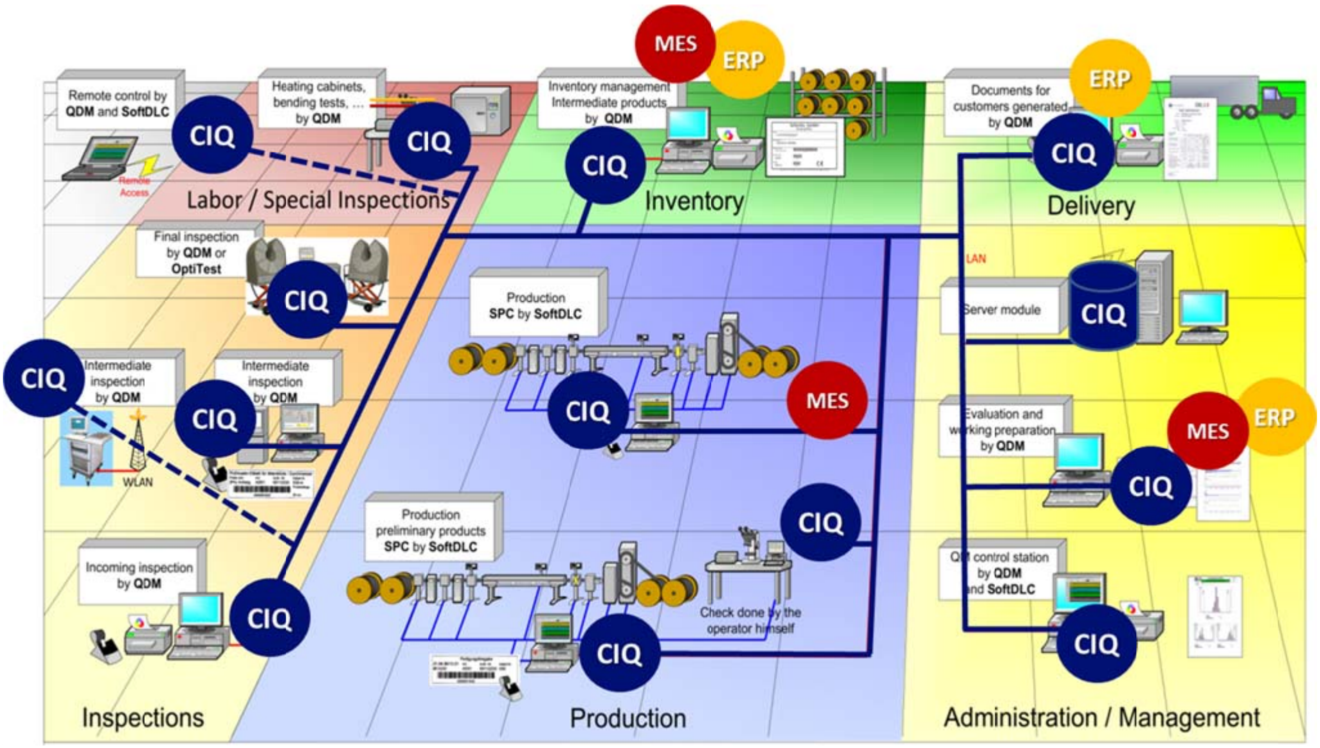


Figure 4. The roles of CIQ as well as ERP and MES within the factory floor

Table 1. Examples of testing instruments and systems that can be integrated in CIQ

- Mechanical dimensions gauges such as callipers or profile projectors
- Diameter, ovality, thickness and eccentricity gauges
- Camera systems for cross section and wall thickness measurements
- Weight scales
- Friction and adhesion tester
- Force and elongation measurement gauges
- Various types of manual handheld systems
- Low and High-frequency cable measuring devices
- High-voltage testers
- Optical Time Domain Reflectometer (OTDR)
- Tensile testers
- Resistance and insulation measuring equipment
- Transfer impedance evaluation
- Screening attenuation testing
- Various “Type Approval” tests

4.1 Process data acquisition module SoftDLC

SoftDLC is a CIQ module dedicated to “in-line” process monitoring and data acquisition. It has been developed to gather events and continuous data streams and it allows displaying them during running production processes.

