YOUR BEST **PROCESS AUTOMATION** SOLUTIONS PROVIDER

TBB
PROCESS AUTOMATION

CONTENTS

ABOUT TBB

TBB is founded in 2014 to contribute to automation industries and academia through commercializing the research experiences and results.

The founder has been researching process control and automation and developing control theories and industrial automation software since 1992.

TBB develops and provides various automation systems, including hardware and software for process automation.

MISSION

Contributing to
automation industries and academia through
commercializing our research experiences and results

PRODUCT & SERVICES

PROMONICON

All-in-one automation software that provides from basic to advanced functions, required for developing automation systems.

System Integration

From designing automation systems to commissioning

Consulting on

Maximizing process productivity and minimizing costs

Training

Get insights on process systems engineering

PROMONICON

Easy Configuration, Advanced Functions, and Open Connectivity

PROMONICON is an all-in-one automation software that provides from basic to advanced functions, required for developing automation systems.

ALL-IN-ONE AUTOMATION SOFTWARE

PROMONICON

Interface	SCADA/HMI	Advanced Control Logics	Sequence Control
Signal Processing	Image Processing	Simulator	Optimization

Features

Open Connectivity

Compatible with a wide array of devices and systems such as PLC, DCS, SCADA, inverters, MES, etc.

Basic SCADA Features

Control functions, process diagram, real-time graph, alarming, data storage, reporting, and remote operation, etc.

Advanced SCADA Features

Image processing, advanced controllers, virtual processes, etc. to extend SCADA capabilities

Flexible Development Environment

Useful to develop complex control logics to meet your specific requirements

Online Implementation of Logics/Scripts

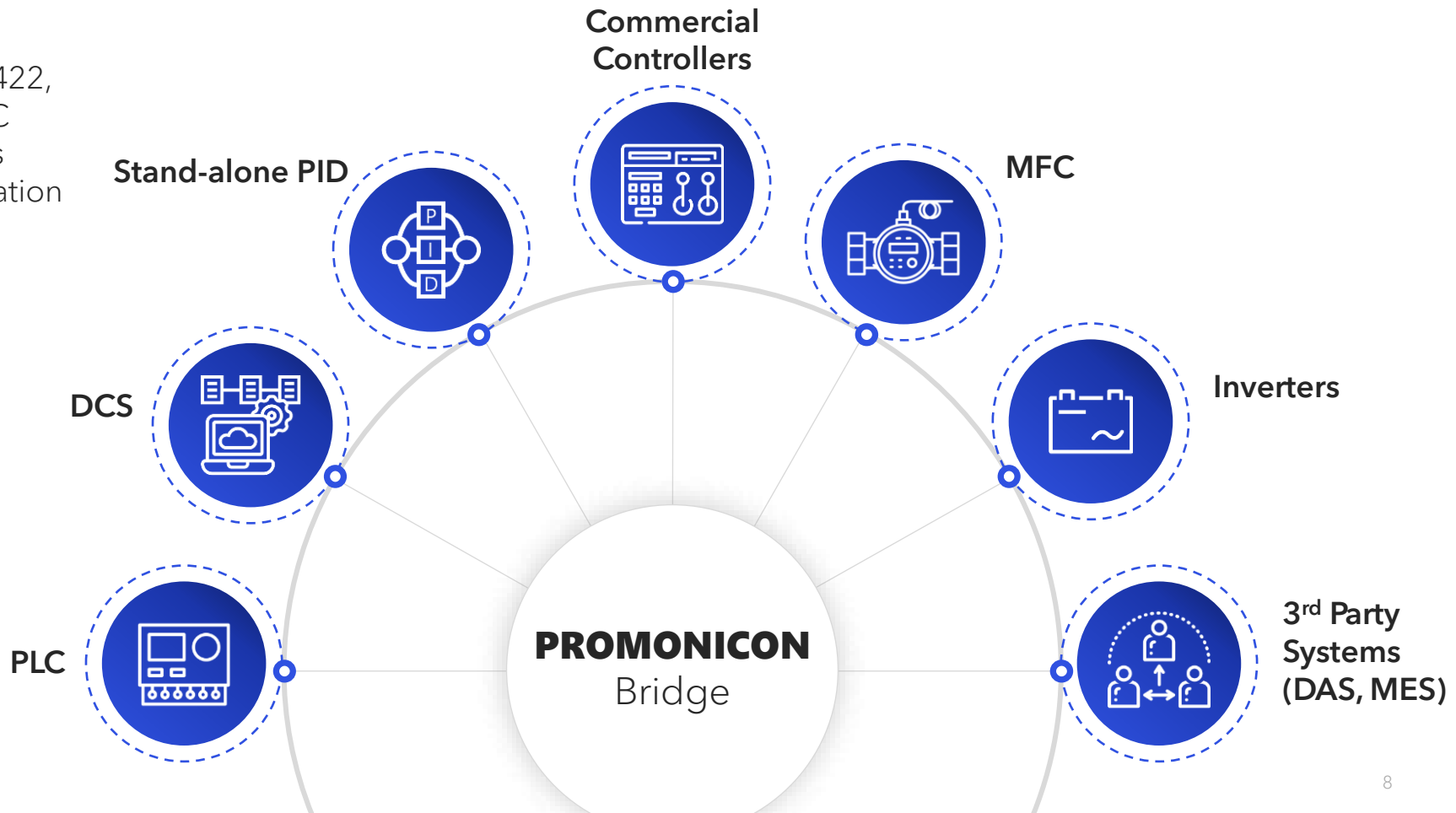
Useful to add, modify, or delete operation/control logics in an online manner and without aborting the system

Open Connectivity

With PROMONICON, it is easy to connect your automation system to many kinds of automation devices such as PLC, DCS, SCADA, stand-alone PID, commercial controllers, MFC, inverter, and third-party systems like data acquisition system (DAS) and manufacturing execution system (MES).

PROMONICON supports many kinds of communication types like OPC, RS232C (RS422, RS485), UDP/IP, TCP/IP, file in/out, and ODBC (Open Database Connectivity). Also, it allows users to implement user-defined communication protocols.

With open connectivity, PROMONICON streamlines data exchange, enhancing the efficiency of your automation systems.



Basic SCADA Features

Conventional Control Functions

PROMONICON includes control functions such as PID control, split-range control, gain-scheduling, cascade control, and sequence control. These functions can be easily configured and implemented.

Graphs

Graph plots process variables in a real-time manner. Users can easily add or remove lines and set the properties such as axis scales, data to be displayed, y axis (left/right), line thickness/color, and legend (title/position).

Alarming

Alarms can be easily configured to ensure timely notifications of process abnormalities.

Report

PROMONICON can easily generate reports manually or automatically in Excel format.

Remote Operation

PROMONICON allows operators to access to remote process monitoring and control systems through Ethernet or Internet.

