Tex Tech
AHMEDABAD 2006

LISTEN. THINK. SOLVE.SM

Statistical Process Control for Global Textile Markets

John McCombs
12 October, 2006

ALLEN-BRADLEY • ROCKWELL SOFTWARE • DODGE • RELIANCE ELECTRIC

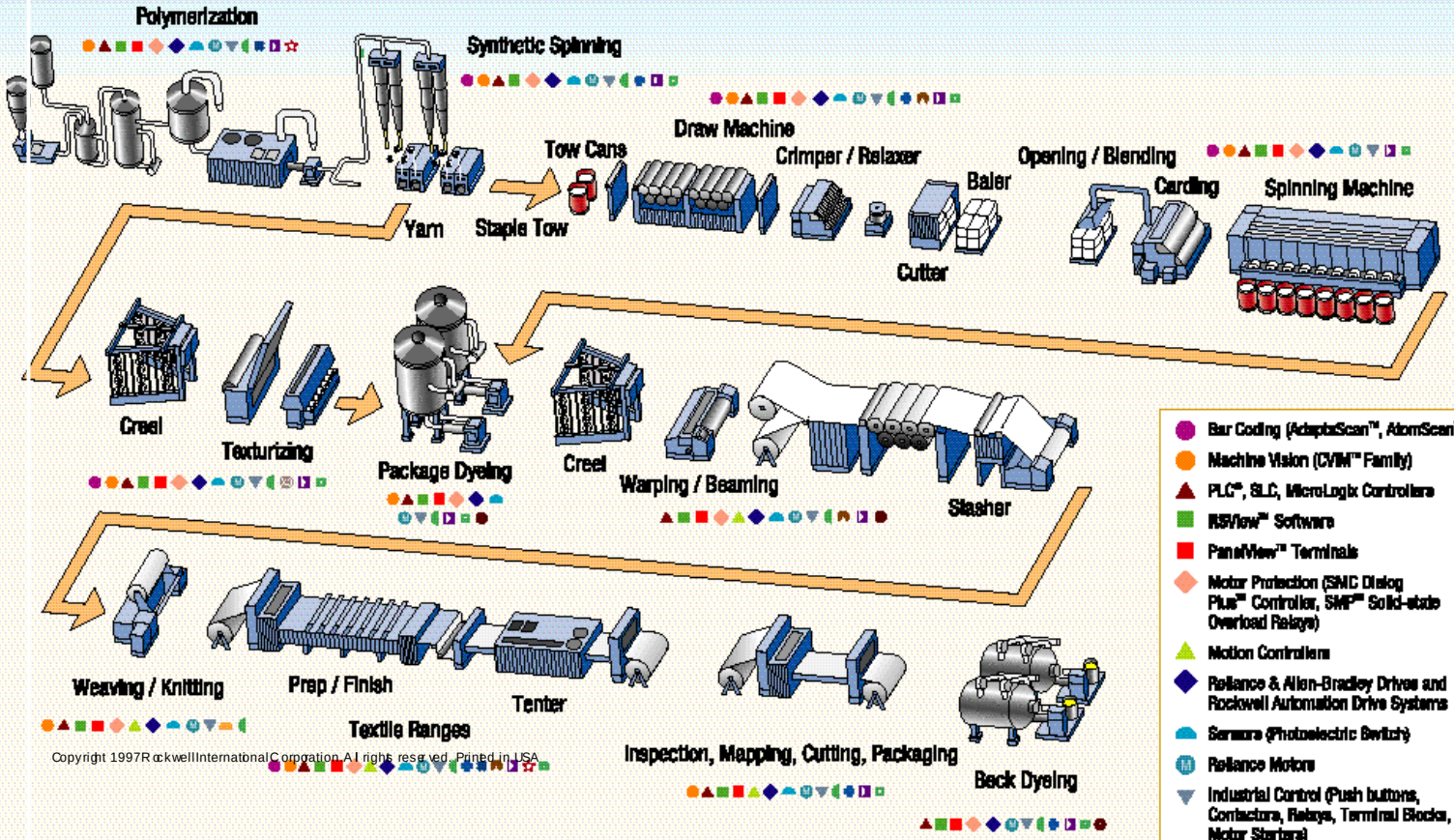
Rockwell Automation

Quote from Hindustan Times 9 October, 2006

- Indian entrepreneurs have learnt to think big
- Money not a problem,
- Quality and management are
  - The message is clear: Quality is non-negotiable. There is no dearth of capital. However, the core issue is: Does the management have the required mental bandwidth to face the challenges thrown up by globalization. By Uday Kotak

Repeatable Quality through Statistical Process Control is a Goal of Automation in the Textile/Fibers Industry