By capturing and visualizing process data in real time, trends and deviations can be identified at an early stage of manufacturing. Therefore, preventive or corrective actions can be taken before any fatal shortcoming occurs. In the event of a defect and/or the violation of a tolerance limits by any measured or operational value, SoftDLC can immediately trigger various types of alarms that can be transmitted to the relevant personnel through different configurable methods.

Process monitoring can make manual intermediate tests redundant as process data is continuously captured. This reduces testing efforts and cuts cycle times, resulting in increased machine throughput rates and cost savings.

SoftDLC may be used at all stages of production: wire drawing, wire insulation, twinning, unit/layer stranding, armouring and sheathing. The module allows for the central storage of all operating, administrative and measured data. Process data can be displayed within company’s network or relayed off-site via remote connection. Instructions (help texts, standards, specifications or recipes) for machine set-up and possible connection to ERP information enables to optimize the process, to reduce start-up losses and maximize material utilization. The system allows for the reduction of the “human failure” factor: the operator receives clear instructions online (for set-up and testing) and is relieved from other administrative activities. Decisions making is no longer subjective but based on objective inputs: clear tolerance limits for measured values, clear “good/bad” status definition.

SoftDLC fulfils the requirements of statistical process control (SPC). It provides the basic data needed for the analysis of weak spots and hence is the precondition for continuous process improvement. It can display evaluations values (for e.g., statistical values) or the results of calculations (for e.g., mean values or ovality). Continuous capture of process data allows to manage process conformity and to drive process optimization initiatives generating productivity improvements and cost savings.

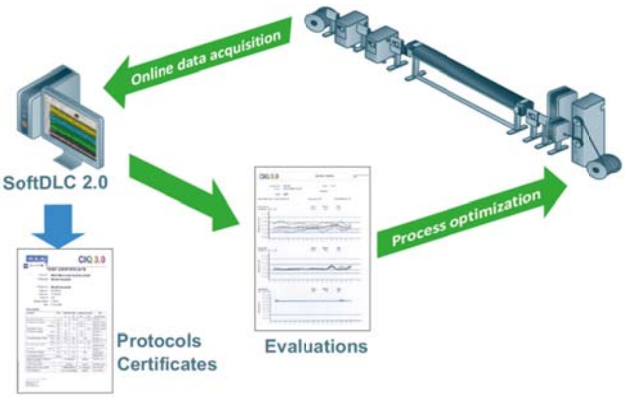


Figure 5. The SoftDLC process data flow and improvement process

4.2 Additional tools connected with the use of the SoftDLC module and processing equipment

In line with the follow-up of process data, other tools have been developed to trace and support the performance of production processes:

- Bar Code Driven Operations: Most common controls and inputs can be operated with a bar code reader and pre-printed bar code command tables. This avoids, or reduces, input errors and unnecessary handling of computer interfaces such as touchscreen, keyboard and any tracking devices, with dirty hands or tools.
- OEE (Overall Equipment Efficiency) tracking tools: Allowing following the “Availability”, “Performance” and “Quality” of the production. Production data is traced and connected with “status inputs” given by the operator concerning the situation of the production equipment. Tracing downtime reasons can easily give valuable information to operations management concerning operator’s efficiency, the maintenance situation of the equipment and the efficiency of product-type changes.
- MSD (Machine Set-up Datasheets): The structure of the system allows integrating additional data related to the set-up of machines. Recipes and machine adjustments can be shown on operator’s workstation. All data is networked by article numbers thus linking: Machine Set-up, Product Specification Testing Plan and Quality Data Values together.

By linking all information within the same data pool, any valuable data connected with quality or performance of a processing line can be traced and stored. High level information such as material usage or energy consumption, up-time (associated with maintenance plans) and production time, or low level info related to the performance of line components, can be interlinked to give a detailed overview of products, processes and events occurring in the workshop.

5. CIQ 3.0 Data Management and Data Evaluation

CIQ networks all measuring and testing devices into one common system and stores all the acquired data in a central data storage / common repository called QDM (Quality Data Module). It allows direct access to process and testing data practically in real time. The heart of the CIQ system is built on a central module supported by various communication, visualization and reporting modules.

