FORCE MES FLEX - Track & Trace

Version 5.12

Product Description

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Overview*

The Track & Trace app is the traceability solution of FORCE MES FLEX (hereafter simply referred to as MES FLEX). It can be used to trace single pieces and batches and supports a paperless production with a digitalized assembly plan.

The Trace Tree is the basic package of Track & Trace and forms the basis for all functions of the three add-ons. It creates the prerequisites for managing important collection points for parameters such as speed, diameter, pressure or temperature. The Trace Tree must be extended by at least one additional add-on, as it can only be used efficiently and purposefully in combination.
The tracing of a single piece relates to a uniquely identifiable object. Recordings are made without gaps across multiple workplaces and operations. When a batch is traced, it is in an identifiable carrier at a specific time and is tracked by batch number.
The Assembly add-on allows you to manage an assembly plan digitally and make it available to the worker on the Shopfloor Terminal. The assembly plan is based on the bill of materials of an operation and is displayed on the terminal when the operation is initiated. It contains instructions on the assembly of the source material. In addition, other documents with helpful or necessary information can be stored, which the worker can call up at any time (e.g. drawings or safety instructions).

ⓘ A prerequisite for using Track & Trace is the **Connectivity Shopfloor Machine/Manual Workplace** add-on of the FORCAM app **FORCE Bridge**. This is where the process data by time is integrated, which continuously records production-relevant values from the machine connection. These provide the foundation for Track & Trace.

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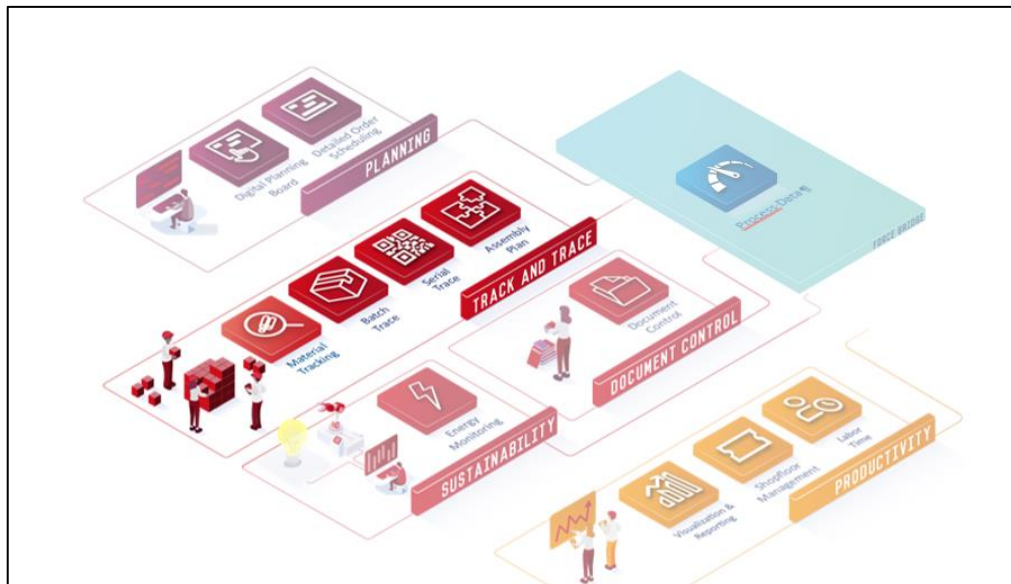
* For better readability, we generally use the generic masculine in the text. These formulations, however, are equally inclusive of all genders and address all equally.

