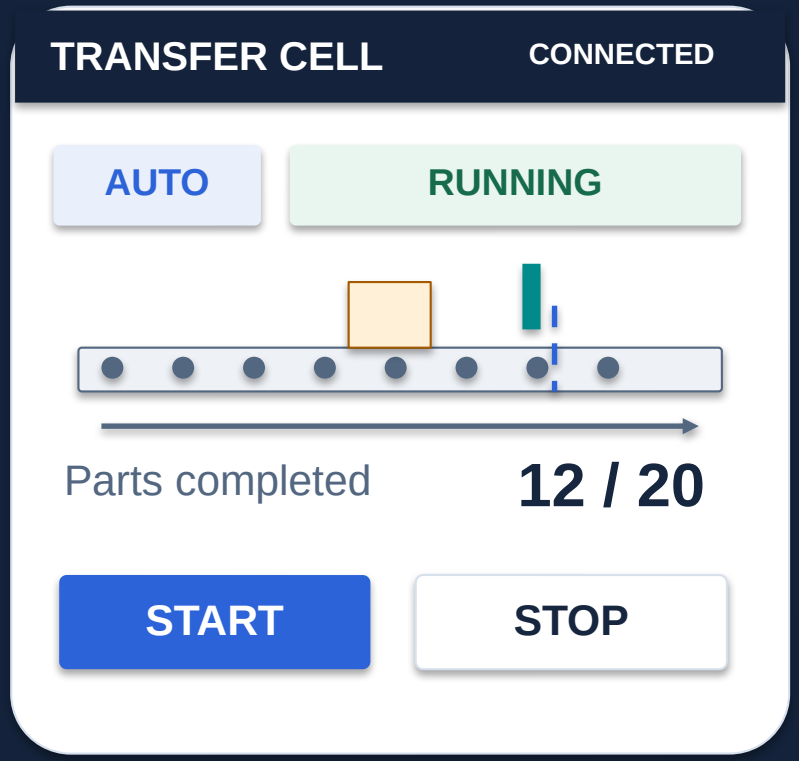
PROCESS AUTOMATION · 2026/27

Human–Machine Interfaces

HMI & SCADA



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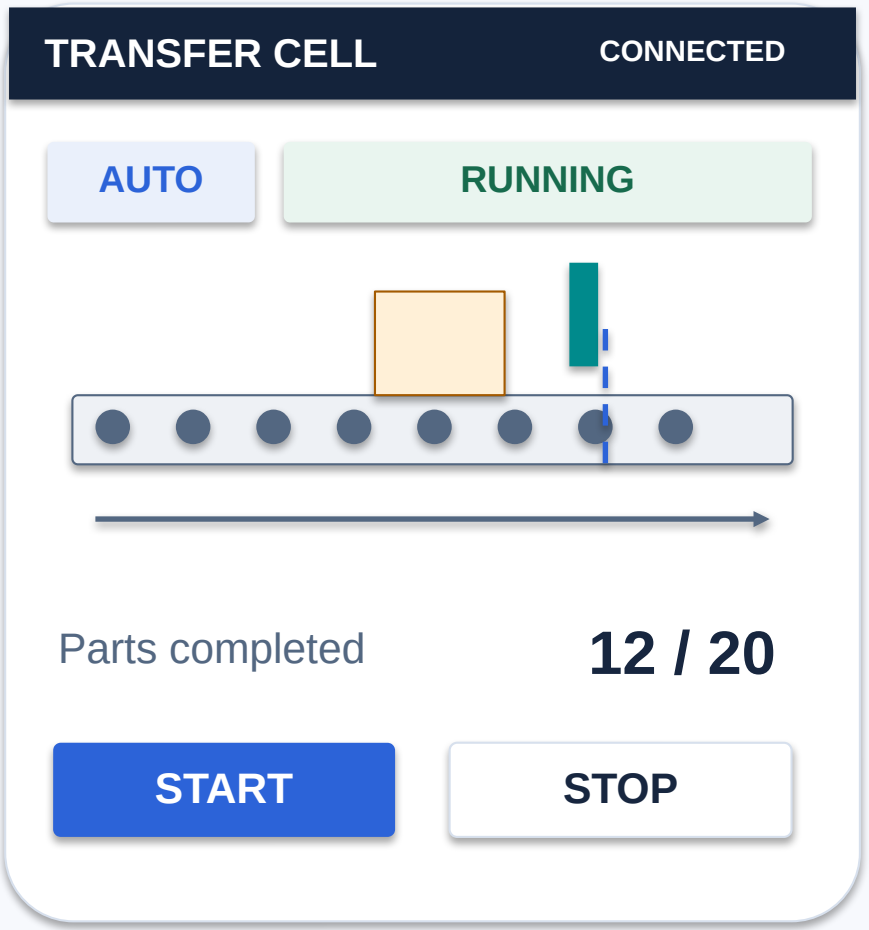
Outline

01 **HMI and SCADA**
Roles, evolution and applications

02 **Components and data**
Controllers, communication and tags

03 **Operator interaction**
Displays, commands, alarms and trends

04 **Software and project work**
Tools, TwinCAT HMI and a first screen



The PLC runs the process. The HMI helps the operator.

Measurements and status

PROCESS

- Sensors measure.
- Actuators move or switch.

PLC

- Runs the control program.
- Checks conditions and interlocks.

HMI

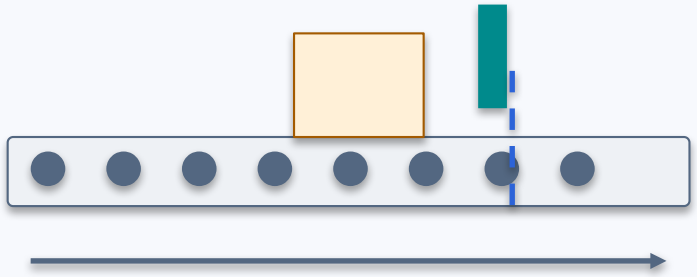
- Shows the actual state.
- Accepts operator requests.