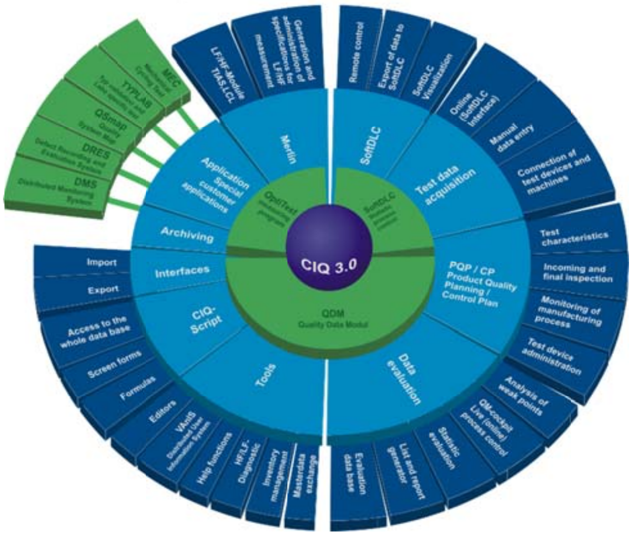


Figure 6. Modular set-up of the CIQ system with its central heart QDM

Keeping and storing all raw measurements can be relatively difficult (especially for in-line process monitoring with SoftDLC or when performing High Frequency cable performance measurements) due to the high amount of generated values. The specific design of QDM allows the storage of the totality of the raw measurements enabling immediate or subsequent analyses. 100% backward and forward traceability is possible and is supported with appropriate filtering and sorting tools. A defect in raw material, for example, can be traced to the relevant shipment. Vice versa, it is possible to determine other products that have been affected by the same faulty raw material.

QDM enables performance evaluations by a wide range of criteria. For example, the production manager can use the data to gradually tighten limits and optimize production and material usage according to allowed tolerances. The system can generate quality charts, periodic reports, product manufacturing cards or other reporting documents supporting the identification of possible fields of improvements. QDM sustains the reduction of assessment costs since many evaluation procedures can be automated.

5.1 Supporting the Management of Quality as well as Quality Assurance personnel

Networking and centralizing allows to dramatically simplify inspection planning because it automates and standardizes many procedures. For example for similar products, CIQ can use basic and product family inspection plans, thus reducing the effort of manual data input. It cuts testing and evaluation efforts and provides the basis for efficient production processes and optimized material usage. In this way, it allows saving material costs and reduces out-of-specification products.

Test specifications, and the related test orders, are the basis for specific and detailed tests, reports and the further evaluation steps. All parameters, limit values, formulas, master data, reports, quality charts may be defined from the office. Avoidance of expensive double or missed tests, reduction in testing set-up, planning and human errors risks combined with a coherent, unified system are maximizing the efficiency of quality tracking.

The stored data generated by all the production stages and areas provides the quality assurance employees with the necessary information needed to perform detailed weak spot analyses and allows systematic identification of existing problems. It also provides the basis for verifiable quality documentation towards customers, or other stakeholders, by facilitating the establishment and the maintenance of an exact and uniform documentation system.

The collected data forms the basis for a holistic, cross-plant analysis of fields for improvement. This approach does not stop when the first "why" question is raised but is capable finding the root cause of a problem. This allows CIQ to become the central point of a continuous optimization process reaching beyond the limits of the shop floor.

