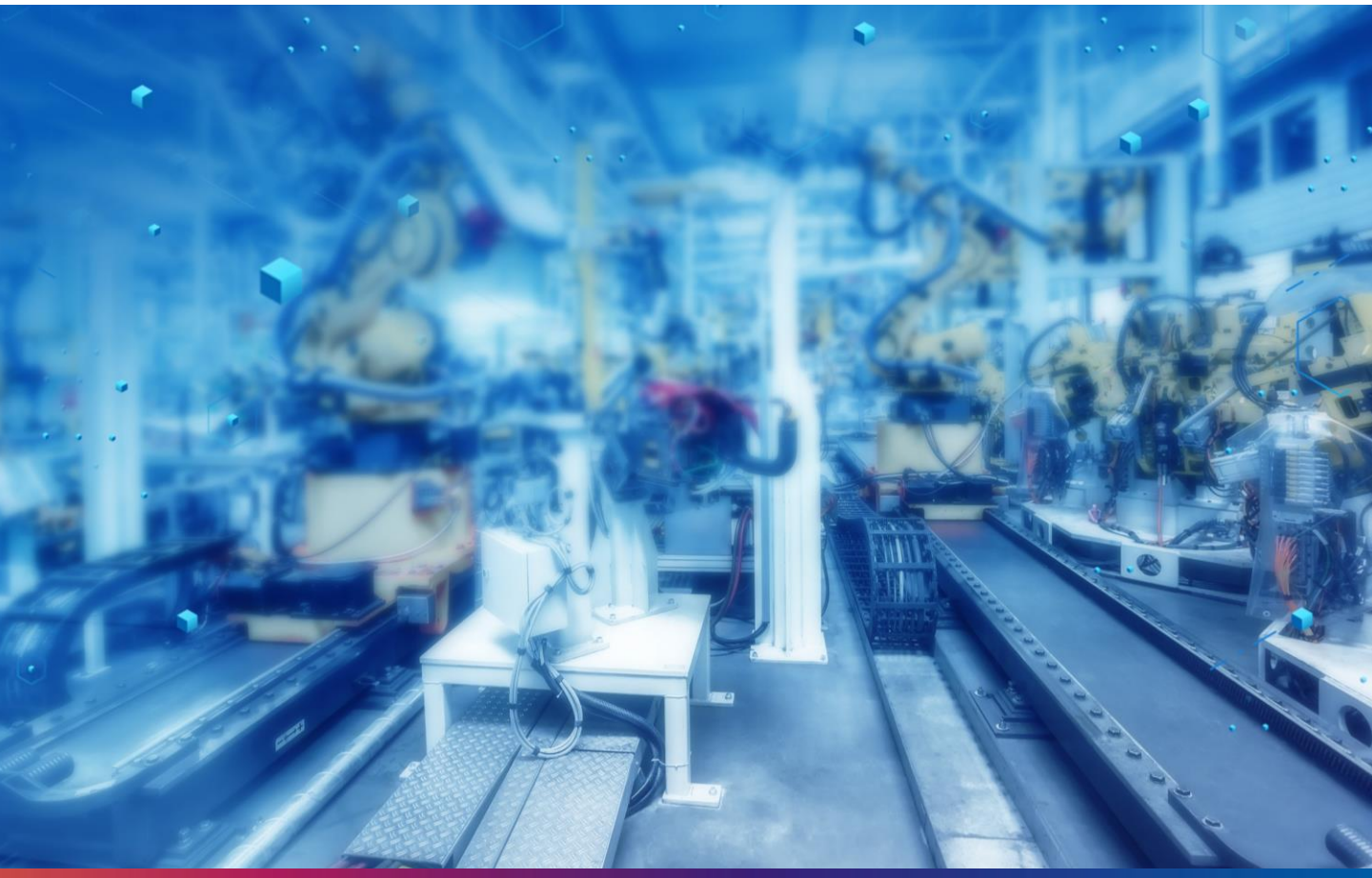
FORCAM
smart factory experts



CONNECTIVITY 4.0

Connect highly diverse machines simply and digitally

FORCAM
smart factory experts

Machine Connectivity 4.0

Learn in six articles on common machine types how to fully open up the data potential of your machine park with the FORCAM FORCE EDGE solution

DIGITIZATION NEEDS CONNECTIVITY

In most factories around the globe, companies work with older machines, the so-called brownfield. For a digital transformation, the key strategic question is therefore how companies can digitally connect both modern new and existing older machines. Without connectivity, there is no digitization. This ePaper "Connectivity 4.0 - Connect highly diverse machines simply and digitally" provides assistance. In six articles for common machine types, author Marc Fröschl outlines how companies can use the FORCAM FORCE EDGE connectivity layer to connect machines - regardless of manufacturer, year or control system - and process the data in higher-level systems such as SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII.