Basic package: Trace Tree

The **Trace Tree** basic package forms the foundation for all functions of the three Track & Trace Add-ons. Together with the Connectivity Shopfloor Machine/Manual Workplace add-on from the FORCAM FORCE BRIDGE app, the Trace Tree creates the conditions for managing important acquisition points for parameters such as speed, diameter, pressure or temperature.
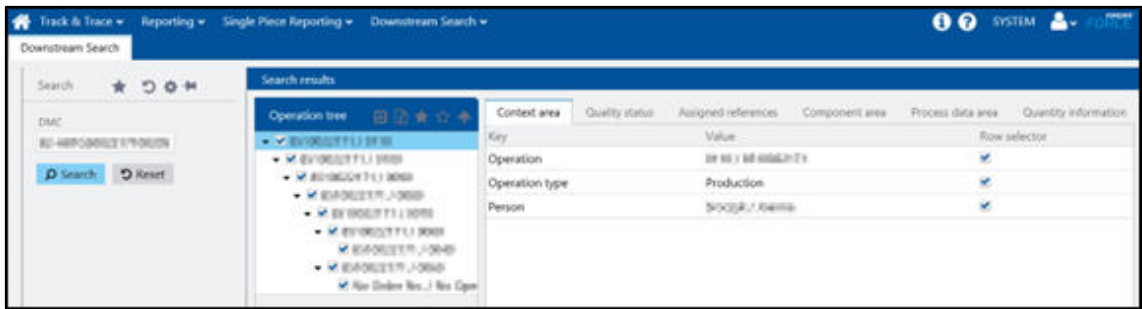
Recording and reporting of trace data

Track & Trace records relevant process data during production. Those process data that are recorded only for one production object (either single piece or batch) are called trace data. This means you have a direct link to the object and to the time of production.

Basically, trace data can be displayed in trace reporting: The Trace Tree offers a wide variety of display and analysis options for sensor and machine data. In addition to the Trace Tree view, it is also possible to display the data as tabular lists. Process data can be visualized by using trend lines, graphics or ratio representations of values/elements. The data-driven continuous improvement process (CIP) is supported based on these evaluations.
By also using the FORCAM app **Productivity**, it is possible to write and evaluate trace data using SQL statements.

Definition and configuration of data collection points (DCP)

The DCPs are used to describe the structure of the recorded trace data. They can be configured in the trace-tree as data collection point types. In this process, structurally identical DCPs are summarized. DCPs can also be enabled or disabled based on individual requirements and conditions for collection.

Definition of physical units

The physical units of the recorded values can also be configured individually. This defines which unit is to correspond to the value supplied by the machine respectively.

Data input

Continuous recording of data ensures end-to-end traceability. The measured data can be acquired automatically in the production/assembly process from a PLC, from CSV files or via a database exchange interface. Every data collection point that can be automatically filled with process data during the process, e.g. via a PLC, can also be manually entered with data by a worker via a dialog in the Shopfloor Terminal. In addition, it is possible to specify triggers for process data collection (e.g. when certain limit values are exceeded or not reached).

Data storage

Selected signals from machines are recorded based on value and written directly to a time series database. Each dataset consists of a value and a timestamp. The storage is not dependent on operations, orders or reference to serial/batch numbers. In most cases, the trigger is a change in a signal value. As an alternative, signals can be written to the database at specific intervals (e.g. every five seconds). Track & Trace can therefore involve large volumes of data (big data). A conventional relational database is not suitable for these large volumes of data processing.
For this reason, Track & Trace uses a document-oriented NoSQL database based on JSON.

ⓘ   FORCAM uses the free community edition of MongoDB. Please contact us if this does not cover your requirements.

Interfaces

The app is also suitable for connecting machines and systems that cannot be connected via a classic machine control system. In such cases, data can be transferred either via CSV files (e.g. for systems with measuring machines) or via an open database interface (e.g. when connecting third-party systems such as a CAQ system).

Configuration of limit values and alarming

The recording of process data can be used to define limit values which, if exceeded or not reached, will automatically trigger an alarm. Therefore, not only the deviations of the threshold value can be configured individually (larger, smaller, unequal, etc.), but also the implications (e.g. alarm in the terminal or email to a desired distribution list).

| LWL: 20 mm | LCL: 19 mm | Normal length: 21-23 mm | UWL: 24-29 mm | UCL: 30+ mm |
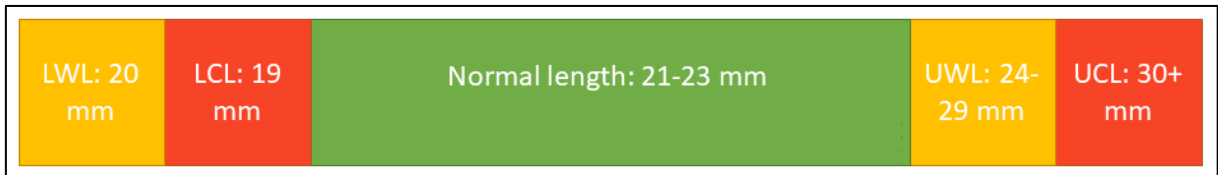
LWL	Lower warning limit
LCL	Lower control limit
UWL	Upper warning limit
UCL	Upper control limit