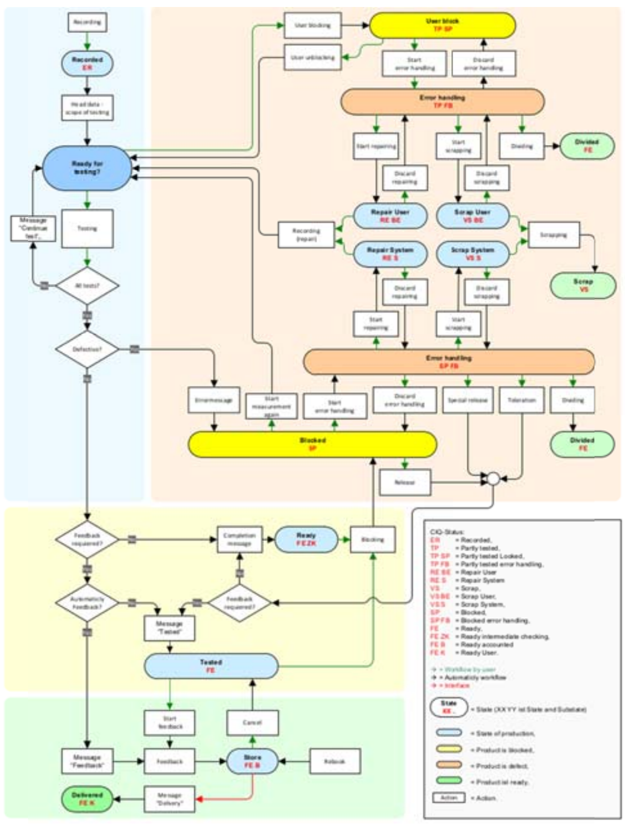


Figure 7. Data flow and inspection task management based on CIQ and ERP data

CIQ when set up as a general quality data processing concept and tool, called InQDaS (Integrated Quality Data System), based on QDM and ERP data, allows to guide quality managers in designing and setting-up the global quality flow leading up to the final inspection of a product. Build on the core functions of QDM, it allows to manage and perform, on one product, several timely staggered tests per process step. The module receives “test production orders” from the ERP system and gives feedback about the testing status (partly inspected, blocked, to be scrapped, to be repaired, to be divided or inspection completed).

In the event of a defect, suitable measures are initiated by the system or the user (for example by generating defect messages, giving instructions for re-measuring, defect treatment or scrapping).

Individual labels and reports can be generated and broader, cross-task evaluations are possible.

6. Specially developed software modules

Since CIQ has been developed essentially for the Wire and Cable industry, specific requirements have generated the need for developing special modules in order to extend the possibilities of the system and to cover particular expectations of this industry.

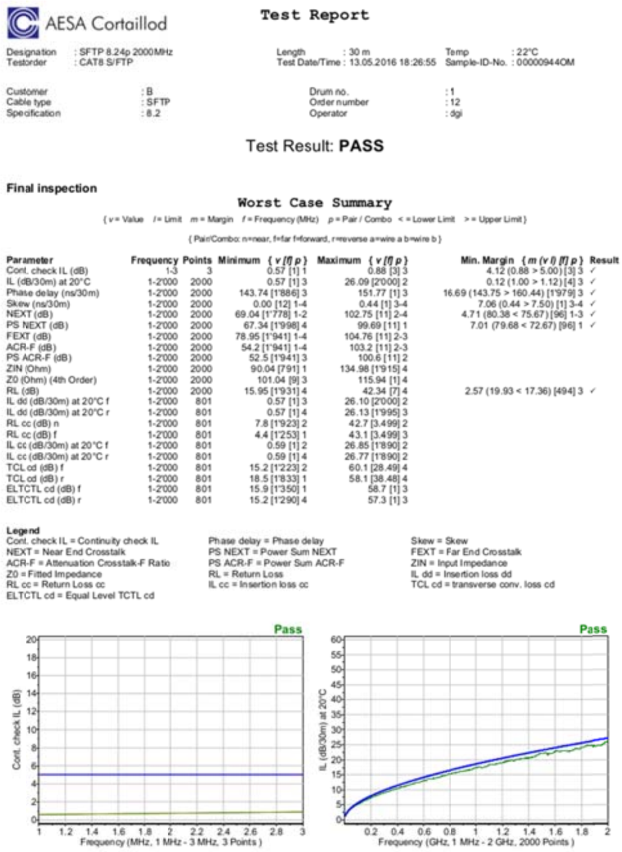
6.1 The “Merlin” Specification Editor

Merlin is an editor supporting the design of specifications and the related test orders and test plans in the area of complex tests. The creation of specifications is carried out by using predefined function blocks and the relevant measurement parameters. They are consisting of different set-up parameters, already prefilled with default values but easily editable by the user.

All essential input parameters are presented to the user and regrouped in different tabs. The use of predefined parameters enables to generate test plans and test orders in a short time without having to look and understand all the relationships between different parameters. After editing, the coherence of all entries is checked by the system and only in case successful result; the test order will be created.