CONTENT

Available on SAP Store

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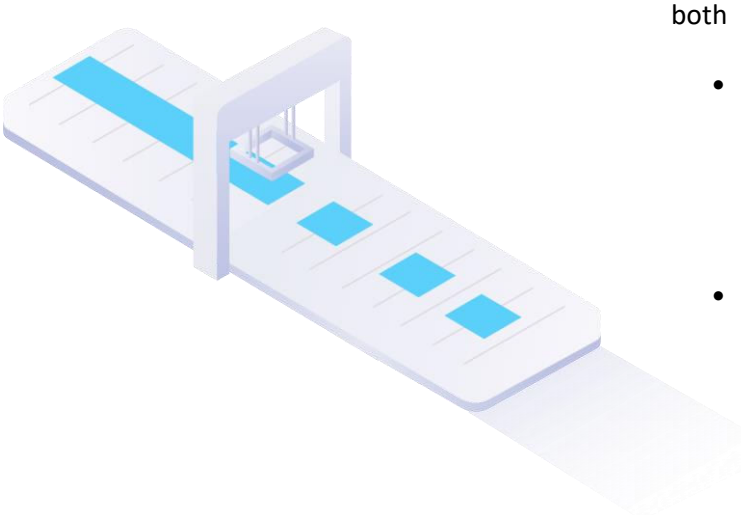
Connect highly diverse machines simply and digitally

Part 1

Presses

EXECUTIVE VIEW

According to a McKinsey study, digital transformation is a major priority for 69% of industrial businesses, with 60% of companies saying they have to replace around 30% of their existing plants. Help is at hand: FORCAM and SAP are working together to enable the highly diverse machinery among existing “brownfield” plants in industrial companies to be connected digitally, and their data ported across to SAP's “digital supply chain”.



PART 1: PRESSES

In factories, pressing machines handle a very wide variety of tasks – primary shaping, forming, joining and dividing – and the various members of the large family of pressing machines are correspondingly diverse. During any digital transformation, however, it is important to take a uniform approach to connecting assets in highly diverse plant inventories – i.e. machines of differing vintages and from differing manufacturers.

In this blog entry, we look at the relationship between machine connectivity and presses. We use the term “presses” generically, covering both

- a simple press running one production order on one material with one operation to operations with several pieces per stroke (one stroke = 1 piece or one stroke = x pieces),
  and
- complex presses on which two operations using different materials are undertaken at the same time. Car doors are a good example – in automotive press shops, modern systems complete the left and right-hand vehicle doors at the same time with a single stroke. This example can be applied to all types of presses.

MACHINE CONNECTIVITY 4.0

Connect highly diverse machines simply and digitally

Part 1

Presses

MAKING THE DIGITAL CONNECTION

The following procedure is recommended for digital connection of presses:

1. First, it is important to identify a reference machine (press). This is selected from a group of presses of the same type, the most commonly found group in the plant. This way, the reference machine can subsequently be the one used most often as a copy template.

2. The second step is to connect the machine physically. To do this, the connection type and the necessary plug-ins are selected. The questions to be asked are:

   a. Is the press essentially capable of being networked? (If not, can it be connected via the FORCAM I/O box?)
   b. What type of control system is used in the press?
   c. What are the relevant signals (reading/writing)?
   d. Is it necessary to send and receive NC programs?

3. The third step looks at the actual production workflow. This means an analysis of how the press is integrated into the production process and how production is organized around the press. This checks, among other things, whether the press is in a

   a. workshop,
   b. standalone production setup or
   c. production line

from an organizational point of view. These processes are usually individual to each company and cannot be transferred 1:1 to other sites as a blueprint.

BASIC SETUP ARCHITECTURE

The next step is to map the process requirements onto the FORCAM solution portfolio. This creates a basic setup architecture which is based, say, on the following scenario:

The machine or its controller supplies operating status information via the FORCAM FORCE™ plug-in to the “FORCAM FORCE EDGE Machine Connectivity and Model” module. There, the resulting signals are acquired, harmonized and assigned to a standardized semantic machine data model. FORCAM FORCE EDGE then supplies the standardized, harmonized machine data in the form of machine events to a downstream system, for example the SAP DMC (Digital Manufacturing Cloud).