Commands and settings

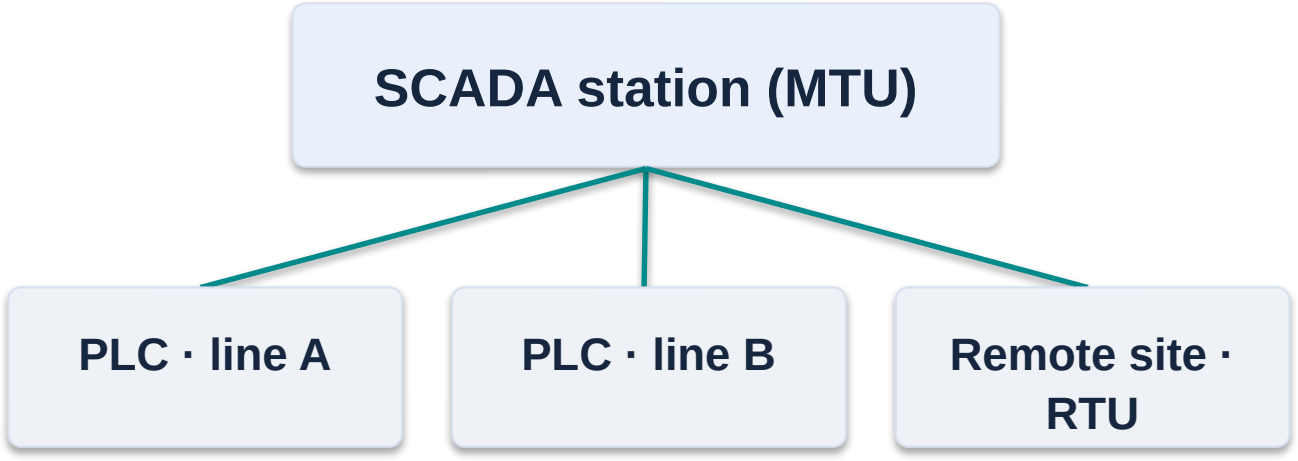
HMI and SCADA: from one machine to a whole site