Data Logger

Data logger can be implemented both manually and automatically. Automatic data logging can be executed through 'Script Programming' or 'Sequence Control'.

Process Diagram

A kind of HMI (Human-Machine Interface) that allows operators to monitor the status and operate the process. It is easy for users to configure the diagram with a variety of functions such as:

- Loading the background process diagram images
- Displaying current status of the automation system in the forms of data link, icon, and progress bar
- Directly setting process variables by clicking data links
- Executing script programs by clicking buttons

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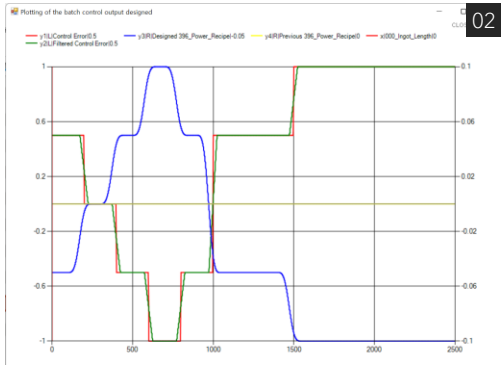

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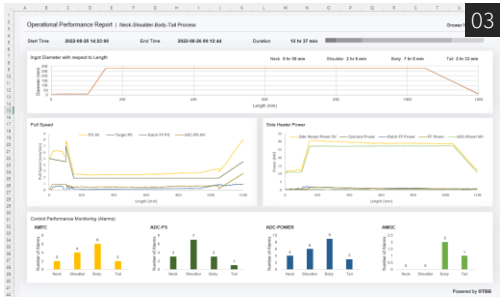

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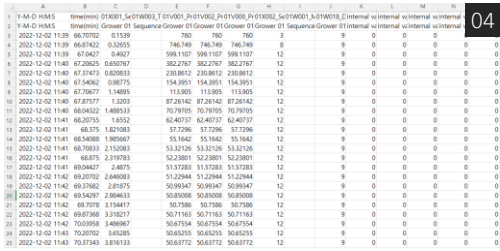

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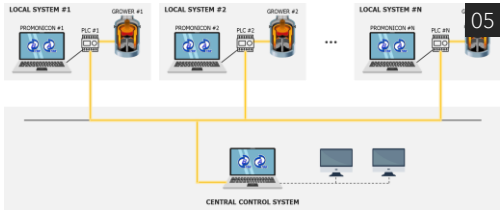

Advanced SCADA Features

Image Processing

PROMONICON provides the image processing module, which takes the images of an object and extracts useful data from the images.

Advanced Control Functions

PROMONICON supports advanced control techniques such as:

- PID auto-tuning
- PIDA (PID-Acceleration) control, cascade anti-windup
- High-performance TBB0 control
- Iterative Learning Control (ILC) for advanced batch control
- Model Predictive Control (MPC)
- Process optimization based on successive LP (Linear Programming)

Virtual Process

With PROMONICON, you can build virtual processes (which are based on transfer functions or operation data), which can be linked to operation/control logic. It is useful to debug and validate operation/control logics, or to construct model-based controllers. Also, this module can be applied to develop an OTS (Operator Training System).

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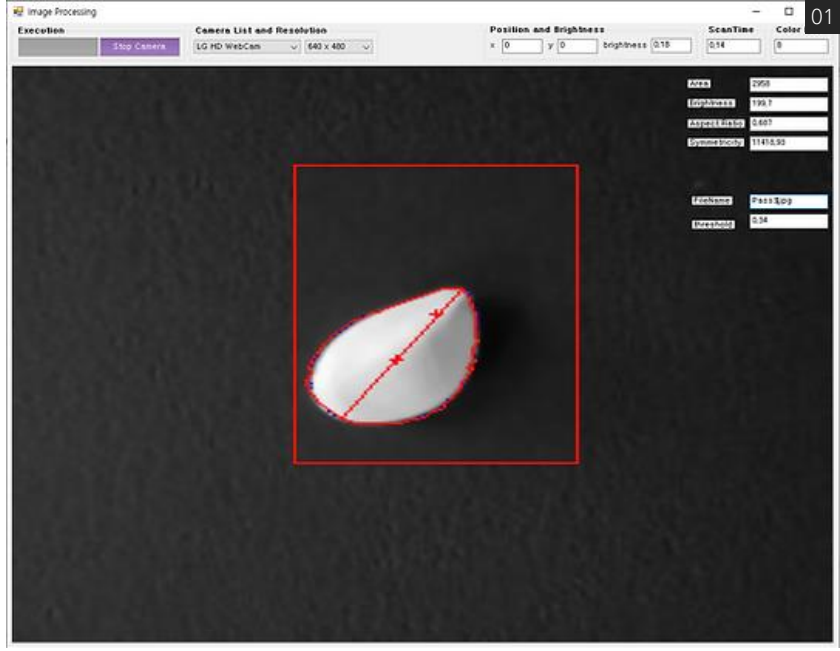

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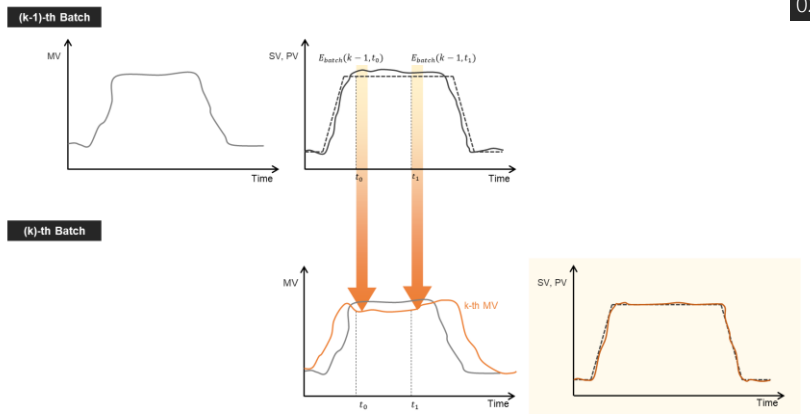

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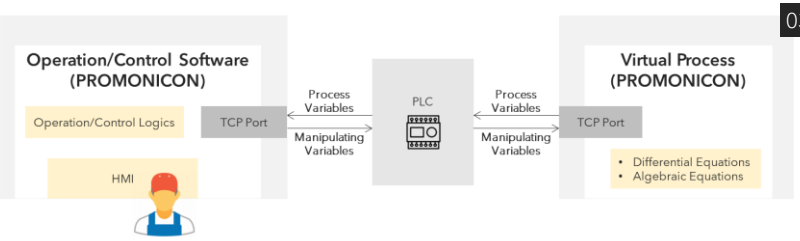


Flexible Development Environment

PROMONICON offers a powerful **script programming module** that enables you to develop complex control systems effortlessly.