Textiles and Fibers Process



- Bar Coding (AdaptaScan™, AtomScan™)
- Machine Vision (CVIM™ Family)
- PLC®, SLC, MicroLogix Controllers
- RSView® Software
- PanelView® Terminals
- Motor Protection (SMC Dialog Plus® Controller, SMP® Solid-state Overload Relays)
- Motion Controllers
- Reliance & Allen-Bradley Drives and Rockwell Automation Drive Systems
- Sensors (Photoelectric Switch)
- Reliance Motors
- Industrial Control (Push buttons, Contactors, Relays, Terminal Blocks, Motor Starters)
- Medium Voltage Control (Starters, SMC Controllers, Medium Voltage Drives)
- Networks, (Ethernet®, ControlNet™, DeviceNet™, Remote I/O, Data Hwy+™)
- In-plant Distributed Process Control
- Radio Frequency Identification System
- Power Transmission
- Automax®
- Dodge - Belts, Sheaves, Couplings, Gear Boxes, Mounted Bearings
- BurnerMaster™ and CombustionMaster™ Systems
- CENTERLINE® Motor Control Center
- Open Controller™

Statistical Process Control for Textiles

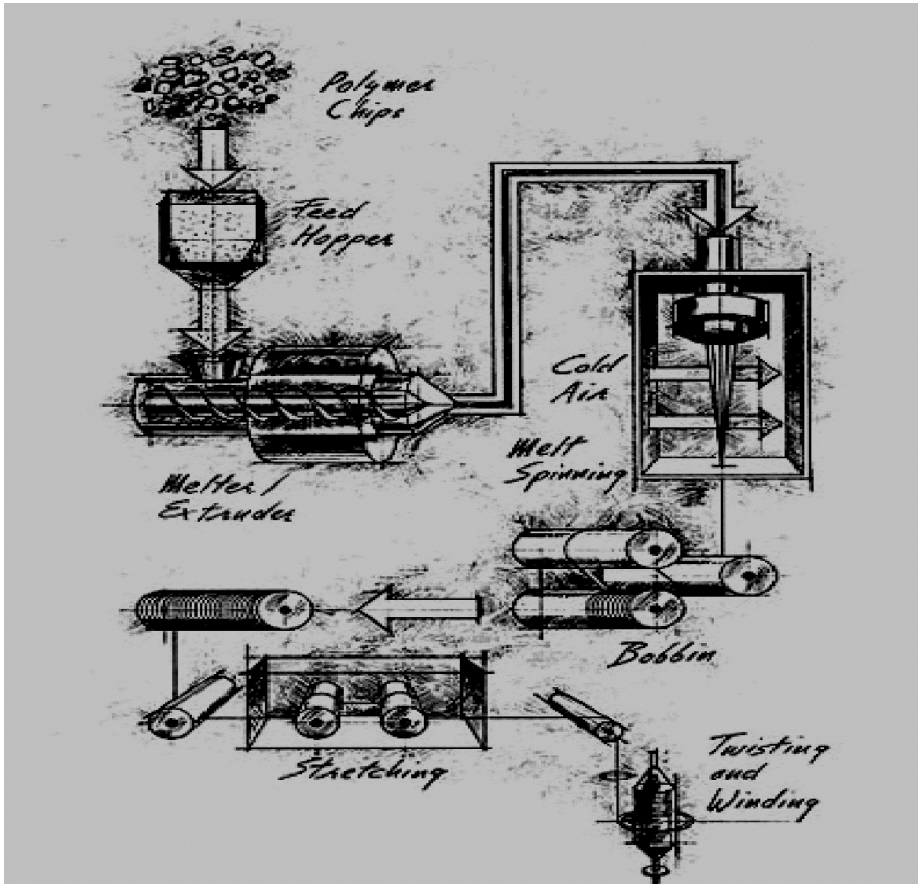
- The Electrical Control Industry has grown with the Textile Industry into automation systems including Statistical Process Control
- Manual systems have become automated
- Technical improvements have improved quality/repeatability
  - Many of the steps in Textile production is to assure repeatable quality
    - Opening Blending, 1st sliver, 2nd Sliver, drafting –all aimed at repeatable quality
    - Dyeing variations are a certainty without repeatable quality
- Dyeing and Finishing have become an automated necessity for World Class Quality. Dye matching is a requirement even when runs are two months apart.
- Computer Scheduling Can add a layer of improved quality to normal automated systems.

Repeatable Quality through Statistical Process Control is a Goal of Automation in the Textile/Fibers Industry