A local HMI

- Panel beside one machine
- Mode, commands and status

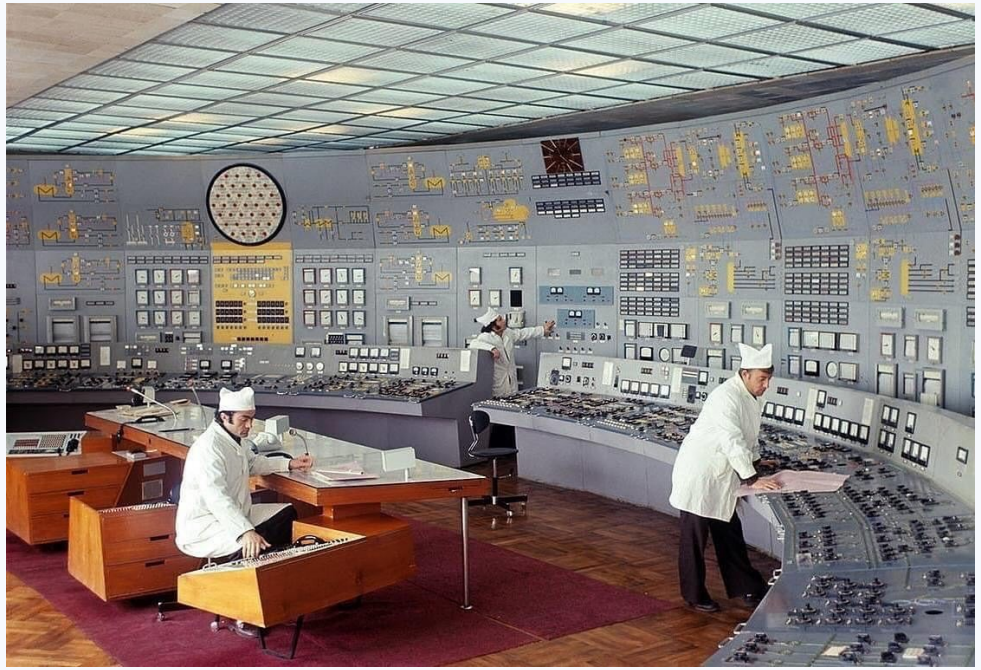


SCADA = Supervisory Control and Data Acquisition



Shared displays · alarms · history · reports

From control panels to connected screens



Dedicated panels and instruments

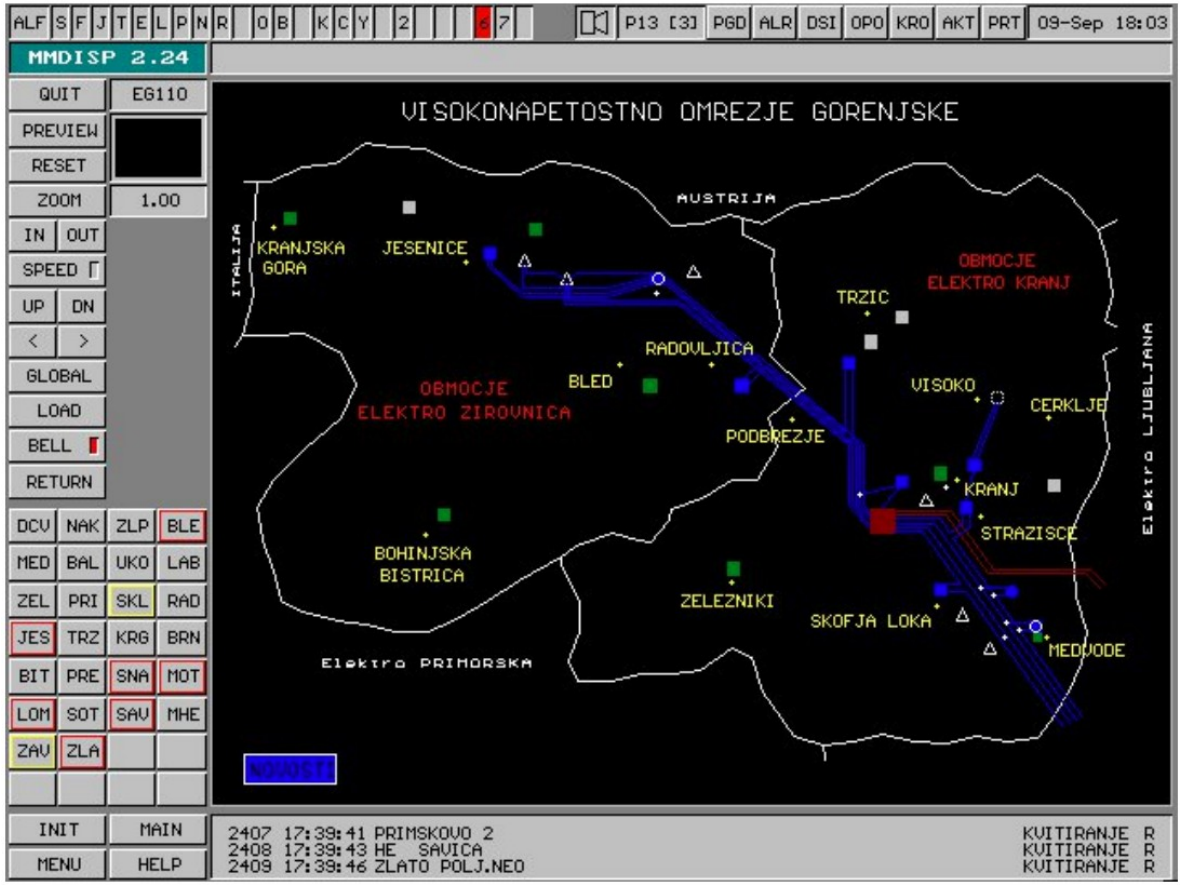
The operator reads local indicators and operates physical controls.



Computer-based supervision

One interface combines live data, alarms and history. Clients can run in a browser.

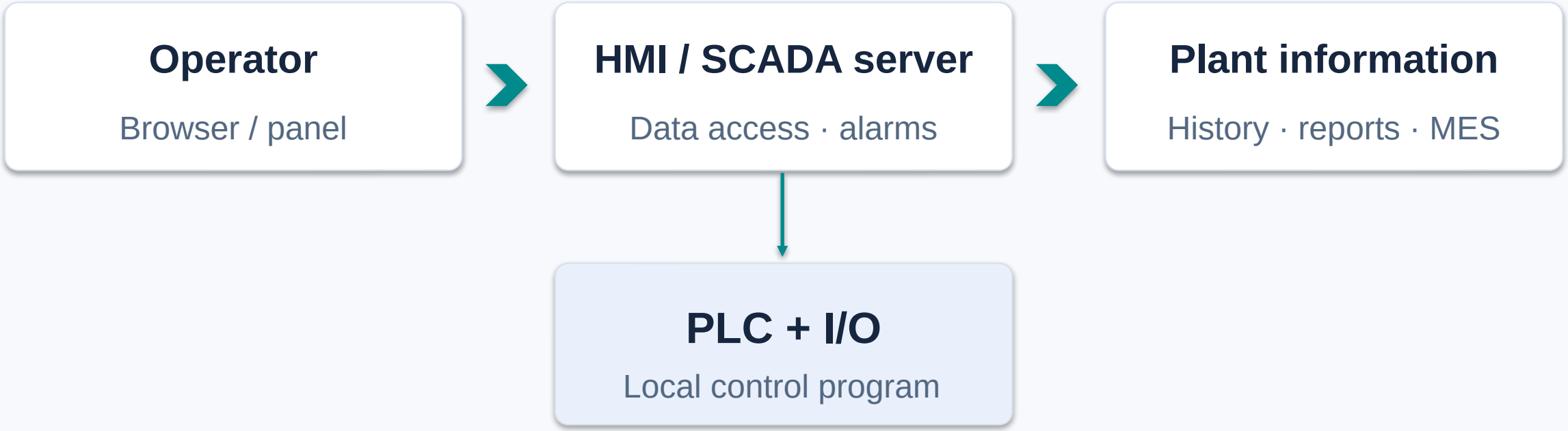
SCADA brings distributed equipment into one view



Where it is used

- Electricity, gas and water networks
- Railways, highways and telecoms
- Power plants and manufacturing
- Laboratories and test systems

Supervision connects operators, controllers and records



When the link is lost, the PLC follows its local rules. The HMI shows “offline”.