For example, the module has been implemented in connection with the execution of complex electrical tests allowing to go far beyond the normal use of a simple Vector Network Analyser (VNA) by:

- Driving and controlling the VNA.
- Performing measurements in sweep mode and/or by using frequency tables.
- Entering of an unlimited number of measurement points (not limited by the specific VNA and with open choices for start/stop frequencies and the number of points)
- Generation of complex limit curves.
- Driving of fully automatic calibration management including automated calibration procedure.
- Control of a wide range of measurement modes such as HF Sweep, HF Sweep(Alien), HF Coax-50, HF Coax-75, HF fixed frequency, LF single cores, LF pairs, LF triples, LF quads, LCL, LCTL, TCL, TCTL, TI, AS, worst case summaries for HF-Sweep / LF / HF discrete frequencies, inductance, conductance and high voltage.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Test Report

Designation : SFTP 8.24p 2000MHz
Testorder : CAT8 S/FTP
Length : 30 m
Test Date/Time : 13.05.2016 18:26:55
Temp : 22°C
Sample-ID-No. : 00000944OM

Customer : B
Cable type : SFTP
Specification : 8.2
Drum no. : 1
Order number : 12
Operator : dgi

Test Result: **PASS**

Final inspection

Worst Case Summary

{ v = Value l = Limit m = Margin f = Frequency (MHz) p = Pair / Combo < = Lower Limit > = Upper Limit }

{ Pair/Combo: n=near, f=far f=forward, r=reverse a=wire a b=wire b }

Parameter	Frequency	Points	Minimum { v [f] p }	Maximum { v [f] p }	Min. Margin { m (v l) [f] p }	Result
Cont. check IL (dB)	1-3	3	0.57 [1] 1	0.88 [3] 3	4.12 (0.88 > 5.00) [3] 3	✓
IL (dB/30m) at 20°C	1-2'000	2000	0.57 [1] 3	26.09 [2'000] 2	0.12 (1.00 > 1.12) [4] 3	✓
Phase delay (ns/30m)	1-2'000	2000	143.74 [1'886] 3	151.77 [1] 3	16.69 (143.75 > 160.44) [1'979] 3	✓
Skew (ns/30m)	1-2'000	2000	0.00 [12] 1-4	0.44 [1] 3-4	7.06 (0.44 > 7.50) [1] 3-4	✓
NEXT (dB)	1-2'000	2000	69.04 [1'778] 1-2	102.75 [11] 2-4	4.71 (80.38 < 75.67) [96] 1-3	✓
PS NEXT (dB)	1-2'000	2000	67.34 [1'998] 4	99.69 [11] 1	7.01 (79.68 < 72.67) [96] 1	✓
FEXT (dB)	1-2'000	2000	78.95 [1'941] 1-4	104.76 [11] 2-3		
ACR-F (dB)	1-2'000	2000	54.2 [1'941] 1-4	103.2 [11] 2-3		
PS ACR-F (dB)	1-2'000	2000	52.5 [1'941] 3	100.6 [11] 2		
ZIN (Ohm)	1-2'000	2000	90.04 [791] 1	134.98 [1'915] 4		
Z0 (Ohm) (4th Order)	1-2'000	2000	101.04 [9] 3	115.94 [1] 4		
RL (dB)	1-2'000	2000	15.95 [1'931] 4	42.34 [7] 4	2.57 (19.93 < 17.36) [494] 3	✓
IL dd (dB/30m) at 20°C f	1-2'000	801	0.57 [1] 3	26.10 [2'000] 2		
IL dd (dB/30m) at 20°C r	1-2'000	801	0.57 [1] 4	26.13 [1'995] 3		
RL cc (dB) n	1-2'000	801	7.8 [1'923] 2	42.7 [3.499] 2		
RL cc (dB) f	1-2'000	801	4.4 [1'253] 1	43.1 [3.499] 3		
IL cc (dB/30m) at 20°C f	1-2'000	801	0.59 [1] 2	26.85 [1'890] 2		
IL cc (dB/30m) at 20°C r	1-2'000	801	0.59 [1] 4	26.77 [1'890] 2		
TCL cd (dB) f	1-2'000	801	15.2 [1'223] 2	60.1 [28.49] 4		
TCL cd (dB) r	1-2'000	801	18.5 [1'833] 1	58.1 [38.48] 4		
ELTCTL cd (dB) f	1-2'000	801	15.9 [1'350] 1	58.7 [1] 3		
ELTCTL cd (dB) r	1-2'000	801	15.2 [1'290] 4	57.3 [1] 3		