Example 1 from Synthetic Fiber History

Synthetic Spinning History

Automation the Process Partner



Melt Spinning Polymer from Chip

The controls grew as the process improved

Synthetic Fiber Progress Diagram

Tex Tech
AHMEDABAD 2006

Phase 1

Mechanical Line Shaft

Two Step Process

Phase 2

Inverters, synchronous motors

one step process

Electrical Line Shaft

Phase 3

Analog regulators replaced in

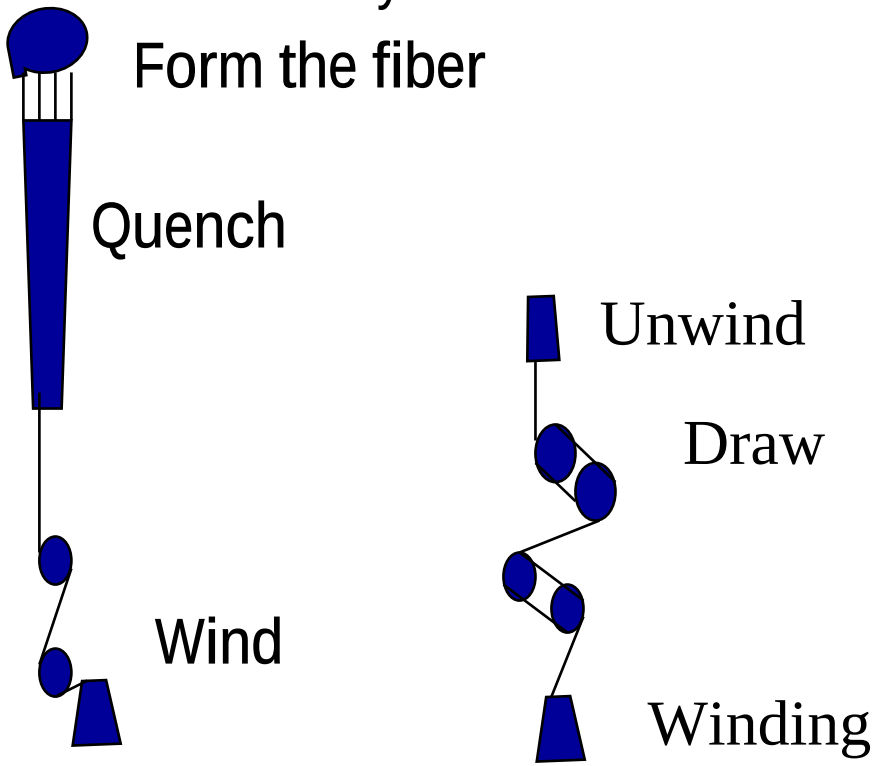
1970s by digital regulators, which greatly increased repeatability

Phase 4

Single Motor Drives

controlled by hierarchal computers and plcs

- In the beginning a two step process
- Machines were mainly mechanical



Drawing the fiber

Different draw ratios required different gear sets

The controls grew as the process improved

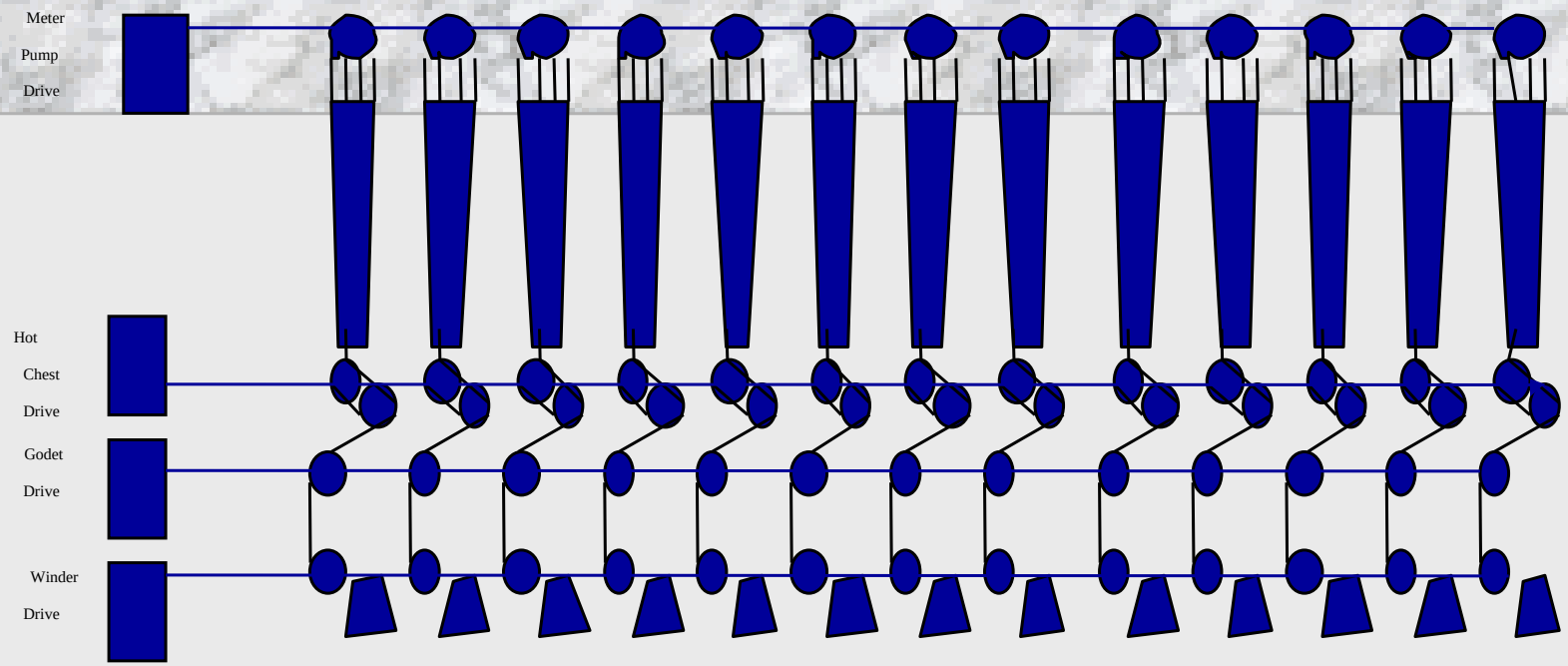
Inverters invented for this process 60's