Six functions, one operator workspace

1 Acquire

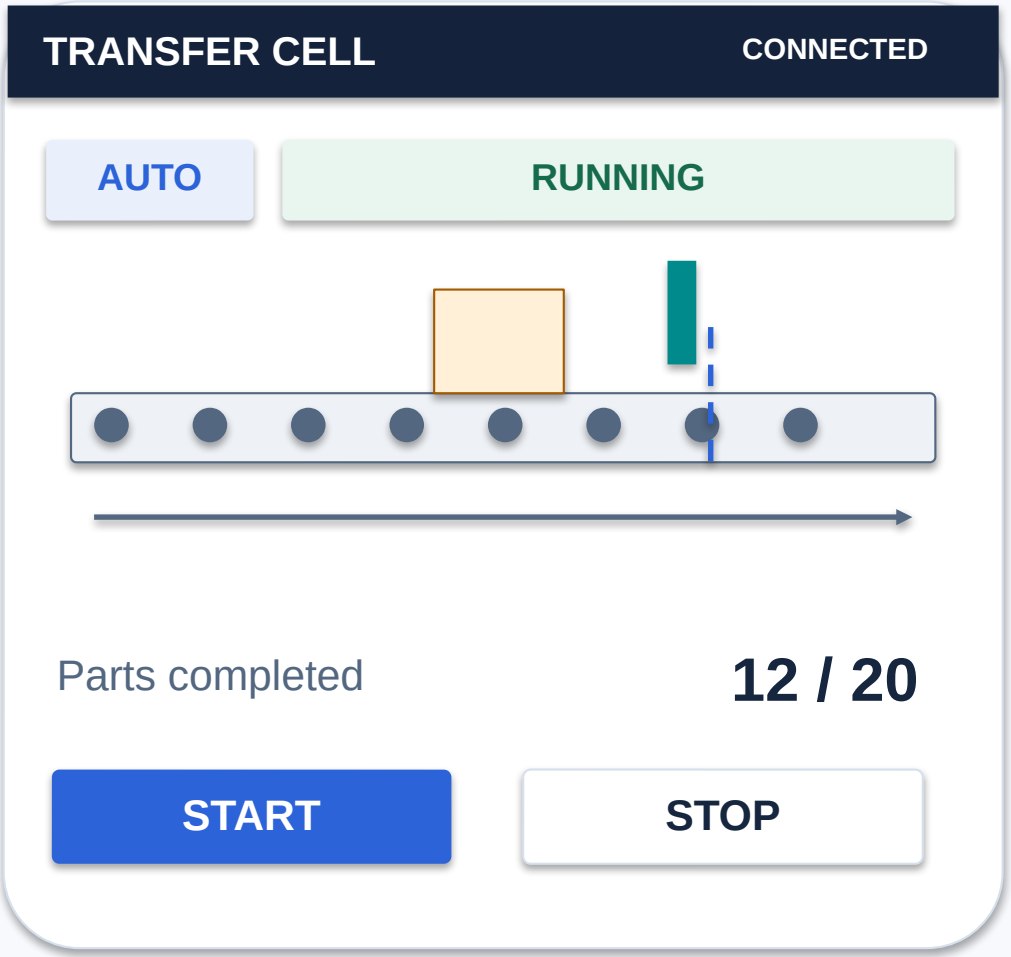
Read controller data

2 Operate

View state; send requests

3 Alarm

Draw attention to a problem



4 Archive

Save selected history

5 Report

Summarize operation

6 Diagnose

Check links and devices

A tag is a named value the interface can use

PLC variable

`GVL_HMI.nCount`

›

Mapped symbol

`PartCount`

›

Screen control

Parts completed: 12

Tag	Type	Example value	Used for
`bPartPresent`	BOOL	TRUE	Presence indicator
`rTemperature`	REAL	62.4 °C	Numeric display
`nTargetCount`	INT	20	Operator setting
`bStartRequest`	BOOL	FALSE	Start command

A live value needs a timestamp and a connection state

Three different timings

- PLC task: executes control logic
- HMI update: refreshes the screen
- History: records selected samples

Match the update rate to the operator’s task.