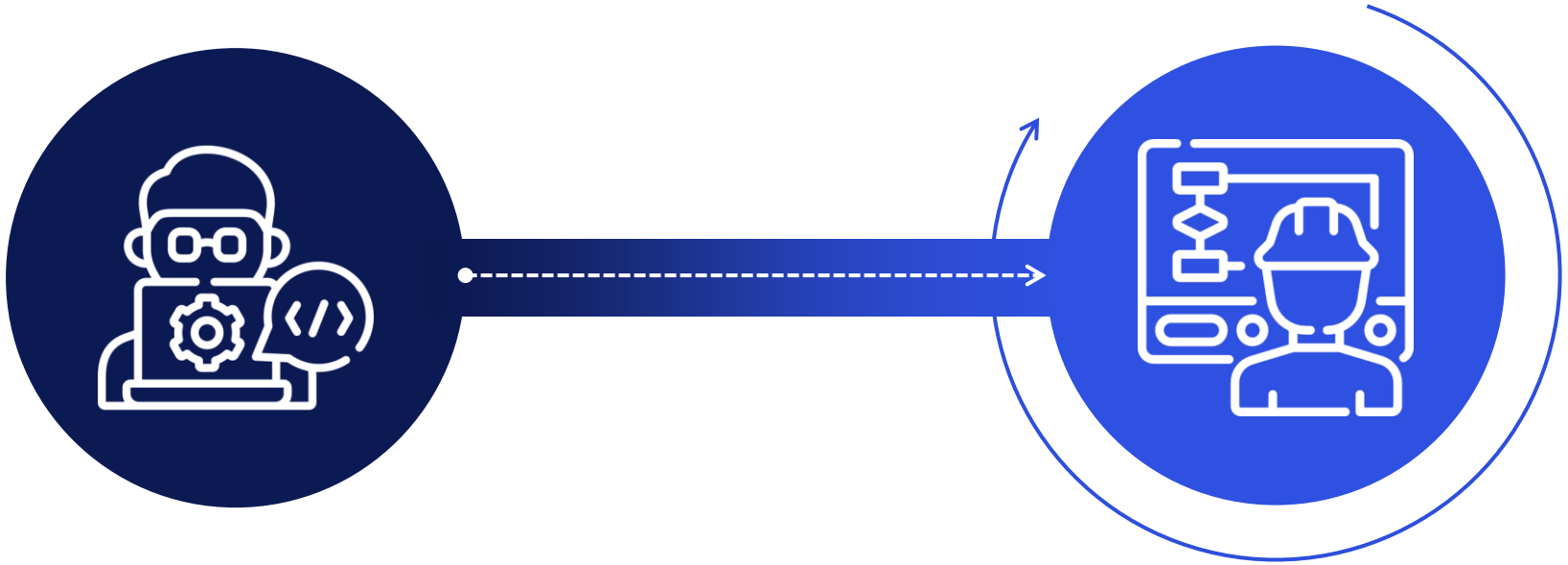
With a rich set of features, you can customize your automation processes to meet your specific needs.

Math Functions	power, trigonometric, logarithm, square root, exponential, min/max, sign, round off/up/down, etc.
Arithmetic/Comparison/Logical Operators	+, -, *, / >, <, <=, >=, ==, != and, or
Control Structures	if statement, loop statement
Integral Function	useful to solve differential equations and construct model-based controllers
Time Delay	useful to delay a signal and construct model-based controllers
Interpolation	useful for gain-scheduling of PID controllers and designing operation scheduling
Importing/Exporting Data from/to csv file	useful to import and export data from/to csv files
Resolution Enhancers	PWM (Pulse-Width-Modulation), DSM (Delta-Sigma-Modulation), and dither functions to overcome low resolution problems of actuators
Signal Filters	low-pass, average, median, std, and polynomial filters to remove noises and disturbances
PID Controller Applications	nonlinear gain-scheduling, setpoint scheduling, and auto/manual scheduling
Model-Based Advanced Controller	advanced control logic implementation on the basis of process models such as Iterative Learning Control (ILC), Model Predictive Controllers (MPC), Smith predictor, Internal Model Control (IMC), etc.
Sequence Control	useful to implement large-scale and complex sequence logics

Online Implementation of Logics/Scripts

In PROMONICON, you can **add/modify/delete operation/control logics in an online manner**. For examples, there is no need to abort PROMONICON to update the following items:

- Communication with automation devices
- PID controllers
- Scripts
- Process diagrams
- Graphs
- Variable attributes
- Data storage settings
- ...



Online Modification **In Operation**

Differences between PROMONICON and Other SCADA Products

	Other SCADA Products*	PROMONICON
Interface	Compatible with only their own PLC and OPC	Supports communication interfaces with typical PLCs as well as general communication interfaces like OPC, TCP, UDP, and serial comm. with various kinds of automation devices (e.g., inverters, sensors, actuators, controllers, etc.).
HMI Implementation	Only offline HMI implementation	Supports easy HMI implementation in both offline and online manners.
Control Logics	No control logics	Provides basic/advanced control functions: industrial PID/PIDA control, Iterative Learning Control (ILC), cascade control, gain-scheduling, feedforward control, model-based control, controller parameters tuner, (cascade) anti-windup, and TBB0 advanced control.
Sequence Logics	No sequence logics	Provides a specialized sequence logic module.
Basic (low-level) Script Programming	Only low-level script coding (based on, such as C, Basic)	Provides low-level script coding (e.g., arithmetic/comparison/logical operators, if and loop statements) and various math functions.
Advanced (high-level) Script Programming	No high-level script coding using advanced functions	Provides many advanced functions (e.g., resolution enhancers, signal filters, transfer function, integral/derivative/delay operator, bits manipulation, interpolation, HMI control, reporting, data storage control, variable initialization, .csv importing/exporting, etc.).
Image Processing	No image processing modules	Provides the image processing module (e.g., image capturing, ROI setting, edge detecting, object (blob) detecting, curve/straight line detecting, circle detecting, similarity measuring, white balancing, RGB-to-grey converting, characteristics value extraction).
Simulation	No simulation modules	Supports various simulation works for operator training systems and virtual processes. (related functions: transfer function, integral, derivative, various math functions, time-delay, etc.)
Optimization	No optimization modules	Provides successive LP (Linear Programming) solver.
Connection to User-made .exe Programs	No connection to user-made .exe programs	Supports easy connection to user-made .exe program with file input-output or typical communication interfaces.
License	Subscription-based license with maintenance fees	Provides permanent license without maintenance/upgrade costs after one-time purchase.

*WinCC, InTouch, Factory talk, Autobase, etc.

PROMONICON

Success Story: Silicon Single Crystal Growers

Advanced Control Logics

Improved control performances in controlling diameter and pull speed of silicon single crystal growers

Central Control and Monitoring System

This system can access 100+ growers to monitor and control.