Legend
Cont. check IL = Continuity check IL
NEXT = Near End Crosstalk
ACR-F = Attenuation Crosstalk-F Ratio
Z0 = Fitted Impedance
RL cc = Return Loss cc
ELTCTL cd = Equal Level TCTL cd
Phase delay = Phase delay
PS NEXT = Power Sum NEXT
PS ACR-F = Power Sum ACR-F
RL = Return Loss
IL cc = Insertion loss cc
Skew = Skew
FEXT = Far End Crosstalk
ZIN = Input Impedance
IL dd = Insertion loss dd
TCL cd = transverse conv. loss cd

Figure 8. Typical example of generated testing report

6.2 Defect Recording and Evaluation System module (DRES)

DRES is an additional module designed for a convenient recording and evaluating of defects that are detected during and after the production process. DRES records defects systematically and analyses potential defect causes, defect types, defect consequences. Then, as soon as a defect cause is recognized, selective corrective measures can be immediately proposed, such as the segregation of the deficient product. After correction of the defect, the product can be released for further processing.

DRES can be integrated into the normal test procedure thus allowing for the complete traceability including blocking and releasing of faulty products. It can also be used as an individual module instead of “defect cards” which are still used in many cable manufacturing plants.

DRES has full access to CIQ’s pool of data, especially to measurement and machine data, and vice versa. Therefore very meaningful additional evaluations reports can be provided thanks to this module.

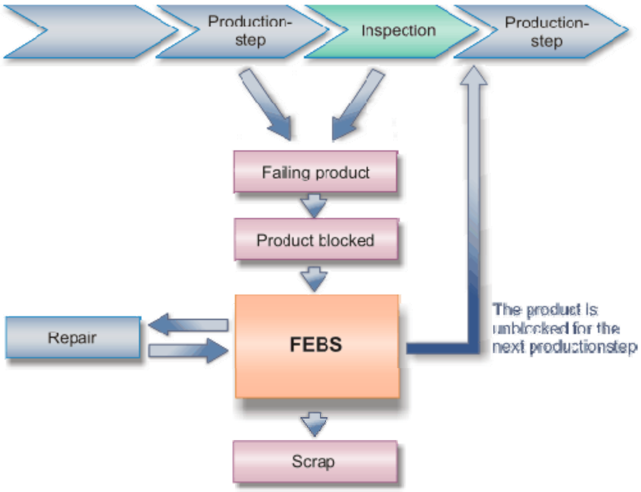

Figure 9. The DRES data flow and segregation process

6.3 Management module for Laboratory Testing (TYPLAB)

TYPLAB is specially designed for the management of laboratory tests. It allows planning, performance evaluation and the documentation of all kind of investigations. The system fulfils the requirements in documentation depth, traceability and data protection.

The advantage of TYPLAB, compared with standard test orders, is its capability in combining various individual orders into a single high level test order. In a regular production mode, process tests are forced to be performed in sequential succession. If TYPLAB is applied for final inspection, the tests can be performed in any sequences or simultaneously.

Within the TYPLAB system, all test orders and their respective partial orders can be checked and their current production status can be continuously monitored. Deadlines, status lists, various reports, certificates and evaluations can easily be generated.

Figure 10. Sequence of partial inspection orders managed by TYPLAB

6.4 Monitoring modules for the follow up of slow moving cyclical measurements

6.4.1 Automatic Long Term Testing module (MEC – Mechanical Cycling Test). The additional module MEC has been specifically designed to control long-time tests (e. g. bending tests, drag chain tests). The system allows for the tracking of values measured after reaching a predefined amount of cycles (e.g., the resistance value of a cable can be measured after each set of 1'000 bends and its evolution within the time can be traced). MEC provides a precisely arranged table containing the most important data and processing stages of all the connected devices. Among them, status, busy times, target specifications, current values and defects can be monitored.