CONNECTED

62.4 °C

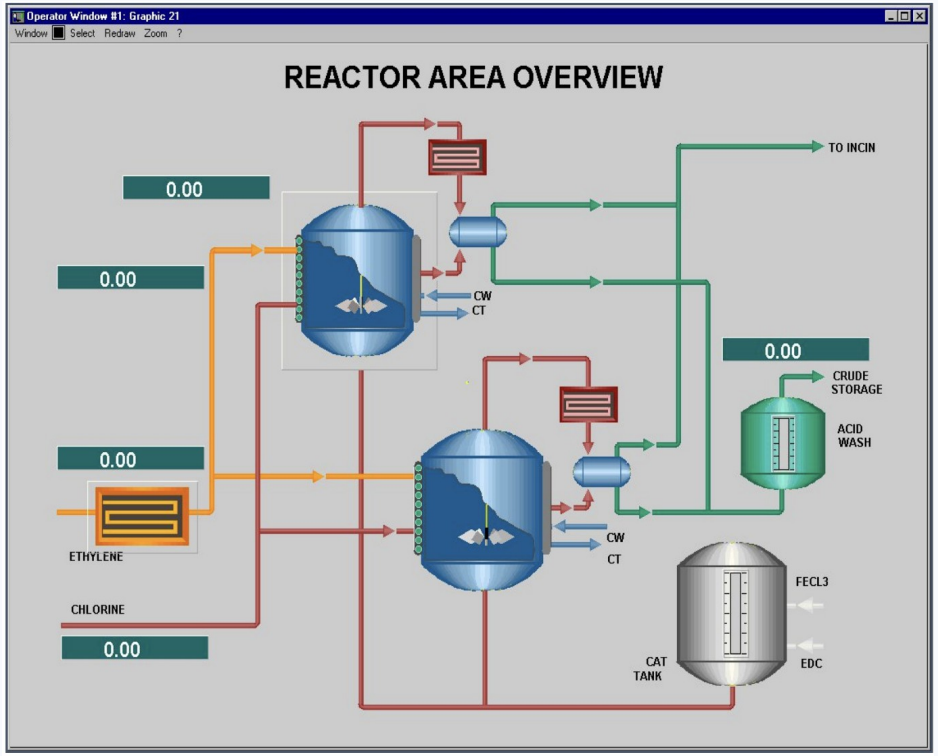
Updated 10:05:02

CONNECTION LOST

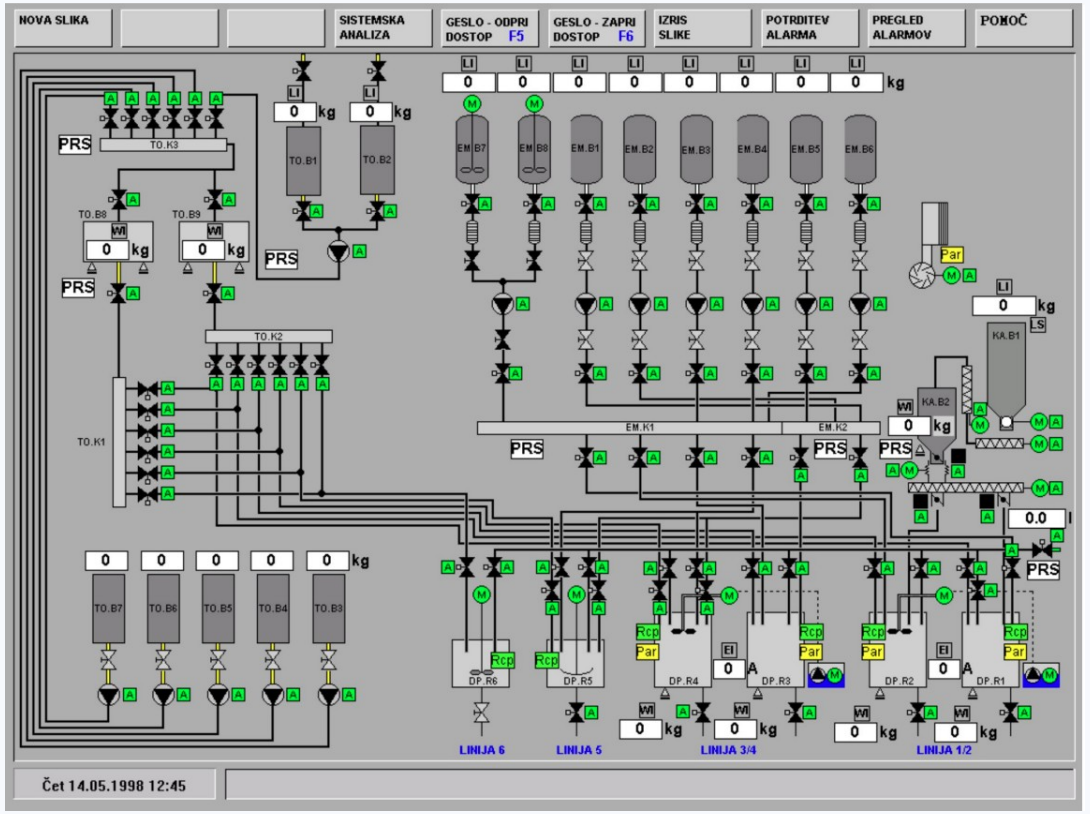
62.4 °C

Last valid value: 10:05:02

Start with an overview; open details when needed



One process unit



A larger plant overview

Pressing START sends a request; feedback confirms motion

1 Operator

Presses START

2 PLC

Checks mode and permissives

3 Equipment

Reports running / flow

PUMP P1

RUNNING

Measured flow

12.0 L/min

When a request is blocked

- Show the reason: “Tank empty”.
- Keep actual status: “Stopped”.

Make status readable at a glance

Hard to interpret



Explicit status and units

Pump P1	**Stopped**
Valve V2	**Open**
Motor M3	**Running**

Label states and units. Use consistent navigation and meaningful colors.

Manual and automatic modes share the same feedback

MANUAL

- Operator requests one movement.
- Example: extend the pusher.
- Show home / extended feedback.

AUTOMATIC

- PLC executes the sequence.
- Detect → move → confirm.
- Show the active step and its condition.

Same machine state, different source of commands.

Mode changes are checked and accepted by the PLC.

A recipe is a named set of process settings

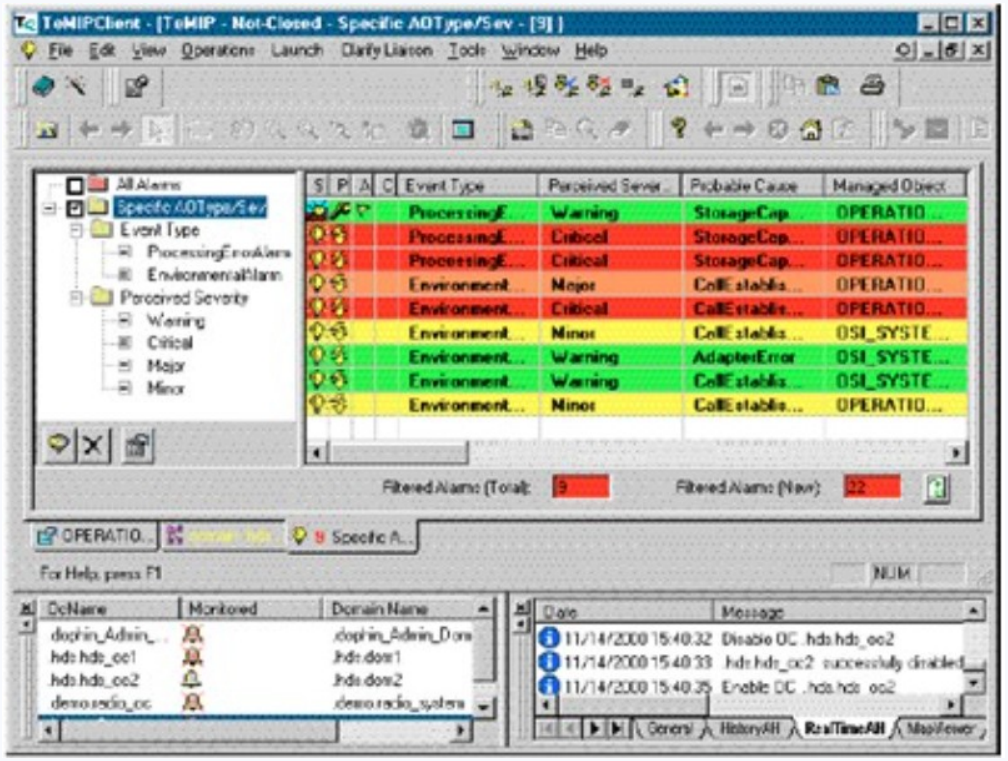
TRANSFER CELL · RECIPE

Setting	Small batch	Large batch
Target count	10	30
Wait at station	0.5 s	1.0 s
Destination	A	B

Selected: Small batch

1. **SELECT**
   Choose a stored parameter set.
2. **REVIEW**
   Check values and units.
3. **APPLY**
   PLC validates and accepts it.