Operator Training System

Operator Training System (OTS) is developed using simulation functions of PROMONICON.

Image Processing

Key process variables can be obtained through image processing module of PROMONICON.

Advanced Control Logics

TBB improved the control performances in controlling the **diameter and pulling speed of silicon single crystal growers** by using…

Enhanced Control Logics

Feedback control, feedforward control, iterative learning control, sequence control, etc.

Signal Processing Techniques

median-average filters and bumpless techniques

Resolution Enhancers

PWM, dither, DSM, and noise-suppressing parameter adjustments, etc.

The Results are remarkable:

The limitations of the previous control logics are overcome, and much better control performances are achieved.

Diameter Variance Reduced

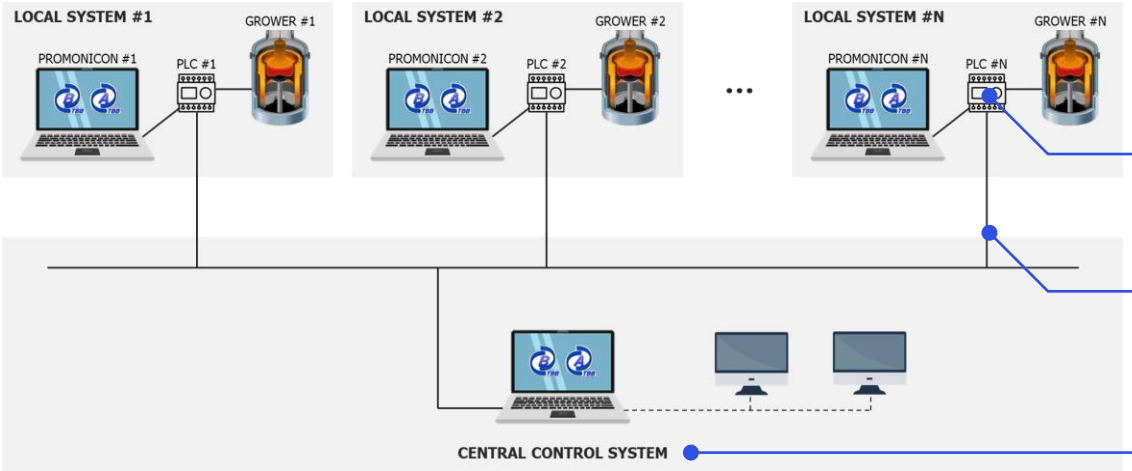
Diameter variance is reduced by 15%, enhancing the uniformity and quality of the silicon single crystals.

Pulling Speed Increased

Our advanced control logics have successfully **increased the average pulling speed by 20%**, which leads to higher productivity, reducing production time and cost.

Central Control and Monitoring System

TBB designed a central control/monitoring system for Si single crystal growers based on PROMONICON. **This system can access 100+ growers to monitor and control the growing process.** The topology of the central control/monitoring system for growers is presented as below:



Each grower has its own PLC and local control/monitoring system.

The local and central control/monitoring system are connected through PLC and TCP communication.

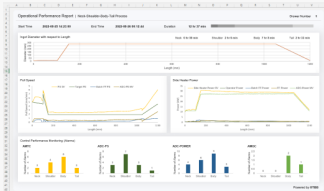
The central control/monitoring system can manipulate multiple growers in a simultaneous manner by interfacing with PLCs through TCP communication.

Redundancy Assured

A grower can be controlled by either its own local control/monitoring system or the central control/monitoring system. For examples, the local control/monitoring system will **take over control automatically in a bumpless way** if the central control/monitoring system is failed, and vice versa.

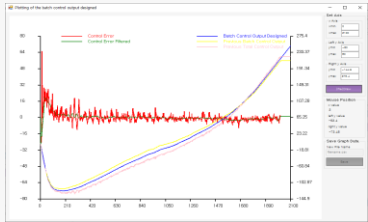
Automatic Reporting

The central control/monitoring system collects process data of all the growers and processes them, followed by **generating reports in an automatic way.**



Recipe Design and Application

The system enables **automatic design and application of recipes** to multiple growers



Operator Training System (OTS)

Operator Training System (OTS) is developed by using the simulation functions of PROMONICON. The OTS consists of a real-time virtual process, an operation/control system, and PLC.

The real-time virtual process is developed with the simulation module of PROMONICON. The virtual process is defined by transfer functions (i.e., differential equations) and algebraic equations, which emulates important dynamics in the single crystal growing process.

The virtual process receives the manipulated variable signals (such as pulling speed, heater power, etc.) determined by the operation/control system through PLC, and sends the emulated measurements (process variables such as ingot diameter, melt temperature, etc.) to the operation/control system through PLC.

This system is useful to validate the operation/control logics and train the operators.

