Factory IT solutions

Business Unit

Since its transfer to MATEC in 2005, B. U. "Factory IT solutions" (if you prefer "Informatica di Fabbrica) on the one hand had to ensure the maintenance of know-how on dated systems (still developed in DOS environment!), on the other hand it found itself developing new solutions on new architectures: over the years we have developed countless software applications in the industrial field, from DCS (Distributed Control System) for the control and command of automation systems, SCADA (Supervisory Control And Data Acquisition) for supervision and acquisition of plant data, up to the most recent implementations of MES (Manufacturing Execution System), for JIS (Just In Sequence) management and traceability (Product Traceability).

These are the so-called MTS (Matec Traceability Systems), which for market needs and business choice have never merged into a single product on the shelf: the MaTrace platform was instead created, a set of modules that from time to time are assembled and customized to meet the needs of each individual customer, integrating into a complete MES project..

MaTrace

In fact, MaTrace implements many aspects of the ten "pillars" that, according to the MESA (Manufacturing Enterprise Solutions Association) model, correspond to the processes managed by an MES system:

Dispatching Production Unit

- Production batch setting
- JIS (Just In Sequence) processing
- Execution of Production Plans

Data Collection & Acquisition

- Manual identification (Barcode readers 1D, 2D, RFID hand-held)
- Manual data collection
- Automatic identification (Barcode readers 1D, 2D, fixed RFID)
- Automatic data collection (interface with PLC or remote I/O)

Controls

- Control and interfacing with PLC (via OPC_Server)
- Control and interfacing with ROBOT
- Control and interfacing with Welding Drawers

Process Management

- Product labeling / marking management
- Production control and progress
- Management of Batch / JIS flows
- Product machinability control

Labor Management

- Operator login management (Badge reading)
- Permissions management / access level
- Guided drive of visual inspection / repair stations

Resource Allocation & Status

- Work calendar management
- Management of raw materials availability
- Component availability management
- BOM Management

Quality Management

- WebApplication to search historical data
- Data export in Q-DAS format

Product Tracking & Genealogy

- Product and Process Traceability and Traceability
- Historicization on db WIP (SQL Server / MySQL)
- Data export to central repository

Logistics

- Labeling finished product / pallet
- Dot peen / laser marking
- Warehouse Management System

Performance Analysis

- Production statistics / OK/KO parts shift (Pareto)
- Real-time progress display on Andon

MTS – TOPICS

Integrated solutions

MATEC has always specialized in Industrial Coding Solutions, from product identification (automatic labelers, percussion and laser markers, RFID tags) to its recognition (code reading and verification, vision systems) then managing traceability through software solutions implemented in close collaboration with the customer, to allow perfect integration in the company..

Identification

Objectification and traceability are achieved only through unambiguous identification.

Identification takes place through optical code readers, marking systems and printers. Each batch/unit produced is identified with the affixing of the label. At each significant event, the data is historicized by the software.

Objectification

Electronic instruments or operator guidance interfaces (HMIs) are used to ensure the correct execution of assembly and testing operations in industry. By communicating with them it is possible to have the entire production process under control: setting the work parameters and verifying the outcome of the operations.

Traceability (ISO 8402)

For the control and management of production, and the collection of "real-time" data, the need arises to be able to adapt in a flexible and integrated way, also through the creation of hardware / software devices designed ad-hoc.

For years MATEC has been developing TRACEABILITY systems in the Anglo-Saxon sense of the term, which incorporates the concepts of Traceability (TRACKING) and Traceability (TRACING) often mistakenly used as synonyms in Italian:

- **Tracking:** it is the documentation referring to the phases of the production process and to all the input elements that go to create, modify or transform a product (downstream).
- **Tracing**: it is the inverse function that allows to trace from the finished product to the entire supply chain of raw materials used and to the processing processes (upstream)

MATEC traceability systems are designed for the entire production chain up to the end user, or part of it, depending on the customer's needs:

- **INTERNAL traceability**: it takes the form of a series of internal procedures, aimed at improving the production process, which concern both compliant products and waste..
- **Traceability of SUPPLY CHAIN**: it is an inter-company process, with the aim of certifying the conformity of the product that has arrived at the sale.

Data Processing and Analysis

The data is used by the software and allows control and management

- ❑ of the parts being processed
- ❑ of the processing itself
- ❑ of the workstation
- ❑ of the operator

The processing, also exploiting statistical analysis, returns the real trend of production and allows to verify the adherence between what is happening in the reality of the departments and what had been established in the production plan.
Special functions also support the resolution of all problems related to product quality in an end-to-end perspective (production ascent).

