A PLC based Configured Controller for Bioreactor Systems

Pete Vranesich
Service Engineer
Applikon Biotechnology, INC.
• Autoclavable systems
• Stainless-steel: Bench, Pilot, Project
• Controllers: ez-Control, i-Control
• Software
• Microreactors: Microflask, SDR, SFR
• Biomass Monitor – BM200, Futura
• Rambio
• Sensors
• Biosep acoustic perfusion system
Pete Vranesich - Bio

• Educational
  – BS in Mechanical Engineering from University of Utah

• Occupational
  – 15 years in the Design and Engineering of Process Controls and Process Equipment in the Process Gas and Biopharma industry
  – 2 years with Applikon
  – Current responsibilities include:
    • Programming and support for Custom and Standard product controls for our customers in North America.
    • Technical Sales and Project Support for our Sales and Service Staff.
    • Installing, Testing and Maintaining Equipment primarily on the East Coast and Canada
Product Description

- Autoclavable systems
- Stainless-steel: Bench, Pilot, Project
- Controllers: ez-Control, i-Control
- Software
- Microreactors:
  - Microflask
  - Sensor Dish Reader
  - Shake Flask Reader
- Biomass Monitor – BM200, Futura
- Rambio
- Sensors
- Biosep acoustic perfusion system
BioReactor Systems

- Autocalvable Bioreactor Systems
BioReactor Systems

• Modular Autoclavable Solutions
• Single Use Bioreactor Solutions
BioReactor Systems

• SIP/CIP Systems
BioReactor Systems

- Stainless Steel
- BioPilot
Design Strategy

- Configurable Product Functionality vs Traditional Custom Design Functionality to Control a wide range of fermentation and cell culture bioprocesses
- 0.6L autoclavable/disposable vessels to 3000L CIP/SIP vessels
- ISA-S88 modular design standard
- Designed to be Validated to current cGMP and CFR 21 part 11 standards.
- User Interface compatibility for Research laboratory, Process Development laboratory, and Manufacturing/GMP environment.
Configurable Product Functionality

- One-Time Engineering costs for a Product Line vs Custom cost per project with less ongoing expense.
  - Configurable Modular Product with Options to cover most of Customers needs.
  - Costs spread out over multiple projects.
  - Software more manageable as a released Standard with revisions instead of multiple projects.
  - Product software more robust.
  - Sales Staff can sell options at less cost in a known product Matrix.
  - Can be manufactured as a product w/options
  - Service can install, inventory, and maintain standardized set of options (parts)
ISA-S88 modular design

- ISA-S88 modular design

**Physical**

- SCADA Level
- Local HMI Control
- Bioreactors
- Temp, Gas, Agit, PID loops, Valves, Pumps

**Software**

- Operations Phases
- Control Modules
- Equipment Modules
- Batch/Recipes
- AUTO
- MAN
- OFF
- CIP, SIP Cult.
- Rinse, Innoc.

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I/O Configurable Through HMI

- Controls Hardware Layout
I/O Configurable Through HMI

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- Controls Hardware Layout
User Interface Compatibility

User Interface compatibility for Research laboratory, Process Development laboratory, and Manufacturing (cGMP) environment.

- R&D & PD lab folks want:
  - Maximum flexibility in access/control Administrators Changes between and sometimes during runs.
  - Ease of use/training for interns
  - Less (or No) security, no time outs, etc.

- cGMP Requires
  - Defined auditable Process
  - Ease of Use
  - CFR 21 Part 11 Compliance. Electronic Signatures
Delivery Team

• Applikon
  – Larry Forman:
    • Project Manager
  – Brian Trippe
    • North Eastern Sales
  – Pete Vranesich
    Engineering Lead

• Rockwell Automation Solutions
  – Jim Hunter:
    • Project Manager
  – Chris Steffas:
    • Sales Director
  – Mark Givens:
    • Sales Director
  – Phil Veverka:
    • Designer
Project Execution: Foundation Work