Locking and securing processes

The recorded data is used to ensure that the prerequisites for further processing or for processing in a subsequent process are met. The following tests are available for this purpose:

- Previous process completed
- Previous result is qualitatively acceptable
- All components are available

Scope of functions

The FORCAM app **Track & Trace** basic Trace Tree package provides the following functions:

- Recording and reporting of trace data in Trace Reporting or by using the Productivity app
- Individual definition of data collection points
- Free definition of desired physical units
- Interfaces for connecting older machines or for third-party suppliers
- Tests for locking and securing processes
- Data storage in the document-oriented NoSQL database MongoDB

Add-on: Batch

ⓘ Prerequisite for using the **Batch** add-on is the basic Traceability package.

MES FLEX Track & Trace lets you trace a production batch by batch numbers. A production batch is located in an identifiable container (e.g. in a crate) at a specific time.

Batch trace
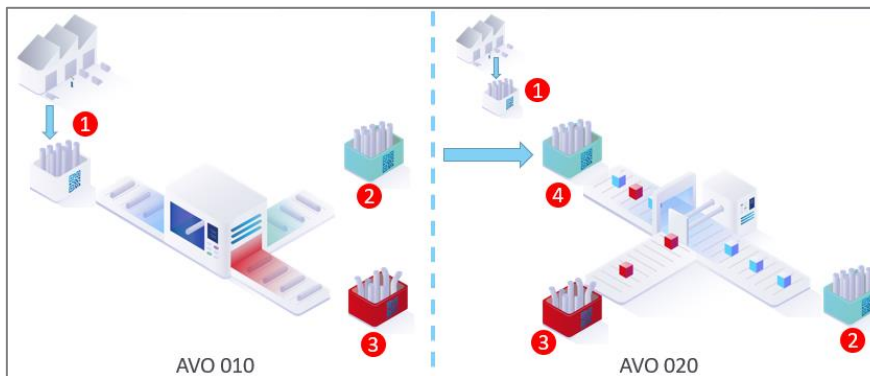
Important elements:
1) Material supply from the warehouse
2) Container for the good parts
3) Container for rejected parts
4) Material supply from previous operation

Containers or product carriers with single pieces, components or auxiliary materials (e.g. screws, washers, etc.) are recorded from the in-house production or in the warehouse. Therefore, each container has its own unique identification number (ID), preferably machine-readable. The ID contains information about the manufacturer, model, date of manufacture, batch number, etc. As an alternative to automatic ID scanning, the worker can also enter the data manually. Based on the ID, the entire production history of each registered container or its contents can be recorded, precisely identified or traced back afterwards.

When they enter the production process, the contents of the storage containers are combined, if necessary, with those of other containers from the in-house production, with supplied auxiliary materials or other materials to form production containers (input containers). They too carry their own ID. In each work step, the worker takes materials from input containers that, after being processed, are put into output containers, where they are taken to the next work step. These are then booked back in as input containers.

After passing through the entire manufacturing process, finished assemblies, single pieces or final products leave production in various output containers - for yield parts, for rework parts or for scrap parts. These containers also have their own ID and are recorded by the system, so they are identifiable and can be traced afterwards.

Material and quantity movements between containers

All data generated during the production process is recorded for registered containers or production batches. They are also called trace objects. This trace object can consist of one or more containers or even single pieces. Process data can also be recorded for each trace object. To ensure unique identifiability, the trace object must be marked with an ID. It is either machine readable or manually recorded.

Any material or quantity movements between input and output containers are managed via the Shopfloor Terminal. At each work step, the worker processes materials from input containers, that, after being processed are put into output containers and sent to the next work step, where they are booked back in as input containers.