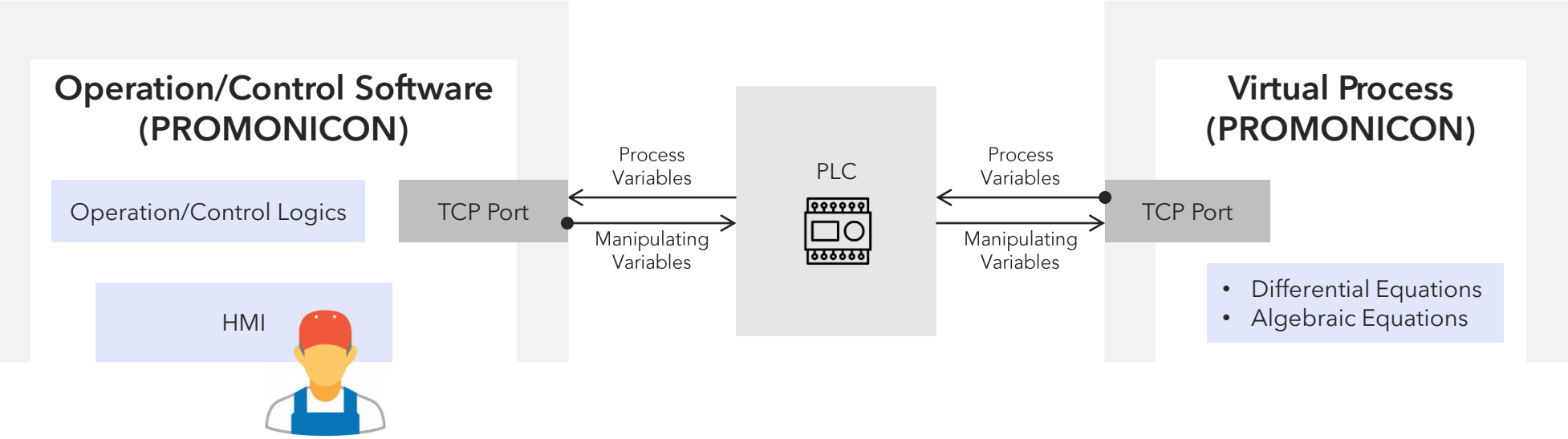
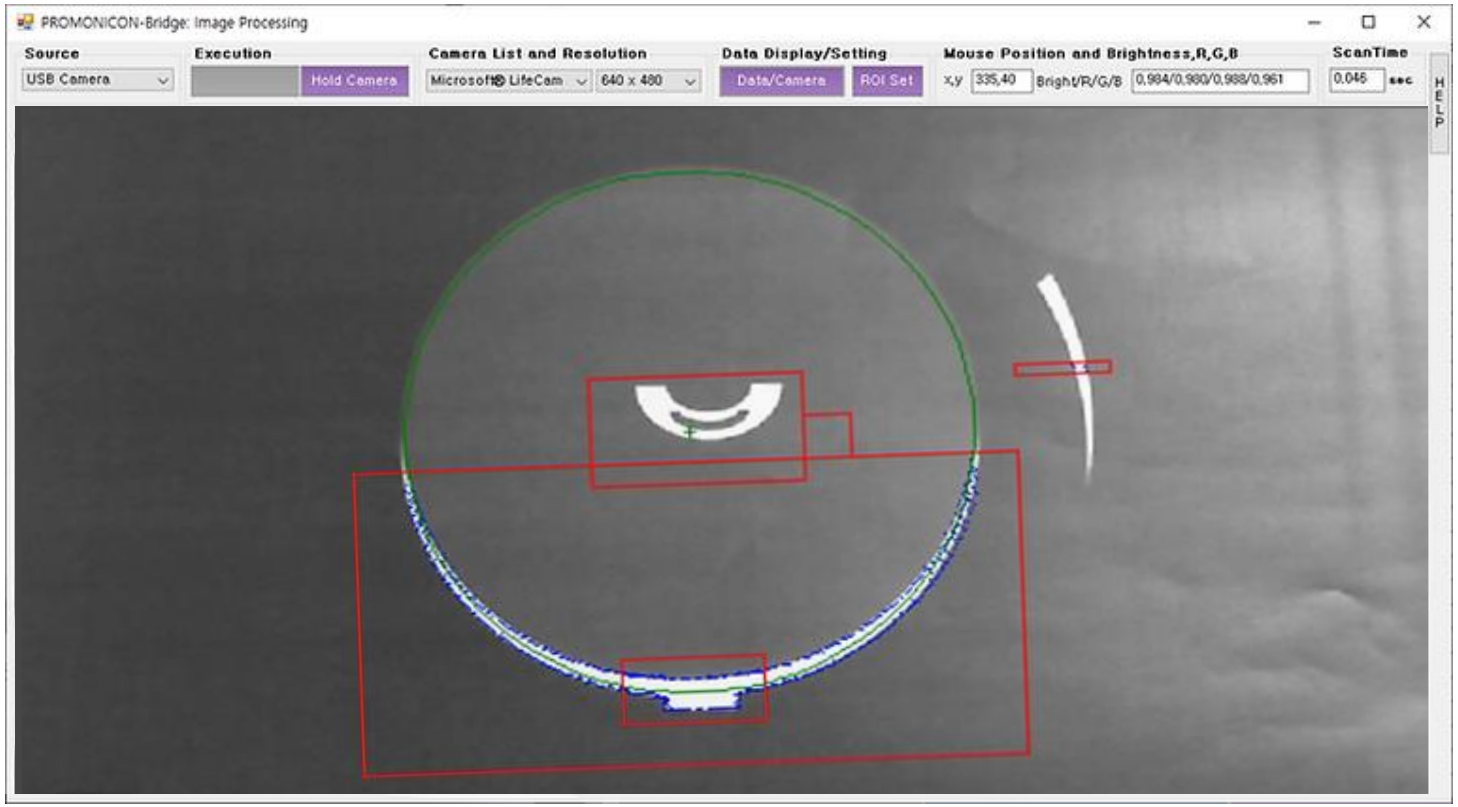


Image Processing

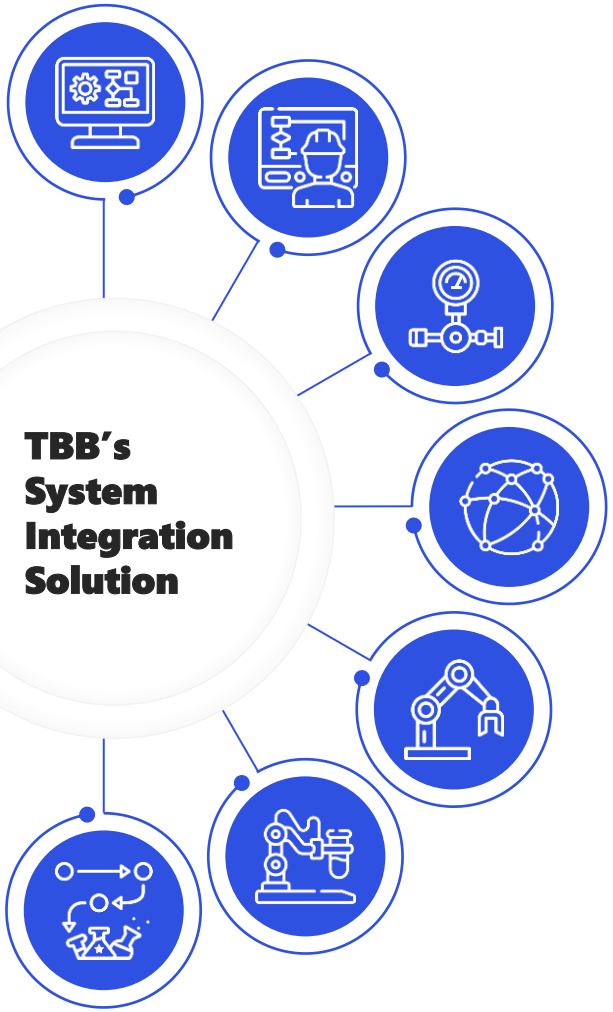
With the image processing module of PROMONICON, the following key variables (not measurable) to control and operate the silicon single crystal grower can be obtained.