• User Requirements/Functional Specification Specification and Proposal
  – From Quote Generated between Rockwell and Applikon for our Customer for 38 units
  – Allowed for project to be on fast track
  – Mapped out entire process (Blueprint)
  – Completed and approved before design started
  – Contractually binds the deliverables and acceptance criteria

Design

• Design and Fabrication
  – Heavily Leveraged Rockwell’s Design and Production Staff, Jim Hunter, Phil Veverka
  – Created a design based on Existing Applikon designs and migrated as much as possible to Rockwell components.
  – Allowed for project to be on fast track
  – Project Management/Execution by Rockwell including Applikon Sourced and supplied parts which were tracked in Rockwell system.
Project Deliverable to 3 Separate Sites

- Massachusetts Site:
  - 5 panels/2 reactors per panel 2 racks of I/O per panel DeviceNet
  - 1 panel master w/ ControLogix PLC, 4 Slave panels
  - 5 panels have PanelViewPlus 1000 for local control for 2 Bioreactors Ethernet
  - SCADA by OSIsoft PI via OPC

- Singapore Site:
  - 6 panels/2 reactors per panel 2 racks of I/O per panel DeviceNet
  - 1 panel master w/ ControLogix PLC, 5 Slave panels
  - 6 panels have PanelViewPlus 1000 for local control for 2 Bioreactors Ethernet
  - SCADA by BioXpert via OPC

- Puerto Rico Site:
  - 8 panels/2 reactors per panel 2 racks of I/O per panel DeviceNet
  - 1 panel master w/ ControLogix PLC, 7 Slave panels
  - (2) Laptops running ME Station for local control for 8 Bioreactors each Ethernet
  - SCADA by BioXpert via OPC
Project Execution: Design

• ControLogix L64 Controller
  – Supports existing Control Modules plus room for spare w/ redundancy
  – Primarily Ladder Logic (Modular to Allow for Options)
  – Indexed Memory Maps to Internal Tags To allow flexibility for Options I/O
  – Function Block used extensively: eliminates redundant code for 16 bioreactors

Reactors treated as RIO
  – (2) Racks per Panel
  – Were DeviceNet for Wago I/O with Proprietary pH/DO modules

• Operator Interfaces for Local Control
  – FTView ME for PanelViewPlus1000
  – 250 Screen Runtime License for (2) Laptops
• Performed At Rockwell:
  – Executed FAT in 3 Stages for Puerto Rico, Singapore, and Massachusetts
  – Problems with Proprietary pH Do redesign from Applikon only major delay
• Test Plan: developed against functional spec
  – Delivered at start of FAT, could have been streamlined if delivered earlier (similar to Function Spec process)
  – Executed against test plan and captured punch list items
  – Minor wiring corrections problems with Mass flow controller fitting leaks.
Application Training: Valuable but could have been better
  - Plan was to do FAT first and then train
  - Was a lecture/Hands On, then watch Runs with Live cells
Lessons Learned

• Scaling causes issues not seen in original code:
  – Timing Problems when Scan Time increased to 645ms
  – Bumped into Tag Limits on ME station for 16 Units SE probably better choice.

• Devicenet Vs all Ethernet communications.
  – Scope was changed to use local PanelViews in each panel for Singapore and Massachusetts, IO could have been Ethernet communication throughout.

• FAT:
  – Could (and probably will) be performed by Rockwell.
Benefits Seen

- Highest quality product offered to Customer from World Leader in Controls.
- Eliminated Need for Applikon to hire Engineering staff to complete panel projects in the US.
- Reduced overall hours in FAT/SAT with further reductions seen if Rockwell does FAT.
- Project is a solid base for all future panels. For bioreactors.
• Add SIP/CIP Options to Panel design
• Redesign OIT Screens to a more User Friendly product consistent with our other proprietary products.
• Have Rockwell perform more FAT functions, pH, DO, Elmo Servos.
• Deploy these panels in our Products (Sell more Systems!)
Rockwell Automation
Process Solutions User Group (PSUG)
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