Phase 2

Tex Tech AHMEDABAD 2006

Inverters

Synchronous Motors



By changing the relative speed of the draw rolls different products could be made without time consuming gear changes yielding a single step process

Major Fiber Producing Chemical Company

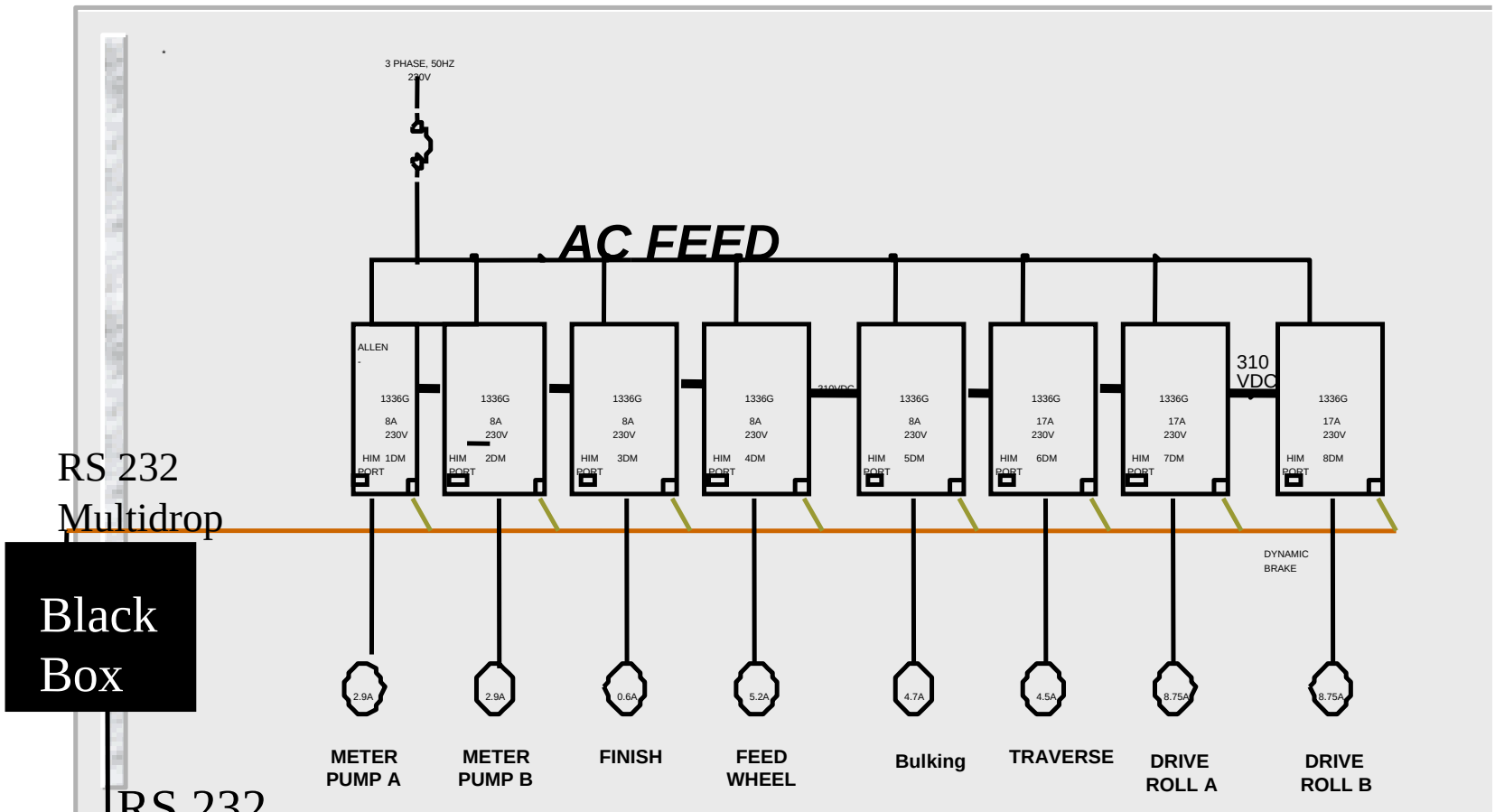
Single step process still meant same product on an entire machine – More Flexibility Required

– **Motivated by JIT - Automotive Carpet Customer**

Decided to replace bulk inverters with small single motor inverters - Good Price, Good Performance

- **NO TOTAL AUTOMATION PLAN**

Typical BCF
Single Position Architecture



Case Study 1

- 2 years later building an ASCII interface to a DCS is not complete (at least 1.5 man years wasted)
  - In an attempt to connect the drives to the main control system a “black box device” to interface to the RS 232 port on each drive has 10 second update time to read all speeds and currents of 8 drives. 40 positions x 10 Seconds = Failed Network