"Zero defects" production

The path that allows you to get to the final product in industrial processes is the set of a series of procedures: having total control of the individual operations is essential to guarantee the quality of the final product, identifying errors in time and stopping the production process in case of non-compliance.

MTS - FEATURES

Developed in MS WINDOWS® environment, the traceability management systems are designed to operate both on line PCs and on Virtual Machines on the plant network, recording data in a local database (SQL Server) and then transferring them to centralized information systems. The main features are:

- ❑ Product **coding** through labeling or DPM marking at the beginning of the production cycle
- ❑ **Batch association** of components used for assembly to the product
- ❑ **Management of the production flow** with indication of "workability" to the machinery
- ❑ Detection of the operations carried out on the product, with association of the **outcome** of the individual processes carried out
- ❑ Detection of the process **parameters** set with historicization of the modification operations of the same
- ❑ Detection of **real process values** with indication of any deviations from the expected
- ❑ **SYNOPTIC**
- ❑ Data update on **ANDON**
- ❑ Analysis of collected data and production **statistics**
- ❑ Historicization of information on the Customer's **database** for subsequent consultation
- ❑ Consultation of data "remotely" via Internet (**WEB Applications**)

MTS – ARCHITECTURE

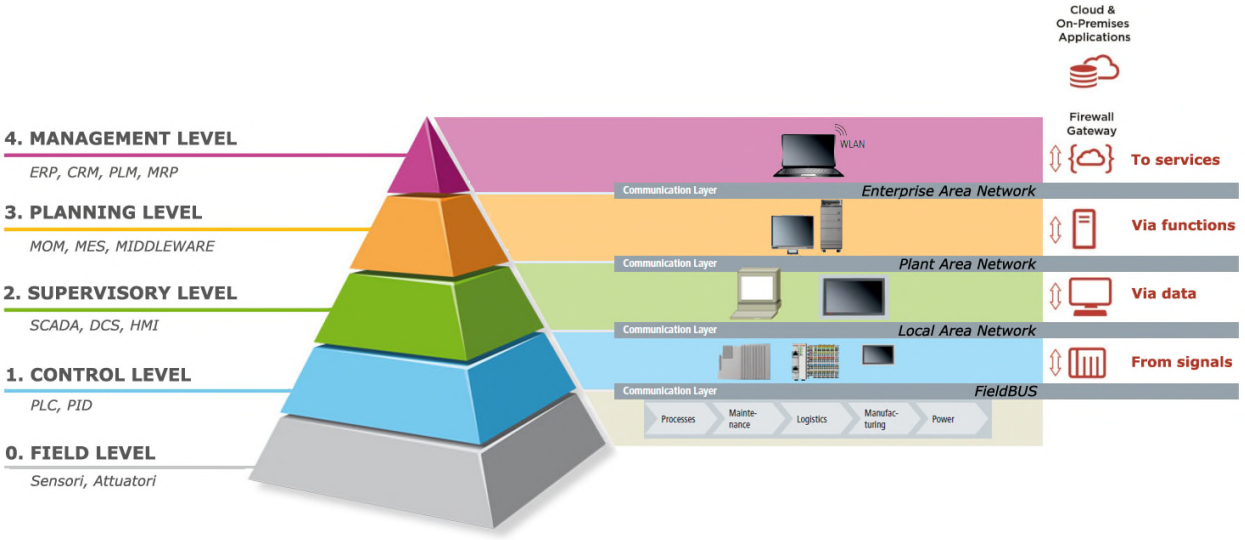
Each Matec Traceability System is an integrated solution composed of hardware of which we are distributors, integrators or VARs (engineering customized solutions), and proprietary software.

Our traceability solutions use the *MaTrace* platform together with vision/OCR sensors, barcode readers or RFID tags, OPC software in the dialogue with PLCs, for data collection from the field.

MTS is the **middleware** that enables the technologies used in the field to communicate with company information systems (ERP, MES, WMS) according to the degree of integration required and according to the security policies in force at the Customer company, and which allows an initial processing and analysis of data.

It therefore acts as a front-end of Level 3 (MANUFACTURING OPERATIONS & CONTROL) of the Purdue Enterprise Reference Architecture business organization model, as a connector between Levels 0-1-2 shop-floor (BATCH, CONTINUOUS, DISCRETE CONTROL), and Level 4 (BUSINESS PLANNING & LOGISTIC). This model has led to the definition of the famous "automation pyramid" and integrated into the ANSI/ISA 95 Standard for the development of automated interfaces between business systems and control systems.