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Part 2

Assembly Line

EXECUTIVE VIEW

Smart Factory processes (known increasingly under the term Industry 4.0) pass through several stages: connectivity, visibility, transparency, predictions, adaptability - all the way to digital services complementing the production process. This applies in particular to “brownfield” plants, i.e. existing machine facilities. At the heart of it all is connectivity. This must be incorporated in a holistic OT/IT architecture right from the outset. FORCAM and SAP offer this holistic architecture with the SAP Digital Manufacturing Cloud.

PART 2: ASSEMBLY LINE

Factory assembly lines involve highly complex processes – from the delivery of raw materials and parts to actual assembly, painting and coating work, storage and delivery. Accordingly, assembly lines come in all shapes and sizes. As a result, installing and running an assembly line calls for sophisticated planning of workflows and logistics. Cloud-based, data-driven manufacturing offers the greatest benefits.

To simplify matters, the following example of an assembly line assumes that it is composed of a succession of manual assembly lines representing a logical progression.

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Part 2

Assembly Line

DATA INPUTS

As per standard practice when designing assembly lines, attention must be given to where data is to be obtained. It is possible to

- collect the data at each individual assembly stage via a corresponding work center control system

or

- acquire the collected information only at the end of the assembly process via a master controller.

In the case in hand, acquiring the data via a master controller is much easier in terms of overall implementation rather than entering it at each individual work center.

MANUAL ASSEMBLY WORK CENTER

When planning the target architecture of a manual assembly work center, attention must be paid to the relevant quality gates in the assembly process and how this information is to be incorporated into the overall assessment of the work output. Furthermore, the selection of suitable plug-ins for communication with the individual control systems at the work centers need to be incorporatec into the target architecture.

The work center control systems or the master controller send data via the plug-ins to the “FORCAM FORCE EDGE Machine Connectivity and Model” module. There, the received data is collated into a semantic data model, i.e. each signal is given its specific meaning. This semantically prepared information is then transferred via standardized machine events to a higher level third-party system, for example the SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII.

Connect highly diverse machines simply and digitally

Part 3

Pallet Machine

EXECUTIVE VIEW

Higher numbers of variants and smaller batch sizes are forcing companies to make production more flexible and more agile. This is particularly difficult to achieve with “brownfield” plants if the machines involved were not designed to be used flexibly in a Smart Factory environment (a.k.a. Industry 4.0). This requires the ISA-95 stack to be upgraded to a digital production platform. In SAP, FORCAM has found a partner for enabling brownfield plants to be connected using the FORCAM FORCE EDGE connectivity layer, regardless of vintage, and linked to the SAP digital production platform – without having to replace machinery or equipment.

In six articles for common machine types, we outline how companies can use the FORCAM FORCE EDGE connectivity layer to connect all machines – regardless of manufacturer, vintage or control system – and process the data in the SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII.

PART 3: PALLET MACHINE

In the manufacturing industry, many machines involve the use of pallets. These “pallet machines” must be considered separately in data-driven manufacturing, because they are usually running several active operations at once.

One characteristic feature of this type of machine is that several pallets are present and are processed actively in the machine at different times. This is the case, say, with machines that feature a separate setup pallet. This means that one pallet is actively processed in the machine while the other is put through a process of preparation. As a result, several operations are running on this machine at the same time, each with a different work status – for example, in production or in setup.

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Part 3

Pallet Machine

REFERENCE MACHINE, PLUG-INS, WORK PROCESS, TARGET ARCHITECTURE

- **Reference machine**

  When selecting the reference machine, one should ask how many pallets this machine has. The main focus is on the preparation of operations on carrier pallets.

- **Plug-ins**

  When selecting the machine-relevant plug-ins, the question arises about network-compatible control systems for tapping signals or transferring NC programs.

- **Work process**

  When analyzing a company-specific work process at the pallet machine, the main focus is on the trigger signals. These requirements are mapped onto the FORCAM solution portfolio.

- **Architecture**

  The data-driven architecture for machine connectivity involves the plant or the network-capable control system delivering signals / information via the FORCAM FORCE™ plug-ins to the “FORCAM FORCE EDGE Machine Connectivity and Model” module. There, the machine signals are assigned to a corresponding semantic.

The machine signals and associated semantics are forwarded to a higher level system, for example the SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII, in the form of harmonized and standardized machine events.