- Good dip
- Crystal loss
- Diameter
- Melt gap
- Melt temperature
- …



SYSTEM INTEGRATION

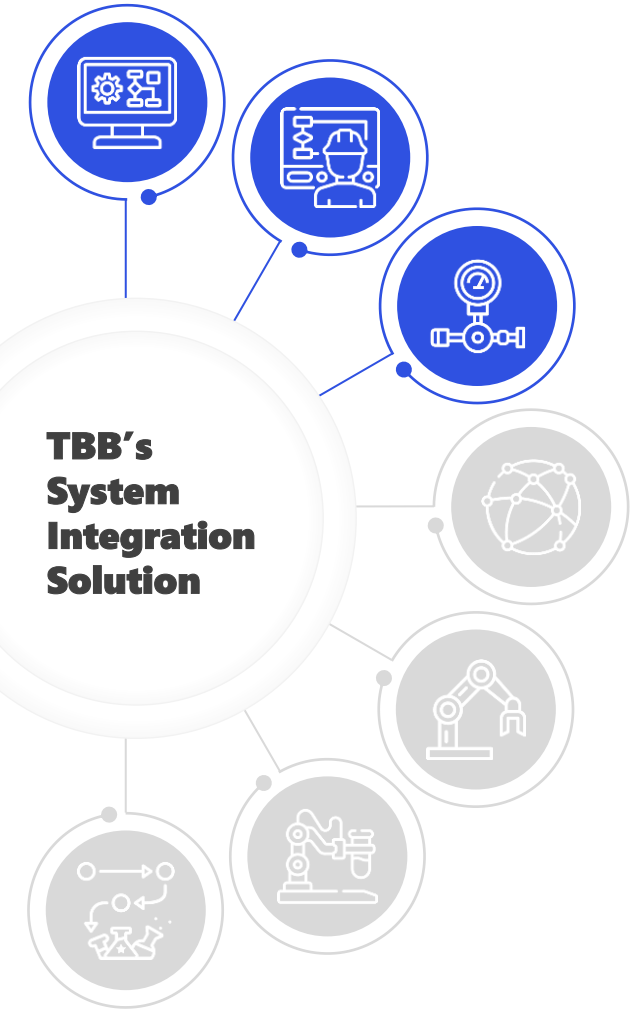
From Designing Automation Systems to Commissioning



TBB can provide a system integration solution by combining the core technologies such as SCADA, instruments, networking, process simulation & design, robotics, and lab automation.

- Control Logic Design and System Identification
- SCADA
- Instruments
- Networking
- Robotics
- Lab Automation
- Process Simulation and Design

Core Technologies for System Integration (1)



Control Logic Design and System Identification

- **Classical Control Theories**: feedback control, feedforward control, auto-tuning, gain-scheduling, split-range control, etc.
- **Advanced Control Theories**: high-performance TBB0 control, Iterative Learning Control (ILC), Model Predictive Control (MPC), model-based PID control, etc.
- **System Identification Theories**: time-series, state space, artificial intelligence, neural network, deep learning, etc.
- **Control Performance Monitoring**: oscillation, resolution, hysteresis, offset, and performance index, etc.

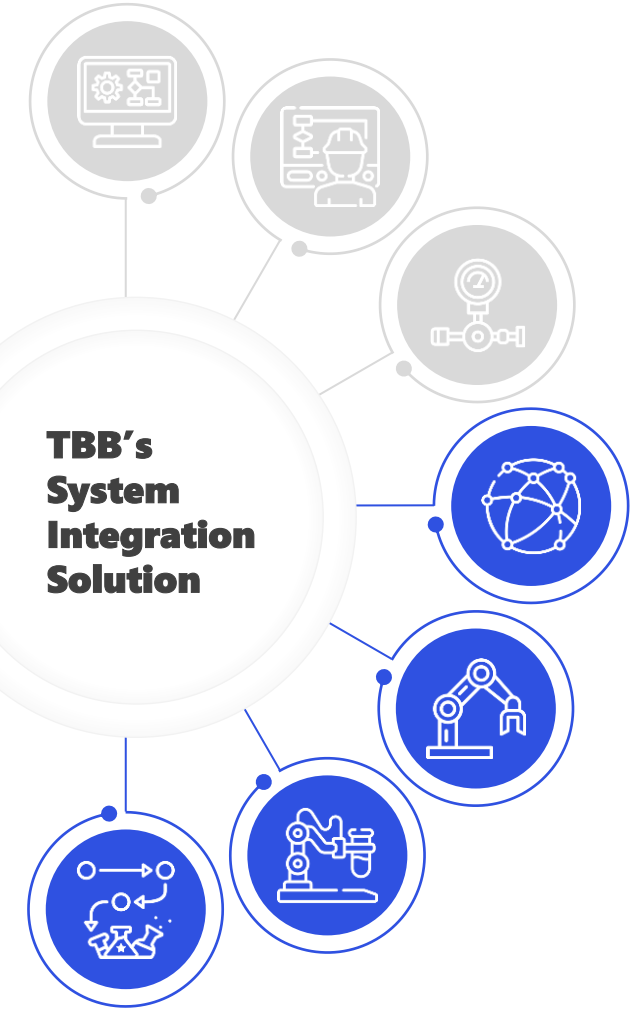
SCADA

PROMONICON, TBB's all-in-one automation software, includes human-machine interfaces (HMIs), basic/advanced operation/control logics, data manipulation capabilities, and functionalities for reporting, alarming, and remote operation/control, and so on.

Instruments

Sensors/actuators, micro-processors, PLCs, and data acquisition modules

Core Technologies for System Integration (2)



Networking

Serial, OPC, TCP, UDP, ODBC, Modbus, CAN, as well as user-defined protocols.

Robotics

Cartesian robots, collaborative robots, and gantry systems

Lab Automation

Robots, analyzers automation, data analysis, and image processing.

Process Simulation and Design

- Tools: industry-leading simulation software products (e.g., ASPEN PLUS, ASPEN HYSYS, PROII) and customized simulators
- Fundamentals in Chemical Engineering: process control, thermodynamics, fluid dynamics, heat transfer, reaction engineering, and separation processes

Success Story: Automation of a Multi-Recipes Polymer Production Plant (1)

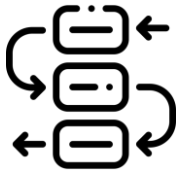
We provided a system integration solution for a polymer production plant (having over 20 batch reactors), which produces various polymers of more than 100 recipes.

The key factors for successful automation of the multi-recipes polymer production process are:

Precise and fully-automated weighing of raw materials

Precise control for reaction temperature, feeding rates, etc.