ANSI/ISA-95
DEVELOPMENT STANDARDS



LEVEL-5: BUSINESS INTELLIGENCE
LEVEL-4: ENTERPRISE, BUSINESS OPERATION
LEVEL-3: MANUFACTURING OPERATION
LEVEL-2: MONITORING AND SUPERVISING
LEVEL-1: SENSING AND MANIPULATING
LEVEL-0: PRODUCTION PROCESS

MTS vs ANSI/ISA-95

THE INTERFACE BETWEEN ENTERPRISE AND PROCESS CONTROL

THE ANSI/ISA-95 LEVEL-0:

- ❑ **PHYSICAL PROCESS**
  - Inputs / Outputs, Voltage / Current / Load cell / Resistance / Others

THE ANSI/ISA-95 LEVEL-1:

- ❑ **SENSING**
  - Transmitters / Sensors
- ❑ **MANIPULATING**
  - Robots / Actuators / MotorsTransmitters

THE ANSI/ISA-95 LEVEL-2:

- ❑ **HMI / SCADA**
  - Operator Interface
  - AI and Machine Learning
  - Historization and Big Data

THE ANSI/ISA-95 LEVEL-3:

- ❑ **MOM:** Manufacturing Operation Management
  - Scheduling
  - Production documentation management, Reporting, OEE
  - Asset tracking
  - Laboratory Information Management System
- ❑ **MES:** Manufacturing Execution Systems **(MES is subset of MOM)**
  - Routing
  - ERP backflush / Chain Traceability
  - KPI monitoring
  - Resource / Tooling management
- ❑ **MIDDLEWARE:** like **MTS** **(MIDDLEWARE is subset of MES)**
  - Internal Traceability
  - Interlocking
  - Rework

THE ANSI/ISA-95 LEVEL-4:

- ❑ **ERP:** Enterprise Resource Planning like SAP
- ❑ **MRP:** Material Requirements Planning
- ❑ **CRM:** Customer Relationship Management
- ❑ **PLM:** Product LifeCycle Management
- ❑ **ASSET MANAGEMENT**

THE ANSI/ISA-95 LEVEL-5:

- ❑ **BI:** Business Intelligence

MTS
THE ROOTS

In the 80s, solutions designed specifically for individual customers were created, identifying the most suitable technologies and developing the required operational functions.

In essence, these were **SCADA** applications, which often integrated hardware solutions specifically designed for the interface with the field and proprietary protocols for communications.

For the FIAT Assembly lines, the Setting and Resolution Stations (**SIDs**) were created: it was the archetype of the early 90s of the Traceability systems that would be developed later: in essence, on each production line there was a Setting Station which, receiving the Production Plan from the management system, guided the operators in the production cycle; the passage of information to the machines along the production line was guaranteed from special TAGs housed on pallets. At the end of the line a Resolution station allowed to proceed with the testing and release of the product.

SYSTEM ARCHITECTURE
CLIENT/SERVER 1-tier: the three levels Presentation (GUI), Logic (Processing), Data (Database), reside on a single machine.

APPLICATION ARCHITECTURE
The application is therefore **unique** and **monolithic**, developed for that specific project. It typically resides on PCs in the line-edge cabinet, and represents the **front-end** of the upper layers towards operators and production conductors.

FUNCTIONALITY
- Line synoptic
- Operator identification and access management
- Production batch setup
- Component Traceability
- Outcome/Timestamp Operations
- Local reporting on period data
- Sending consolidated data to the management system for historicization.

‘80

CASE STUDY

Assembly line FIRE 16V - FIAT Termoli

- ❑ Application **Stazione di Impostazione,** resident on PC in pulpit: production batches are set (Product / Quantity).
- ❑ Application **Stazione di Delibera**, resident on a PC in pulpit: assembly data is aquired and waste is managed.
- ❑ The two applications communicate over line **LAN ethernet** (DECnet).
- ❑ The data from the field are acquired through a special hw/sw module for interface with the **MOBY RFID** sensors on board the pallet, whose content is updated gradually by the station controllers.
- ❑ The processing data are recorded in a **temporary archive** (DBASE IV), and made locally accessible through a special interface.

The dialogue with the **management system** (PMS) takes place through Cabernet protocol datagrams: this applies both to the production setting data and to the end of processing and outcome data for each individual engine.

MTS 2.0
EVOLUTION

The limitations of the 1-tier structure (scalability, portability, maintenance) lead MATEC to redesign the system architecture: the Physical layer becomes independent of the Logical and Presentation layer, and typically resides on a customer's dedicated server.