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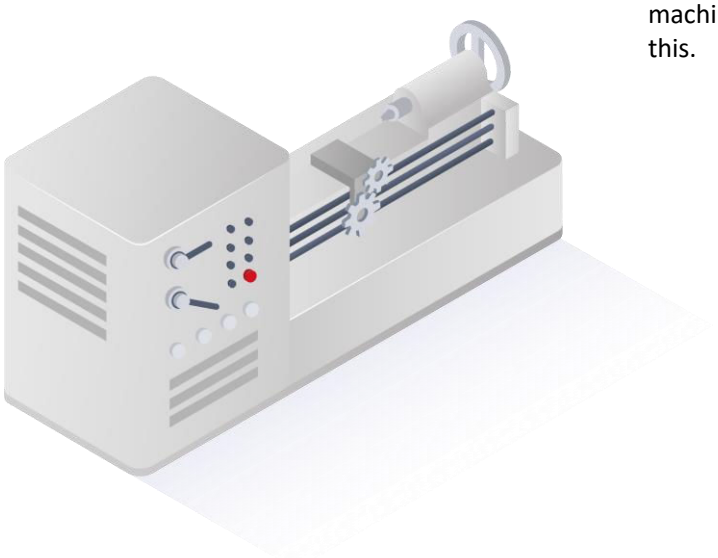
Part 4

NC Machine

EXECUTIVE VIEW

Digital transformation of production requires an integrated IT/OT architecture – for example, the 'Industry 4.0 Solution Blueprint' from SAP. Using FORCAM FORCE EDGE, we can connect your brownfield systems and comprehensively map levels 0 to 2 in the SAP Industry 4.0 Blueprint. Our Edge solution offers maximum system stability and at the same time allows all relevant data to be transferred to the SAP Digital Manufacturing Cloud, where your machine data can be docked seamlessly to all relevant processes.



PART 4: NC MACHINE

In manufacturing technology, the abbreviations NC or DNC (Distributed Numerical Control) are about feeding computer-controlled machine tools (CNC machines) with the required manufacturing information. The software programs required for production are transferred to the machine controller or file system with the aid of a DNC system.

The FORCAM DNC module controls the distribution of NC programs to the relevant machine. The special feature is that NC programs that have been modified on the machine, say in the course of prototype production, can be transferred back to the higher level system, such as the SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII, via the DNC module. An appropriate machine control system is a key requirement for this.

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Part 4

NC Machine

SOLUTION ARCHITECTURE COMPLETE WITH BI-DIRECTIONAL COMMUNICATION

Once a reference machine has been selected, the choice of appropriate NC plug-in is crucial. They key question is whether this machine is capable of receiving NC programs or whether it can also transfer NC programs back to a higher level system. Attention must also be paid to how the machine is integrated into the work process (line, workshop or standalone production).

These requirements are mapped onto the FORCAM FORCE™ solution portfolio. The solution architecture produced features bi-directional communication. This means that a PLM or ERP system transfers an NC program to the machine controller or file system via the standardized FORCE EDGE API web interface and via the DNC plug-ins.

Likewise, the NC program can be transferred back from the machine controller via the FORCE EDGE API to the ERP system using the appropriate plug-ins.

The transfer of NC programs from, for example, SAP DMC to the FORCAM system works via the FORCE EDGE API interface. Further management instructions to the individual controllers is the core task of the FORCAM FORCE EDGE module.

Connect highly diverse machines simply and digitally

Part 5

Energy Monitoring

EXECUTIVE VIEW

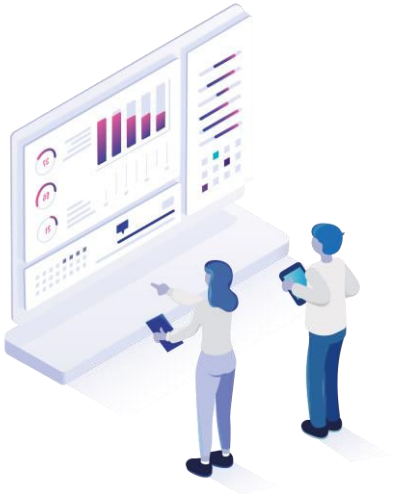
Turn your plant – even brownfield plant – into intelligent assets for the entire company. The FORCAM FORCE EDGE connectivity layer allows you to connect systems regardless of their vintage and retrieve machine data including energy efficiency. This way, your teams can make a measurable contribution to your sustainability strategy. In this specific application, FORCAM deliberately links across to SAP's industry use cases and, in particular, the one entitled “Intelligent Assets”. Doing so enables our joint customers to make a real contribution to the sustainability goals of the UN Strategic Development Program and the Towards a Sustainable Europe by 2030 program.

PART 5: ENERGY MONITORING

Climate protection, sustainability, corporate governance, and costs: Resource efficiency is a top priority in business and in society at large.

Experts know that it’s in factories where value is added. Conversely, the greatest savings potential lies in production, just waiting to be tapped. Continuous improvement processes (CIPs) should therefore be part of everyday life. Data-driven manufacturing can significantly improve resource efficiency and costs.