Sequence control for automatic operation and control of the plant



Success Story: Automation of a Multi-Recipes Polymer Production Plant (2)

To meet the requirements, we conducted,

Instruments design

- **Integrating thousands of sensor and actuators into PLC and HMI** through RS485 and Ethernet communications
- Designing a **redundancy system** for safety
- Optimizing communications with PLC, sensors, and actuators. **About 3,000 I/O points can be processed within 1 sec**.
- Software skills to **overcome hardware limitations** (e.g., low resolution, stiction, hysteresis, high cost)

Designing and implementation of operation and control logics (through PROMONICON)

- **Feedback/feedforward controllers** for accurate/precise control of the reactor temperature, the feeding rates of monomers/catalysts
- **Sequence control** to realize the complex operations and controls
- **HMI** for easy monitoring, operation, data storage, etc.
- **Automatic importing** 100+ recipes and **fully-automated weighing**

Design PLC logics for safety and high-speed data processing

01

02

02

01 The exterior view of the polymer production plant
02 Batch reactors in the polymer production plant

Results

Almost 100% automatic operation

with high-performance control to **manipulate 100+ recipes**, which is not possible with manual operation

Mass production

with operating **20+ reactors (10-ton capacity) simultaneously** by **only two operators** in the control room

Producing 100+ types of polymer products

with the automatic weighing system, followed by the automated polymer reactor system

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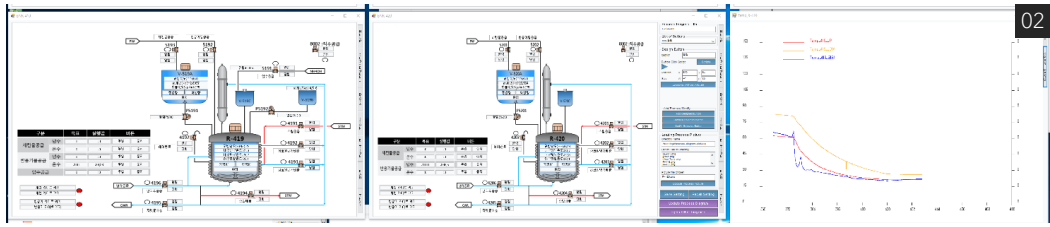

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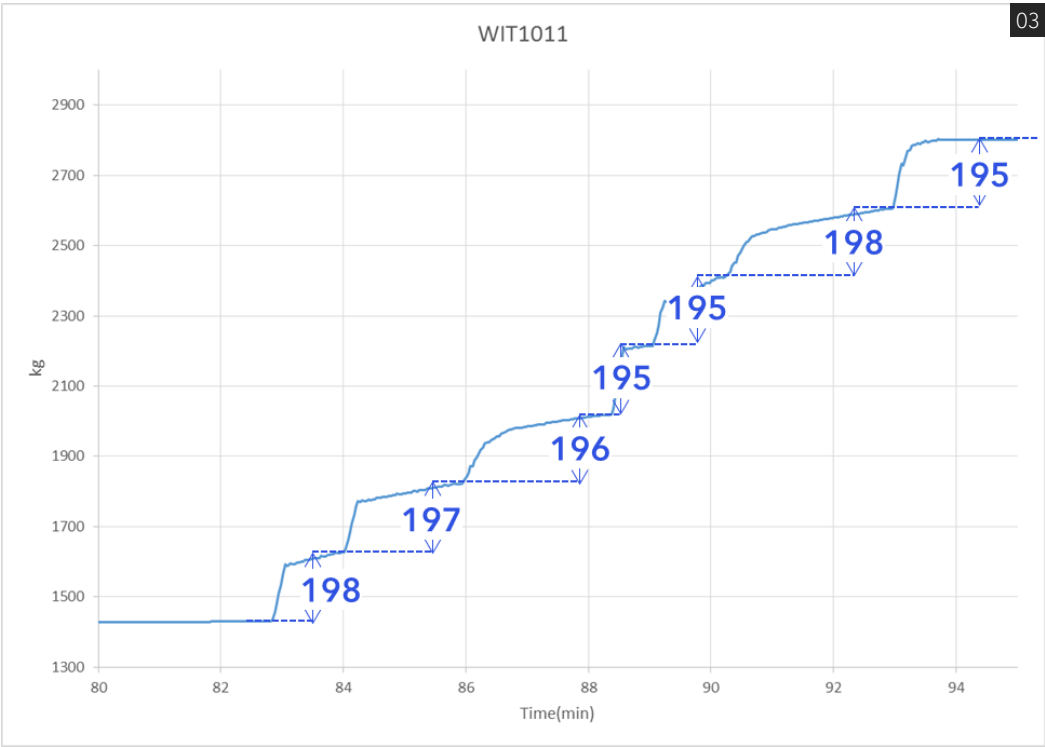
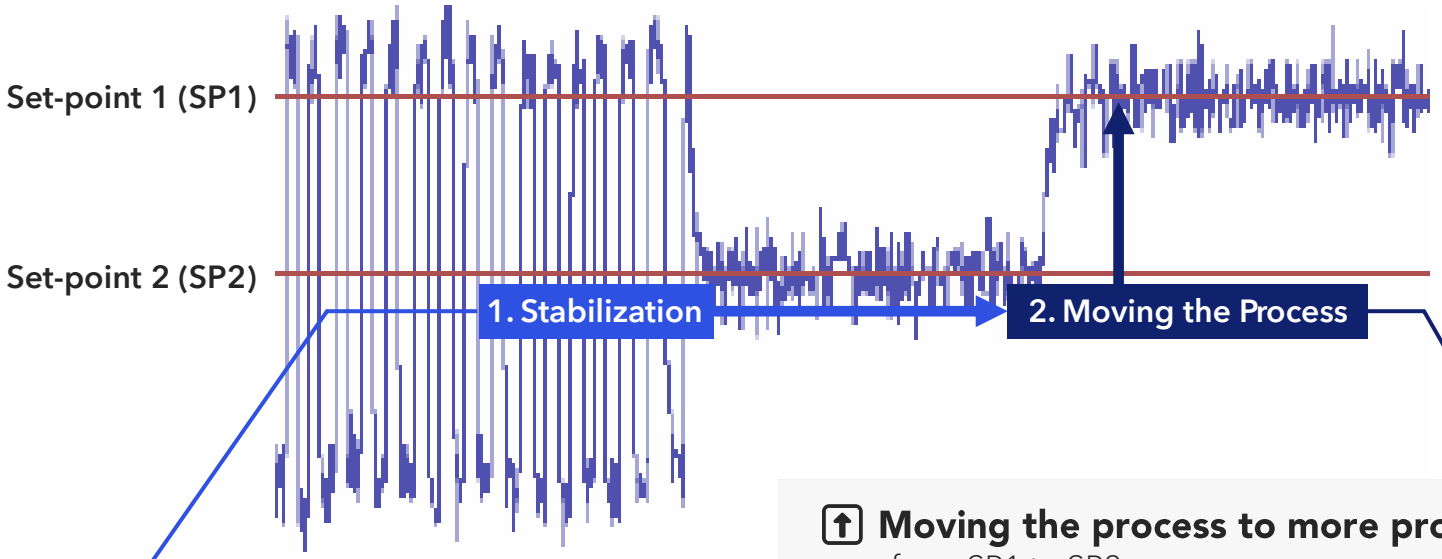


03

01 Control cabinets of the polymer production plant
02 HMI for operation and control of the polymer production plant
03 Weighing result during the polymer production operation

CONSULTING

Maximizing Productivity, Minimizing Costs (1): Stabilization and Moving the Process to More Profitable Operation Regions



- ⬇ **Reducing the variance of process variables***
  (*process variables: temperature, pressure, flowrate, etc.)
- ⬆ **Improving product quality**
- ➡ **Better consistency in yield and production rates**

- ⬆ **Moving the process to more profitable operation regions**
  : from SP1 to SP2
- ⬆ **Improving yield and production rate**
- ⬇ **Reducing raw materials and utilities***
  (*utilities: steam, air, electricity, etc.)