This is how the DATA COLLECTION applications are born, which make available on a centralized database, for distributed query, the data and information detected by the field, typically PLC connected to the fieldbus (FieldBus).

SYSTEM ARCHITECTURE
CLIENT/SERVER 2-tier: The Presentation (GUI) and Logic layers reside on a Concentrator PC, which then transfers the consolidated data to the plant server, the Data tier (Database).

APPLICATION ARCHITECTURE
The application derives from the integration of pre-existing **modules** that are assembled and customized for each specific project. A **Concentrator** PC in the cabinet on the edge of the line interfaces operators and production conductors, and transfers the data to the database of the plant server, where the reporting functions reside.

NEW FEATURES
- Defect management and control/testing benches
- Processing of statistical data (OEE, FTQ, etc.) and visualization on ANDON
- Fault-tolerant management of data stored locally and on the centralized database
- Distributed reporting on period (local_db) and historicized (server_db) data

'90

CASE STUDY

Teksid

Production of PENTASTAR Cylinder Heads

For the Production Line of the Cylinder Heads of the new Chrysler engine, the **Data Collection** system was created:

- ❑ **MTS application** resident on PC in the pulpit: production start/end, operator recognition and data acquisition from field PLCs are managed.
- ❑ **Quality Control** and **Rework** benches: defects are acquired and waste managed.
- ❑ The data from the field are acquired through dialogue with the PLCs via **OPC_Server** (OPC-DA protocol).
- ❑ Processing data is recorded locally in a **temporary database** (SQL Express), and transferred at the end of production to the **factory repository** (SQL Server).
- ❑ Application of **query** and **reporting** on the plant server.
- ❑ Applications and interfaces (PLCs, barcode readers, etc.) communicate over the plant's **ethernet LAN** (TCP/IP)**.**

MTS 3.0
EVOLUTION

From the collaboration with ERGOM (printed parts for the automotive components market, merged into the MAGNETI MARELLI group under the name of PCMA) the first **TRACEABILITY** Matec solution was born, which integrates data collection with production flow control, and makes information available – also in view of a possible production rise, via WEB.
A new leap in quality is required: the MaTrace platform is born in 3-tier architecture that allows greater scalability, portability and maintenance of the system., and the application derives now.

SYSTEM ARCHITECTURE
CLIENT/SERVER 3-tier: **Physical**, **Logical** and **Presentation** layers can reside on different machines, while system functions can also be used via the **Web**.

APPLICATION ARCHITECTURE
The applications derive from a simple composition of the modules of the **MaTrace** platform and provide a server side (**Virtual Machine**), multiple **clients** (Line PC) and distributed **repositories** (SQL, MySql, Oracle ….).

NEW FEATURES
- Processing of Production Plans
- Flow Control Management
- Support to the web_based Production Ascent
- Work Calendar / BOM Management
- Borderò data processing
- Production statistics (Pareto)

'00

CASE STUDY

MAGNETI MARELLI

BSUV Crossbar Welding lines– Goiana (BRA)

On behalf of COMAU, the **Traceability** systems for the 7 Traversa and BSUV – FCA Frame welding lines were supplied.
The **MaTrace** platform manages all the technologies (RFID, Barcode Readers, Sensors, etc …) involved and interfaces with all types of ERP, MES, WMS and company PLCs:

- ❑ Line Conduction Guide and **Synoptic**
- ❑ Local **Repository** (WIP) on database
- ❑ Dialogue with **PLCs** via OPC_DA
- ❑ Dialogue with **Welding Drawers**
- ❑ 2D and 3D **Code Readers** Management
- ❑ DBtoDB connection with the **MM management system** (SITEM)
- ❑ Historical Repository on **Virtual Machine**
- ❑ Reporting functions available via WEB (**Web Applications**)

MTS 4.0
TODAY

The evolution continues, according to the new paradigms of **Industry 4.0,** which provides, for example, the use of **OPC** UA (IEC 62541) as a data exchange technology - or rather information models - between level 1 and 2, similarly to what is defined by the **ISA 95** standard (IEC 62264) for interactions between level 3 and 4 that take place with a provider / consumer mechanism for **XML** file exchange with predefined schemas.

MTS therefore assumes the role of **Edge Gateway**: the main benefits deriving from the use of edge computing technologies are the reduction of processing latency, which allows real-time responses, and the saving of bandwidth, sending to the data center information already processed and therefore smaller.