An alarm should say what happened and what to do



A101 · CONVEYOR BLOCKED

Condition

Exit sensor occupied for more than 5 s.

Operator action

Inspect the exit area and clear the obstruction.

Useful context

Time · equipment · priority · current state

Acknowledging an alarm does not remove its cause

Alarm appears

Process condition

Blocked

Acknowledged: No

›

Operator acknowledges

Process condition

Blocked

Acknowledged: Yes

›

Obstruction removed

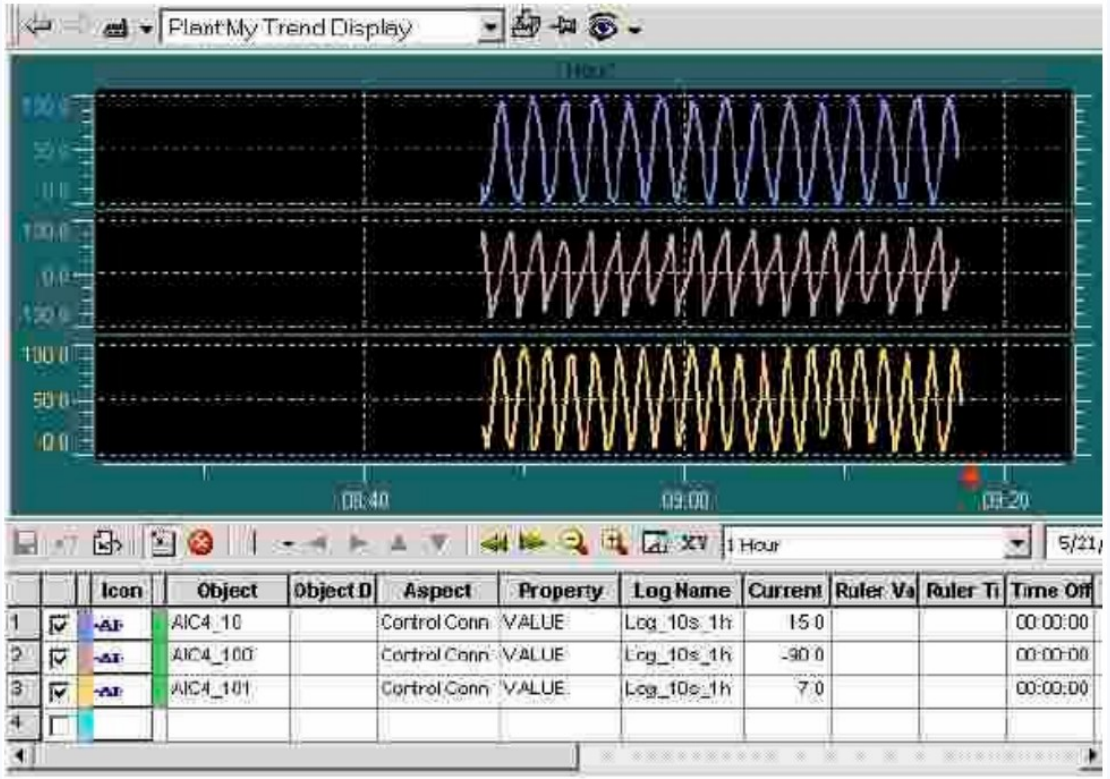
Process condition

Clear

Acknowledged: Yes

ACK means “I have seen it”. The process must still return to normal.

A trend shows what happened before the alarm



Flow through pump P1



Flow falls before the alarm.

Store useful history; turn it into a useful report

ONE RECORDED SAMPLE

```
Time:     10:05:02
Tag:      PumpP1.Flow
Value:    12.0
Unit:     L/min
Quality:  Good
```

Record process values, alarm changes and relevant operator actions.

Shift report

- Parts produced: 240
- Blocked-conveyor alarms: 3
- Downtime: 4 min
- Recipe used: Small batch

Give each user the access their job requires

Action	Viewer	Operator	Engineer
View status and history	Yes	Yes	Yes
Start / stop / mode	—	Yes	Yes
Apply approved recipe	—	Yes	Yes
Change configuration	—	—	Yes

Enforce permissions in the system and validate commands in the PLC.