1st operator interface for drives

2nd DCS operator interface for the rest of the machine = Errors

Four Position 3 Color BCF Machine Arch
One Common Data Base

MMIM

Plant EtherNet

Tex Tech
AHMEDABAD 2006

Zone heater Control
for 3 extruders

PROFIBUS

Controller

ControlNet

160's AC fed

Extruder

Godet Heater Control

Godet Heater Control

6 Spiders are shared bus with fuses in the ac feed and dc link.

METERING PUMP
100 RPM

CHIMNEY AIR TEMP
150 C

Position 1 of 4

Controller

DeviceNet

2 Spiders

Winder drives are ac fed

Godets

DRAW ROLLS
3500 MPM

HOT CHEST
190 C

Motion Turret Position

Winder Bale Roll

Pulse p/u

WINDERS
3500 MPM

1 of 4
Winder Panels

BCF Machine

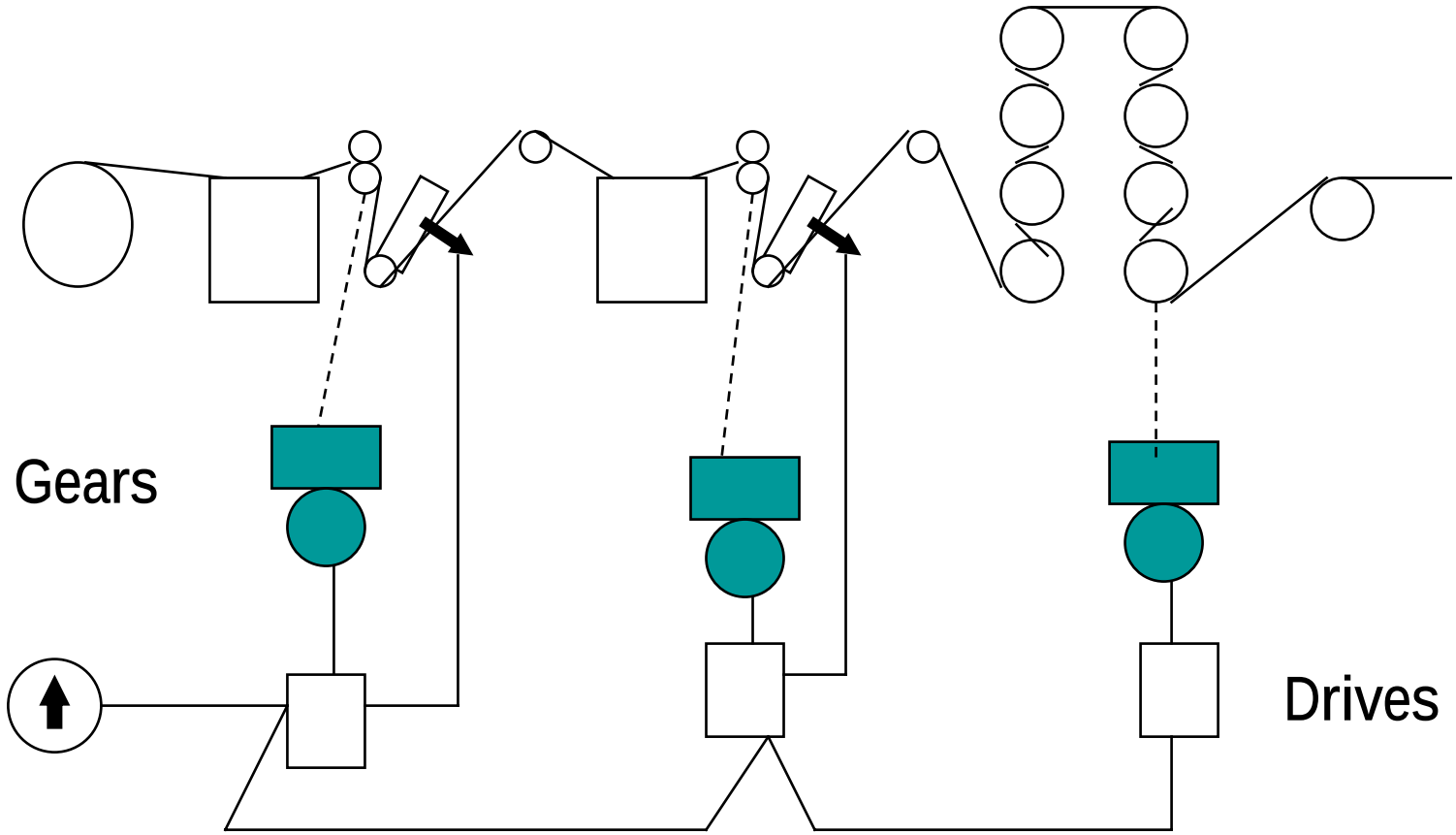
SINGLE SPINNING POSITION

Example No. 2 Fabric Processing