SYSTEM ARCHITECTURE

WEB ORIENTED 3-tier: **Interface Level** - is the statically or dynamically generated front-end displayed by the browser on the client computer; **Logical Level** - is the dynamic content generator software (Application Server ASP.net); **Data/Physical Layer** - includes data storage and DBMS software (back-end). They typically reside on servers/virtual machines.

APPLICATION ARCHITECTURE

Applications are now **service-based:** Service Oriented Architecture (**S.O.A.**) decomposes individual applications into elementary functions (Web Services) that can be called by programs when necessary. The software system is therefore designed to support interoperability between different computers on the same network or in a distributed context.

NEW FEATURES

- The substantial novelty is that all the functions of MTS are now accessible via the Web, in Intranet or Cloud, distributed on the various levels (back_end, application, front_end).

CASE STUDY

FCA
FIAT CHRYSLER AUTOMOBILES

'10

Plastic Unit - Melfi

A first, partial implementation of MTS 4.0 was provided for the Tank, Dashboard and Bumper production lines, first B-SUV and now COMPASS, of the FCA plant in Melfi. In particular, on the **COMPASS Tank** line, Matec middleware performs the following functions:

- **Station PC**: Instance specifically configured to act as a front-end for line operators, and as a temporary data repository in case of network connection unavailability.
- **Line PC**: instance specially configured to act as front-end in client-server plant architectures, and as a line supervisor (Synoptic, Andon, etc..).
- **Edge Gateway**: typically resides on virtual machines and is the set of DBMS and Application Servers (back-end). It provides local methods of access to **Internal Traceability** (Quality) data, processes and manages production requests (JIS – Just in Sequence) from the FCA MES, to which it then sends the data for **Supply Chain Traceability**.
- **Communication Middleware**: operates bidirectionally from level 1-2 via **OPC_UA** Server to level 3-4 via **DBtoDB** and **XML files**.
- **Web_Applictions**: allow access to data via the web, both for configuration and for analysis and reporting.

MTS 4.0
THE FUTURE IS HERE

Industry 4.0, IIoT and MES systems: changing the rules of the game

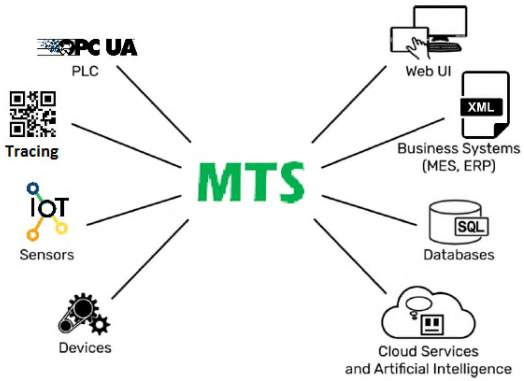
The Internet of Things, declined in the factory as "**Industrial Internet Of Things**" (IIoT) is one of the founding elements of **Industry 4.0,** which will transform the way of thinking about the factory, processes and relationships within the entire supply chain.

What changes with the application of IoT technologies is the logical-architectural scheme that connects the different solutions present in the factory: we move from devices connected to applications, to applications and devices connected to a central communication infrastructure. It is thus possible to reorganize and review production in an integrated form with design, work organization, product control and subsequent maintenance, marketing and sales.
Convinced that MES systems need to reinvent their role in a renewed way of interconnecting old and new systems, technologies and components, in MATEC we are working on the completion of the **new MTS platform**:

- A new **IoT Gateway** to integrate and collect production data from machines, sensors, devices, automation systems and other physical objects, according to the new paradigms of the Industrial Internet of Things.
- Evolution towards Edge Computing; the added value of the **Edge Gateway** is linked to the ability to convey and make available in real time all the information collected and to integrate it with the human and collaborative aspect: data transformed into knowledge.

'20

CASE STUDY



Already today MTS allows to realize the complete traceability and traceability of the production process, managing the flow (eg **JIS**), identifying batches and individual components of the semi-finished and finished product.

Starting from the recorded data, MTS allows to reconstruct the production cycle of each product ensuring compliance with the requirements, in support of the **QC**, and the possibility of identifying the causes of any non-conformities to efficiently manage **recalls** from the market.

MTS will be the **middleware** that enables the technologies used in the field to communicate with corporate information systems (ERP, MES, WMS) and that allows data processing.

For this reason it is evolving towards a new communication model, no longer based on a client-server mechanism like the existing one, but on a **publisher / subscriber** architecture specifically aimed at supporting M2M, IoT and M2B (Machine To Business) services.