HMI and SCADA software: current examples

COURSE PLATFORM

TwinCAT HMI

Beckhoff

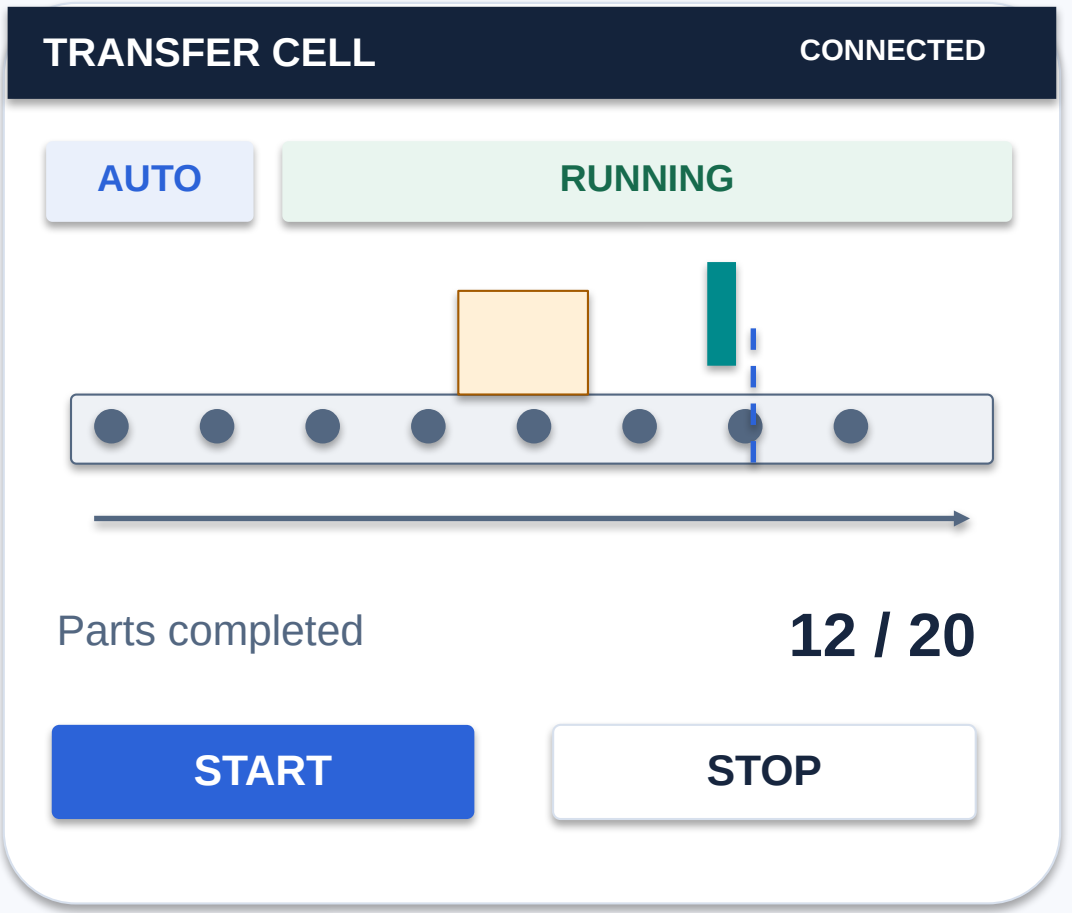
Engineering tools, server and browser clients

WinCC / WinCC Unified	Siemens
FactoryTalk View	Rockwell Automation
InTouch HMI	AVEVA
iFIX	GE Vernova
Ignition	Inductive Automation

Build the screen, then run it against the process

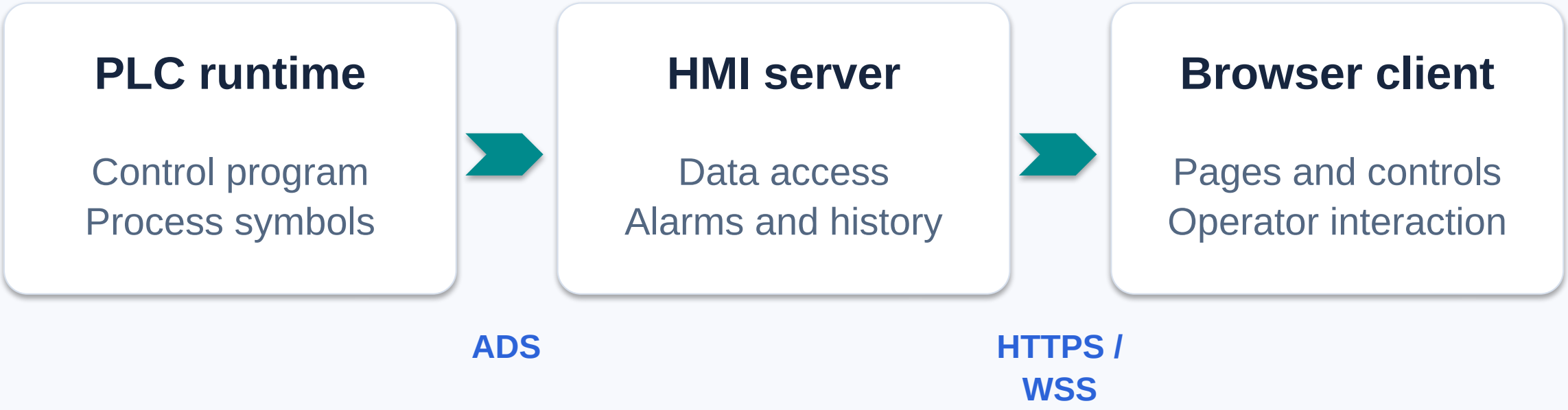
ENGINEERING

- Arrange controls and pages.
- Bind properties to tags.
- Reuse a motor or valve faceplate.
- Configure alarms and user roles.



Runtime: operator view

TwinCAT HMI: PLC, server and browser



An OPC UA extension connects the HMI server to other compatible controllers.

Bind a process value to a display property

PLC

```
rTemperature : REAL := 62.4;
```

TwinCAT HMI binding

- Select the PLC symbol.
- Map it to an HMI symbol.
- Bind the control’s value property.