6.4.2 Monitoring of slow reacting processes or equipment (DMS – Distributed Monitoring System). The DMS module serves for the acquisition, display and storage of measured values made in several locations (e. g. various laboratory heating cabinets and climate chambers). It periodically gathers measurement data, after reaching a predefined amount of time, from each test stations via the local area network. The values are then transferred for visualization to CIQ, offering the opportunity to monitor measured data for each individual channel. The projection contains a clear representation of the most important data of all configured devices. Among them, status, busy times, target specifications, current values and defects can be tracked.

The time line of the measurements may be represented in charts and reports. Due to the concept of separating device-specific driver on one side and the visualization on the other hand, DMS reaches a high degree of flexibility concerning connected devices and the type of tracked values.

7. Practical example and results of a CIQ implementation

The case relates to a large worldwide active group producing telecom cables in Germany. The quality control was consisting in several quality islands. Management decided to integrate those stand-alone units into a unique one, in order to: manage and centralize the data of all electrical tests and allow real time monitoring & visualization of the entire production process.

CIQ solution was installed, including modules for process data capture (SoftDLC), inspection data capture, data visualization, analyse and reporting within a network of 25 workstations.

The implementation resulted in a strong reduction of non-quality costs, the possibility to reassign IT personal to other duties and to release load from quality and manufacturing personnel.

Payback of the global investment was made within one year and management decided to roll out the CIQ system in two additional production sites.

8. Summary and conclusions

The developed CIQ system fully meets the classical needs generated by the "continuous improvement" processes.

But these are only the basics, since its modular and flexible structure allows adapting it to the requirements embracing Industry 4.0, by supporting:

- Real-time data gathering and data analytics
- Process and value chain optimisation/adjustment
- Seamless interconnection of individual data and quality islands
- Decentralized intelligence and offering fundamentals for "Internet of Things" (IoT)
- Optimization of management and production processes and support in decision making

CIQ capabilities have been adapted to cover all the information flows existing on the factory floor and beyond, such as:

- Gathering of continuous process data values and production events
- Quality and measured values of all intermediate or final tests made on the product
- "Type Test" or other laboratory tests
- Real time visualisation and full access to formatted and standardized data

Bidirectional communication allows for the gathering and the combining of the needed product and production information from ERP or other databases. Service oriented interface management, not dependant on any specific hardware or communication interface, allows easy integration and flexible adjustment of the system to any actual or future needs.

With a complete CIQ quality data management system implemented in the shop floor, each end-product unit leaving the factory, has the possibility to be connected to all measurements, parameters or events that occurred during its manufacturing cycle. Capability for storing, retrieving, sorting, analysing all these parameters during production or after delivery and during the entire life-cycle of the product are essential to set the basics for the continuous development of any modern manufacturing activity.

The capability to keep all archived values permanently and readily accessible allows easy access to historical data for an infinite amount of time independently of the amount of stored information. A better understanding of the parameters having influenced the performances and the quality of the final product can be essential for compulsory or legal traceability purposes. Additionally, this can serves R&D tasks and help develop further customer's global experience to insure the profitable growth of any cable producer.

9. Authors

Manuel Felder has obtained his master in Micro engineering in 1989 at the Federal Institute of Technology in Lausanne (Switzerland).

He joined the wire and cable industry through the extrusion technology supplier Maillefer where he held several positions in project management, operations and engineering. He later managed the telecommunication cable business, global sales & marketing and finally the Swiss production unit with the "Pipe Business" division.

Manuel joined AESA in 2017 as Business Development Manager for the CIQ quality management system.

Wolfgang Klein holds a degree of Dipl.-Ing. (TH) Information Technology from RWTH Aachen University (Germany).

During and after his university education he worked in the testing department of the German cable manufacturer Kerpenwerk. His responsibilities connected with central IT were related to networking and automating test equipment.

In 1994, he joined M.E.A. (Mauf und Rudow) where he used his practical experience to design the Quality Management System CIQ 3.0. He also developed the foundation of some modern telecom automatic test equipment such as the balunless data cable measurement systems "Cobalt".

Since the merger of M.E.A. and AESA, he continues his role as head of the System Development Department.