👉 **Ensuring economic benefits**

Maximizing Productivity, Minimizing Costs (2):
Analyze Performances of Control, Sensors and Actuators

Process Data Analysis

Finding and fixing the problems of sensors and actuators

- **Valve problems**: air leak, low resolution, hysteresis, sticking, and cost
- **Sensor problems**: low resolution, bad circuits or wires

Control structure diagnosis and improvement

- Analyzing the need for **new control loops** and tuning
- Modifying **faulty control loops** and tuning.
- Adding a new feedforward control and conducting tuning.

Success Story: Petrochemical Industries

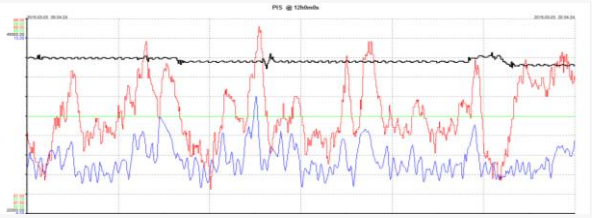
TBB improved control performances by…

- Combination of feedback/feedforward and batch controllers
- Fine-tuning PID controllers
- Detecting problems in sensor and actuator (valves/pumps)
- Detecting wrong control loops and correcting them
- Redesigning control loops

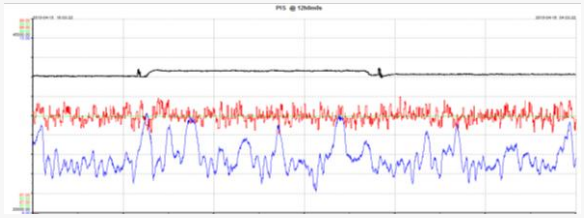
Steam consumption reduced by over **2%**
Average **variance of process variables** reduced by more than **30%**

Faster response time by over **70%** on average

Temperature control

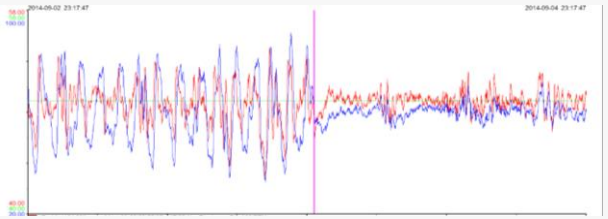


Before applying feedforward control (PID only)



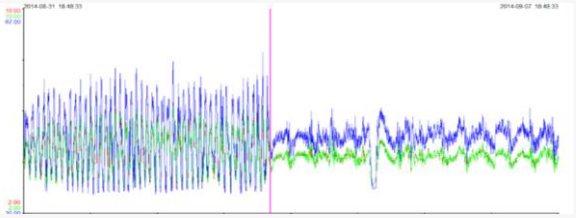
After applying feedforward control (PID+FF)

Column level control



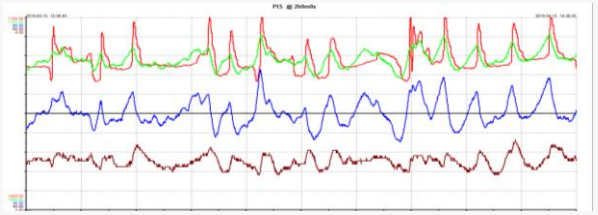
Before fine-tuning | After fine-tuning

Column feed flowrate control

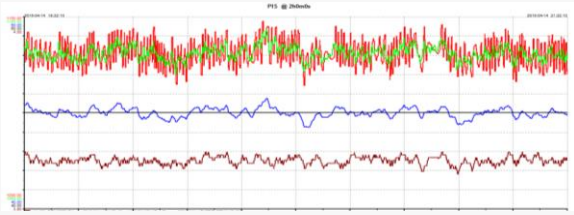


Before fine-tuning | After fine-tuning

Detecting and fixing valve air leakage

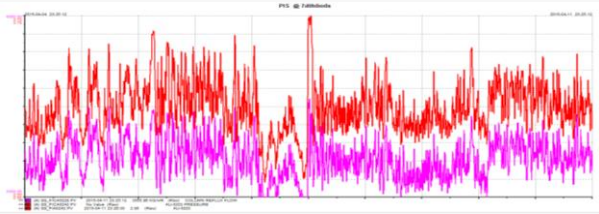


Valve air leak found

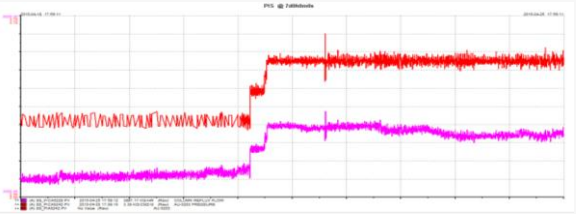


After fixing valve air leak

Analyzing the need of a new control loop and adding it



Before adding a pressure control loop



After adding a pressure control loop

TRAINING PROGRAMS

TBB Training Course Overview

Introduction to PROMONICON

Learn how to develop and build automation systems through PROMONICON

- Connection to automation devices (PLC, DCS, SCADA, etc.) through Serial, OPC, UDP/IP, TCP/IP communications
- PID controllers
- Sequence program
- Script programming for user-defined logics
- Process diagram (HMI)
- Alarm
- Real-time graph
- Data storage
- Reporting
- Importing data from excel
- Remote monitoring and control
- Simulation

Advanced Control Strategies with PROMONICON

Learn advanced control methodologies such as autotuning, cascade control, batch control, signal processing, image analysis, APC, etc.

Learn how to implement them through PROMONICON

- PID autotuning
- Gain scheduling
- Split-range control
- Cascade control
- Batch control
- Signal processing
- Image analysis
- Control Performance Monitoring (CPM)
- APC (or MPC; Model Predictive Control)
- Process optimization

Process Simulation and Design

Learn some background theories of process design and how to design processes through process simulation software products like ASPEN Plus, PROII, and ASPEN HYSYS.

- Basic theories
  - Phase equilibrium thermodynamics
  - Basic numerical analysis
  - Unit operations
- Process simulation and design using ASPEN Plus
- Process simulation and design using ASPEN HYSYS
- Process simulation and design using PROII

Process Control and Identification

Learn process control methodologies and identification theories.

- PID controllers and autotuning
- Advanced process control
- System identification

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