The sequence is as follows:

1. A dialog in the Shopfloor Terminal prompts the worker to register an input container from the warehouse or a previous work step at his workplace/operation.
2. A subsequent dialog prompts the worker to log an output container.
3. The worker takes the material from the input container and processes it according to the specifications for the upcoming work step.
4. After that, the worker puts the processed material into the output container. If the output container is full (sensor detection or message via worker input), it can be logged off manually or automatically and fed to the next workplace or the QM process.

Quantity model

All material or quantity movements are recorded either automatically or manually. Each production lot is assigned to a container at a specific time. It is based on a so-called quantity model, which precisely separates the materials contained in the container per order and operation (= production stage). Process data such as temperature or pressure can also be assigned to the respective production lot. Based on this, MES FLEX can display the material movement of anonymous quantities between input and output containers. Material or quantity movements between the containers are displayed in detail, i.e. indicating the associated order and operation.

In addition to anonymous quantities, a production lot can also contain identifiable single pieces. Even for single pieces, process data can be assigned to the respective single pieces and the single pieces can be moved from one container to another.

Displaying containers in the Shopfloor Terminal

The containers assigned to an operation (input and output containers) are displayed in the Shopfloor Terminal in an extension of the operation mask. In addition to quantity and material number or production stage, they can be identified by a unique lot number.

Inclusion of a quality management system (QM system)

An existing QM system can be integrated into the trace process via a specified web service interface to ensure an efficient production process that is largely error-free. When starting an operation, the QM system (e.g. a CAQ system) is informed via a web service about which order/operation was started in MES FLEX. The QM system can subsequently send (also via web service) the currently valid (sampling) interval for this operation to Track & Trace. The interval can be dynamically adjusted at any time via the web service interface. At the end of the interval, the worker is prompted to take a defined number of parts from the process (output container) and forward them to the QM-system. The QM system will then verify the quality of the transferred parts according to an inspection plan (over several inspection operations, if necessary) and communicate the inspection result (including any measured values) to Track & Trace. If the quality of the partial quantity removed is unsatisfactory (scrap), it is an indication of the quality of the total quantity in the output container. Track & Trace adjusts the quantity model and the quality/release status of the output container accordingly.

Compliance charge

In addition to integrating a quality management system, it is also possible to use the compliance batch function to demonstrate quality and for analyzing the products at each stage of the production process in retrospect in case of a complaint. For this purpose, a sample of good quality is taken from the total production and placed in a separate container. The container receives a label with a compliance ID and is placed in storage. If any quality issues should arise later in the context of a complaint, it will be possible to trace the corresponding compliance batch back to any stage of the production process.

Analysis and visualization options

Track & Trace offers various options for analyzing all collected process data. In terms of batch trace, they are as follows:

- Trace Tree for a production batch
- Search for production batches/containers with specific properties
- Visualization of material/quantity movements between containers

For visualization in the form of trend lines, graphics and relationships between values/elements, MES FLEX relies on the experience and know-how of partners and third-party providers. Professional graphic systems and data analysis tools can present the data collected by Track & Trace in numerous ways. Individual customer-owned tools may also be used.

Scope of functions

The Batch add-on offers the following functions:
- Batch trace:
  - Material and quantity movements between containers:
    Tracking the movement of material quantities and single pieces between input and output containers
- Quality management:
  - Integration of QM systems (e.g. CAQ system) via a web service interface
- Compliance batch:
  - Archiving a sample per production stage for subsequent tracking or verification of quality
- Components:
  - Recording and tracking the components used to draw conclusions, e.g. about the respective supplier
- Intelligent analysis:
  - Search for production batches/containers with specific properties
  - Visualization of material/quantity movements between containers
  - In-depth analysis regarding batches

Add-on: Single piece

ⓘ   Prerequisite for using the single piece part add-on is the basic Trace Tree package.

The single piece feature includes the recording and seamless tracing of single pieces through all production stages.