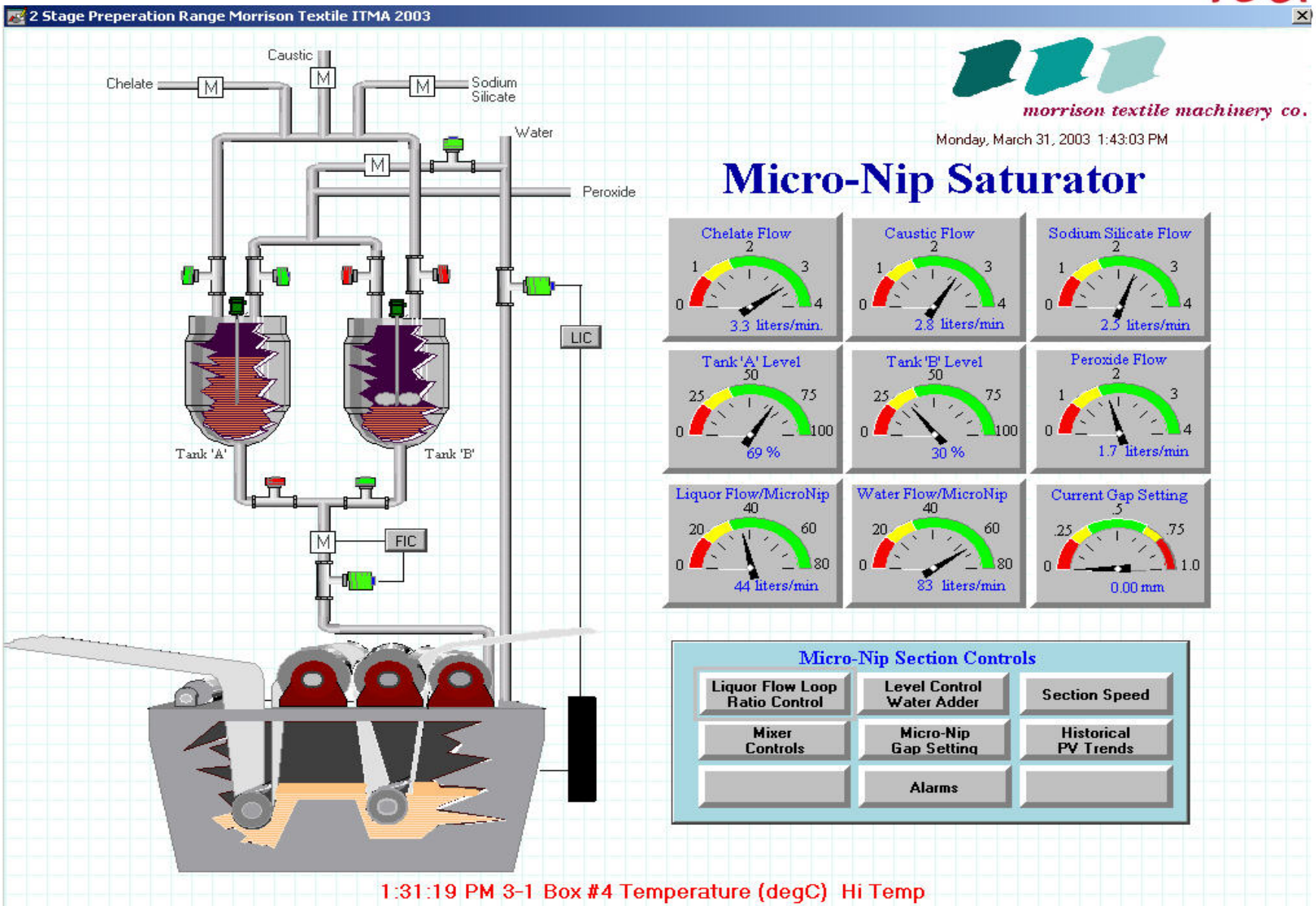
- Processing Fabric
  - Better fabric through chemistry is achieved , delivering the quality customer's desire.
  - The stages include washing, bleaching, shrinking, dyeing and adding stay pressed finishes.
- Automation has enhanced repeatable processes and enhances cost control
- A common data base including line speed, concentrations of chemical and temperatures insures repeatable higher quality.
  - For example by optimizing the bleaching process can reduce the amount of dye needed to achieve the quality color desired in the dyeing process.

Example No. 2

- In the past multiple data bases had to be coordinated
- Processing fabric was often considered an art
  - Time in the chemical was set by the speed of the line, which was controlled by one data base – a Drive system