TANK TEMPERATURE

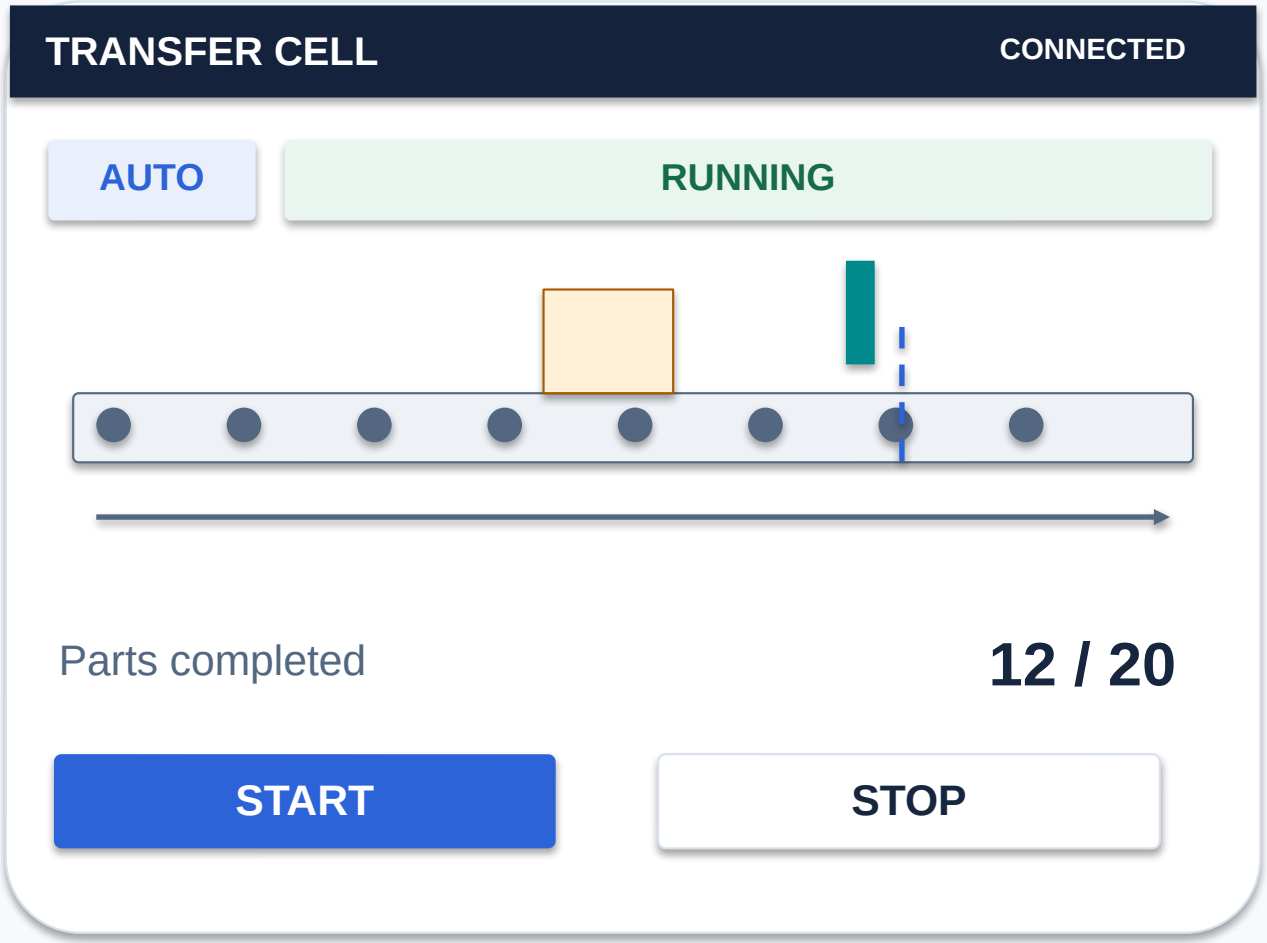
62.4 °C

Live value from the PLC

Build the first screen in five steps

1	**Connect**	Check PLC Run state, ADS route and server diagnostics.
2	**Read**	Map one status variable and watch it change.
3	**Display**	Add labels, units and a clear connection indicator.
4	**Control**	Send a request; display the PLC’s actual response.
5	**Record & test**	Add one alarm and one trend; test abnormal situations.

Try the operator’s view



Try these situations

- Start with no part present.
- Insert a part and press START.
- Create a jam; acknowledge it.
- Clear the jam; restart deliberately.
- Disconnect and reconnect the screen.

Test the screen from the operator’s point of view

Action or condition	What the operator should see
START request rejected	Stopped + a clear reason
Equipment starts	Running feedback + current process value
Alarm acknowledged	Acknowledged; condition remains visible
Connection lost	Offline + stale/unknown values
Recipe applied	Accepted settings or a clear validation message

Explore the tools

1 **TwinCAT HMI showcase**

Explore controls, trends and example screens.

2 **Data binding**

Follow the symbol-to-control workflow.

3 **Recipe management sample**

Inspect a small PLC + HMI example project.

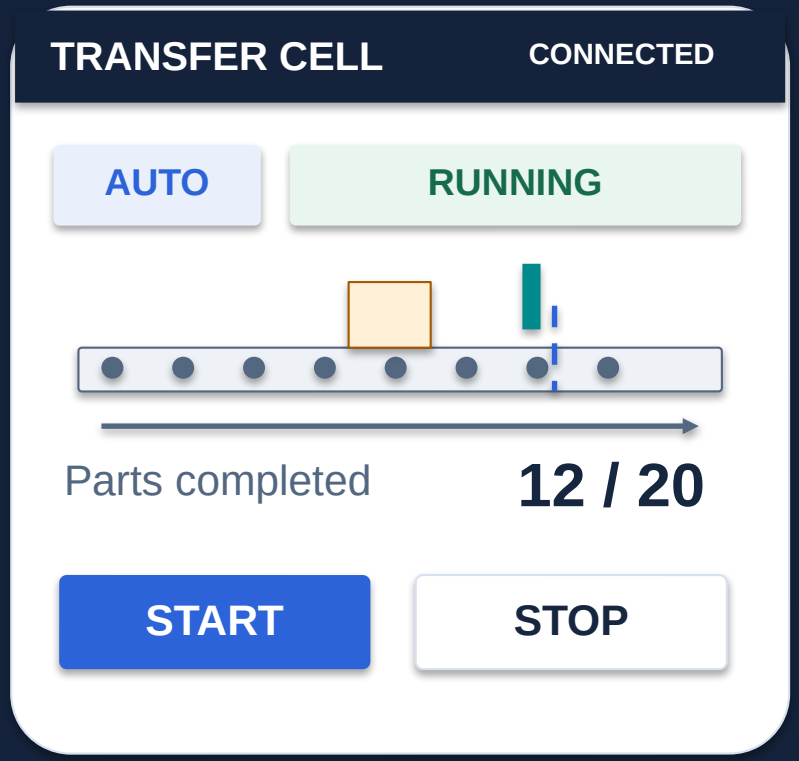
4 **Historize quick start**

Record a symbol and display its history.

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