The traceability of production processes, the traceability of produced parts, but also the ongoing tracking of products and processes is extremely important for quality and production management.
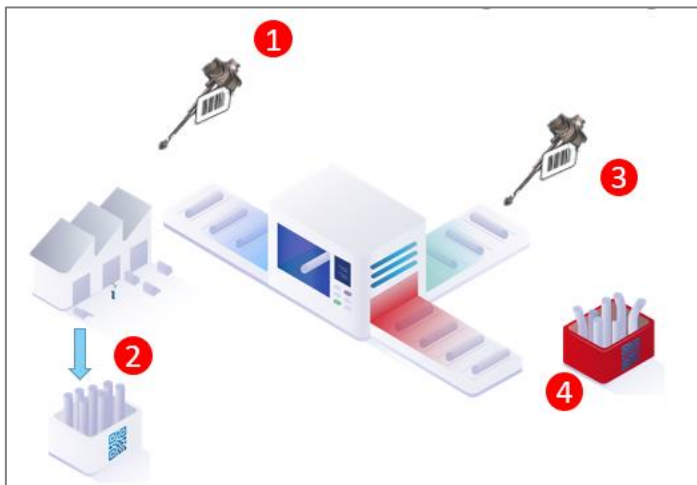
Important elements:
1) Input single part
2) Material supply from the warehouse
3) Checked/verified good part
4) Container for scrap / NA

Single piece trace

Track & Trace permits tracking of a uniquely identified single piece across multiple workplaces and operations, and incorporates the data added at each workplace. A real-life example:
A part with an ID is conveyed into a furnace at a workplace. The furnace temperature is assigned to the part at this workplace. Holes are milled at the next workplace. The cutting speed and hole diameter are assigned to the part at this workplace. Other data generated on other workplaces are appended to the data previously recorded.

Data recording for single piece trace

Data recording starts according to the configuration of the data collection points (DCP).
A DCP describes all process parameters to be recorded (e.g. pressure or temperature) as well as their source (e.g. signal X from machine control Y). In addition, each DCP includes a definition of when data collection is triggered. The specific trigger can be defined flexibly, for example as the change of a signal value to a specific value (e.g. rising signal edge). The end of data recording corresponds to the end of the trigger, e.g. a falling signal edge.

Trace Tree for single pieces

When recording is finished, the process data are saved in a trace together with their valid processing context. Here, the processing context is particularly the executed order/operation.
The system uses the ID of the single piece to check whether it was already processed at a previous workplace/operation. If this is true, the corresponding trace nodes are joined. Joining these nodes creates a Trace Tree that accurately reflects the structure and chronology of the production/assembly operations. If the ID of the single piece is searched for in Track & Trace, the corresponding Trace Tree is displayed.

The following tabs provide information for each operation:

- Context:
  Basic information about order, workplace, person logged in, etc.
- Components:
  Information about components such as component number, name, supplier, etc.
- Process data:
  Information about data collected at this workplace, such as torque, rotation angle, etc.
- Reference value:
  The IDs assigned to the node (e.g. serial numbers)
- Quality status:
  The quality status indicates whether the part is OK (okay) or NOK (not okay) at this stage of production.
- Quantity model:
  The quantity info describing the quantity recorded for this node. This also includes a qualified quantity reason (e.g. surface scratched)

Displaying single pieces in the Shopfloor Terminal

The single pieces assigned to an operation are displayed in the Shopfloor Terminal in an extension of the operation mask. In addition to quantity and material number or production stage, they can be identified by a unique ID.

Inclusion of a QM system

Similar to the batch feature, a QM system (e.g. a CAQ system) can also be integrated for the single piece via a defined web service interface. The functionalities and advantages are the same as those listed under Batch.

Analysis and visualization options for single pieces

Track & Trace offers various options for analyzing all collected process data:

- Trace Tree for a produced piece
- Search for all single pieces with specific properties
- Search for all single pieces and display of correlating parameters (basis of correlation analysis)

Visualization is done using trend lines, graphics as well as ratios between values/elements. Professional data analysis tools enable a comprehensible presentation of the data collected by Track & Trace. However, it is possible to connect and use your own custom tools.