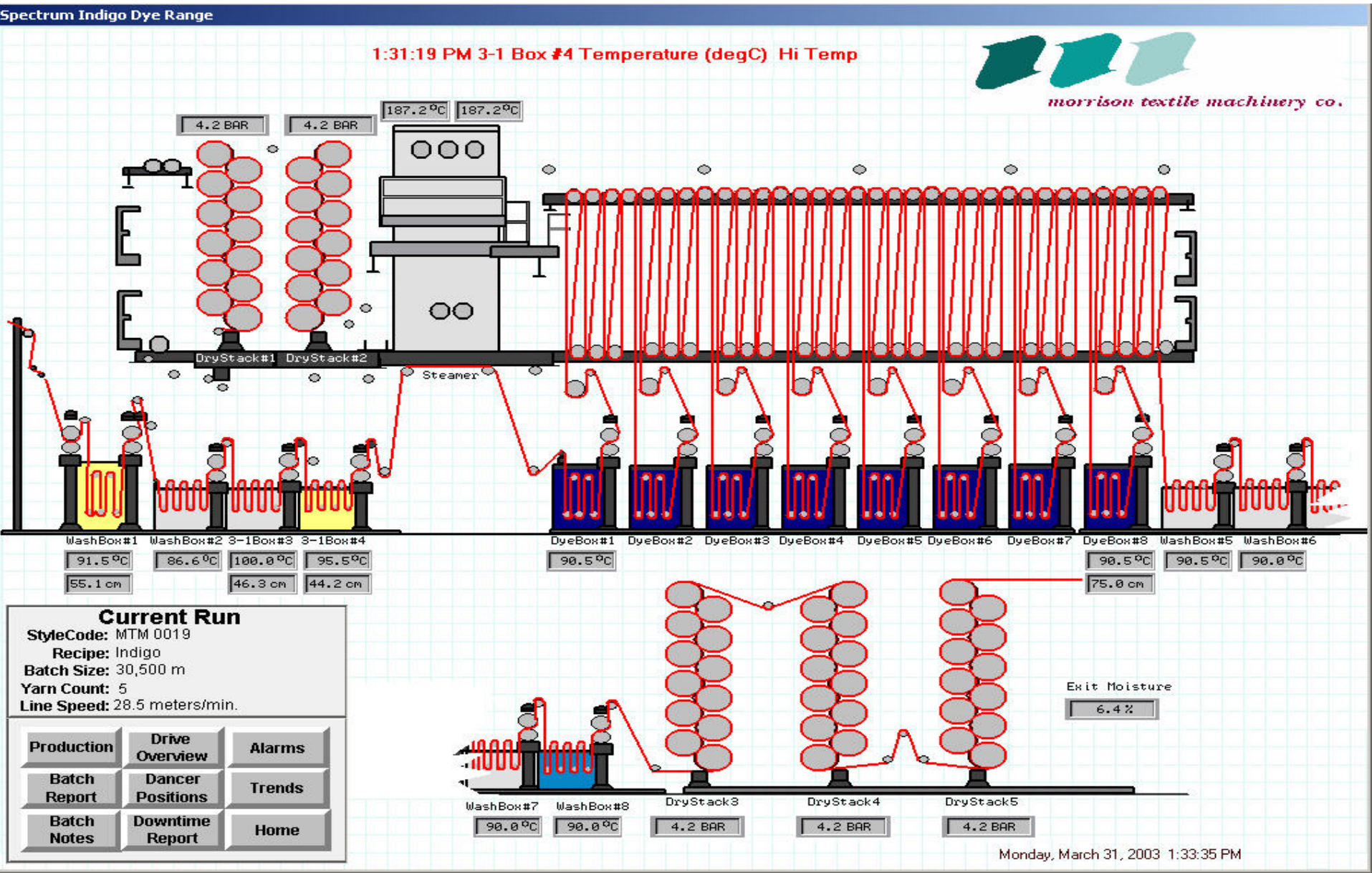


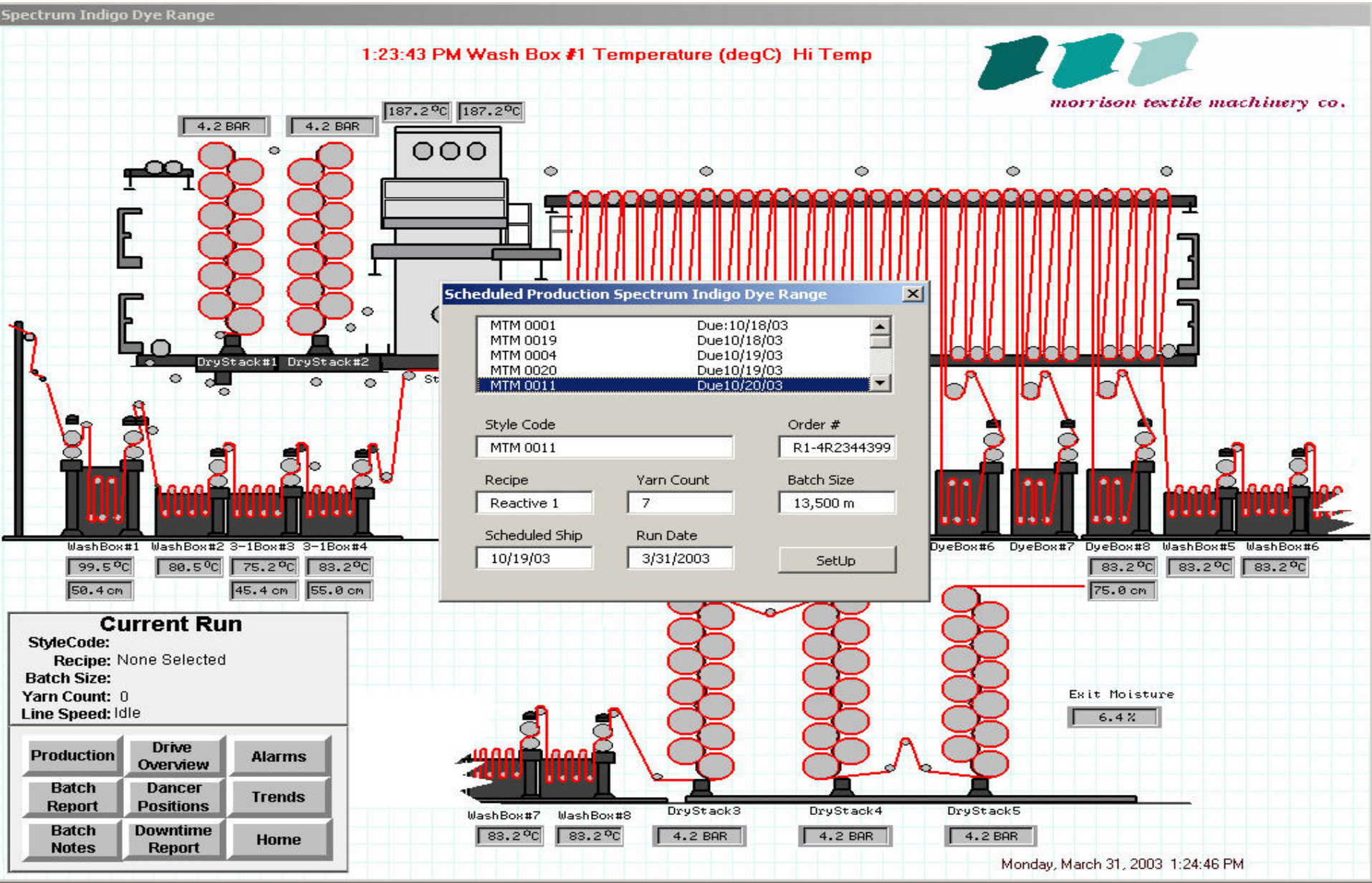
Chemical Concentrations often manually set by valves