In energy monitoring, the basic question is whether plant consumption is the main focus of attention, or whether consumption per item produced or per production order is to be recorded as an ancillary measurement.



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Part 5

Energy Monitoring

REFERENCE MACHINE, PLUG-INS, PROCESS

At a machine level, energy monitoring focuses primarily on the consumption of material or energy by production plants. The key questions are:

- Which plant consumes which amounts of energy?
- At what point(s) in time do energy consumption rates occur?

When selecting the reference asset, one should first clarify which plug-ins are relevant and should be used for communicating with the machine controller.

When considering the process, it is important to know what type of energy meter the system uses, specifically whether the meter on the plant shows an absolute figure which can be transferred directly, or whether the system has to apply the input figure incrementally.

TARGET ARCHITECTURE

All requirements are mapped onto the FORCAM solution portfolio. The resultant solution architecture is described as follows:

The machine measures energy consumption which is then transferred via the FORCAM FORCE™ plug-ins to the FORCAM machine data model for energy and process data, and is then forwarded to a third party system such as SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII via the Edge API.

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Part 6

Traceability

EXECUTIVE VIEW

In the move towards smart factories, SAP's Industry 4.0 strategy comprises four key topic areas: Intelligent assets, Intelligent factories, Empowered people and Intelligent products. FORCAM also believes in the importance of these topic areas and supports SAP's Industry 4.0 strategy with the FORCAM FORCE EDGE connectivity layer connecting our joint customers' brownfield plant facilities. This makes it possible to provide the proof of consistent sustainability along the entire value chain. The FORCAM FORCE EDGE machine connectivity layer and the SAP DMC provide fact-based evidence of your contribution to sustainability in production.

PART 6: TRACEABILITY

Climate protection, consumer protection, product liability, corporate governance: End-to-end traceability of products, components and processes is a must-have in today's modern factories. It's all about knowing – at any time – when, where, how, with what and by whom a product was manufactured.

A task of this magnitude can only be solved reliably using data-driven manufacturing. This provides precise analyses of the entire value-add process and can meet the transparency requirements expected of a manufacturing company.

When it comes to traceability, distinctions are made between three types:

- Individual part – The trace object is an identifiable single item
- Assembly – The trace object is an identifiable main component with all assembly steps performed
- Batch – The trace object is an identifiable container.

Batch traceability describes the tracking of production containers. The term “container” is seen as a collective term for all types of containers. These can be anything from small load carriers or boxes in which bulk material is transported to more complex containers such as sorted workpiece carriers (a.k.a. trays).

Connect highly diverse machines simply and digitally

Part 6

Traceability

DIFFERENT WAYS CONTAINERS ARE HANDLED IN PRODUCTION

Accordingly, it is also possible to reflect different ways containers are handled in the production process:

- The standard case assumes that two types of containers are available in a production process, namely an input container and an output container.
- Where sorted workpiece carriers are involved, the input container can also be the output container.

To ensure traceability, the machine or the production process acquires data from sensors such as pressure, flow etc. and assigns this data to the trace object, in our case the container. This will later ensure that it is possible to trace exactly how, and under which conditions, a part was manufactured.

When tracing, the special feature is that not only machine events are transmitted, but also, where necessary, actually acquired trace data, which usually includes a physical unit when the semantics are assigned. Thus, it is clear after the event which physical unit the acquired value corresponds to.

REFERENCE MACHINE, PLUG-INS, PROCESS FLOW, TARGET ARCHITECTURE

When selecting the reference machine, one must determine which process data is of relevance and needs to be included in the data collection. The same plug-in variants apply to the trace object as to all other machine connection use cases.

When considering the specific process flow, it is important to decide which trace data is to be acquired, which trace data is acquired at what time and what the triggers are for acquiring the trace data.

These requirements are mapped onto the FORCAM FORCE™ solution portfolio.

The target architecture is structured as follows: The machine supplies trace data (signals) via the FORCAM plug-ins to the “FORCAM FORCE EDGE Machine Connectivity and Model” module. There, the signals are acquired and assigned to corresponding semantics. FORCAM FORCE EDGE delivers this data to a higher level system, for example SAP DMC (Digital Manufacturing Cloud) or SAP ME/MII.

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More Information

LINKS

FORCAM FORCE EDGE

https://forcam.com/en/sap-partner-portal/

SAP App Center

FORCAM Force Edge | Manufacturing (sapappcenter.com)

ePAPER Restart in production

https://forcam.com/en/landing-page-epaper/

Available on SAP Store

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