Scope of functions

The single piece add-on offers the following functions:
- Single piece trace:
  - o Tracking a single piece across multiple workplaces and operations, incorporating the relevant trace data added at each workplace
- Quality management:
  - o Integration of QM systems (e.g. CAQ system) via a web service interface
- Components:
  - o Recording and tracking the components used to draw conclusions, e.g. about the respective supplier
- Intelligent analysis related to:
  - o Trace Tree for a produced piece
  - o Search for single pieces with specific properties
  - o Search for all single pieces with specific properties and display of correlating parameters (basis for correlation analysis)
 - o In-depth analyses regarding single pieces

Add-on: Assembly plan

The Assembly plan add-on lets you manage assembly plans and make them available to your workers in the Shopfloor Terminal.

When an operation is started (AVO), the worker's Shopfloor Terminal displays the bill of material (BOM) for the respective operation. Each assembly plan also includes detailed assembly instructions. The correct assembly sequence is ensured during the assembly by entering/scanning the respective serial/batch numbers.

In addition, document links can be defined for each component, which the worker can or even must call up to obtain helpful or critical information (e.g. drawings, safety instructions, etc.). The worker confirms the execution of the individual steps by manually entering them at the Shopfloor Terminal.

For each item on the bill of materials, it is also possible to configure parameters that are to be entered manually, including limit values. These parameters must also be manually entered by the worker when installing a component.

An assembly process is not completed until all mandatory steps have been confirmed as completed by the worker. However, it is always possible to interrupt an assembly process and resume it later seamlessly with all the data previously recorded.
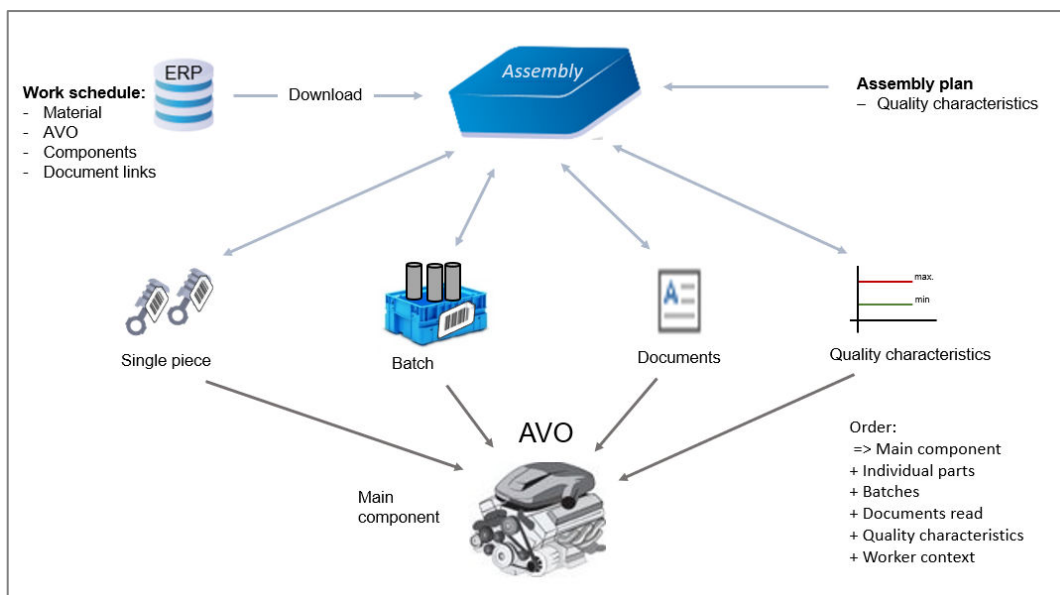
Scope of functions

The Assembly plan add-on offers the following functions:

- Assembly plan:
    - Predefined assembly instructions with prerequisites that a worker must fulfill during assembly to complete an operation
    - Calling-up document links including logging of the call-up
- Quality management:
    - Integration of QM systems (e.g. CAQ system) via a web service interface
- Components:
    - Recording and tracking the components used to draw conclusions, e.g. about the respective supplier
- Intelligent analysis:
    - Trace Tree for a produced piece
    - Search for specific parts/components
    - Search for production batches/containers with specific properties
    - Additional analyses based on graphics systems and data analysis tools from third-party providers or FORCAM partners