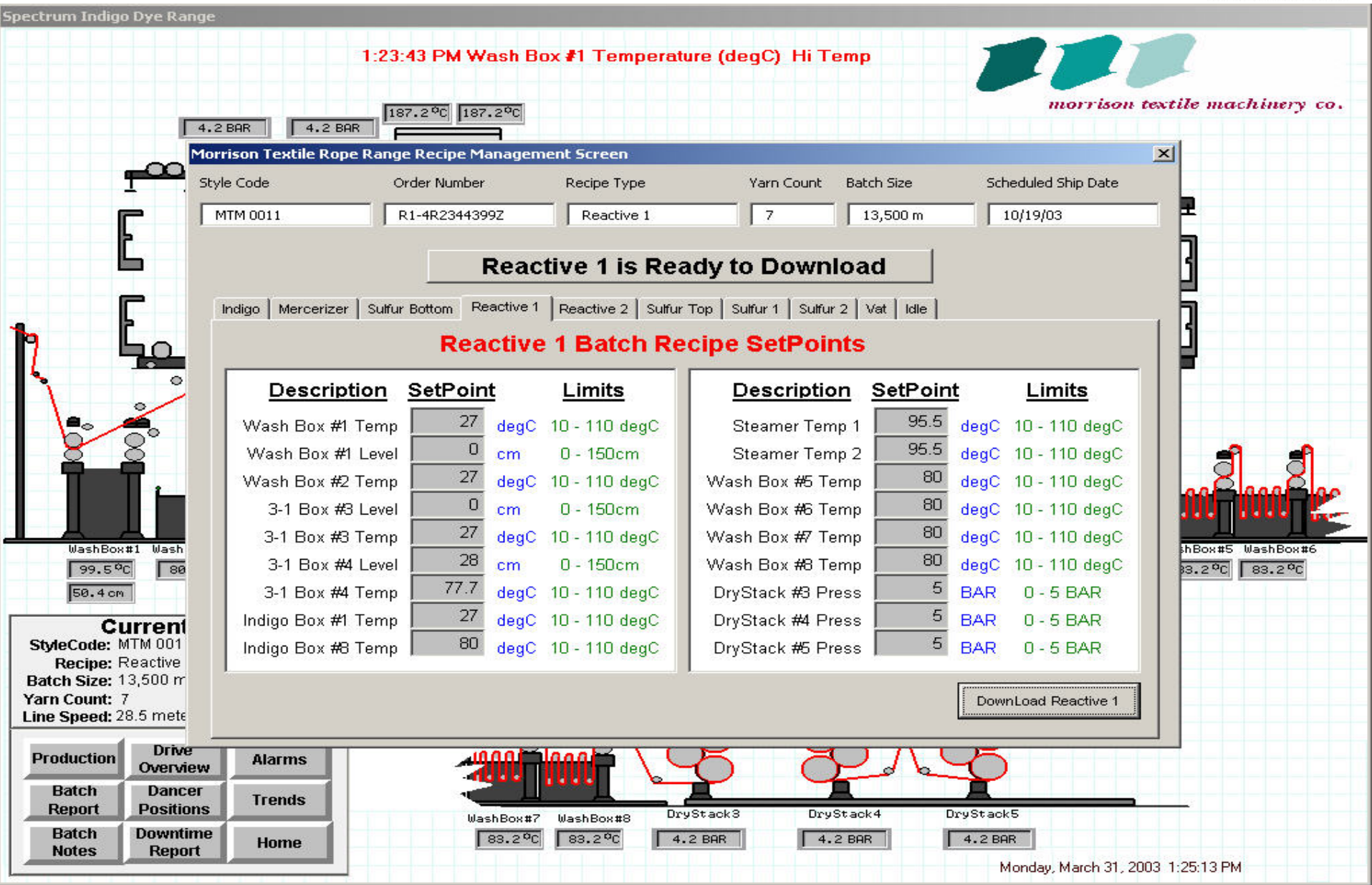


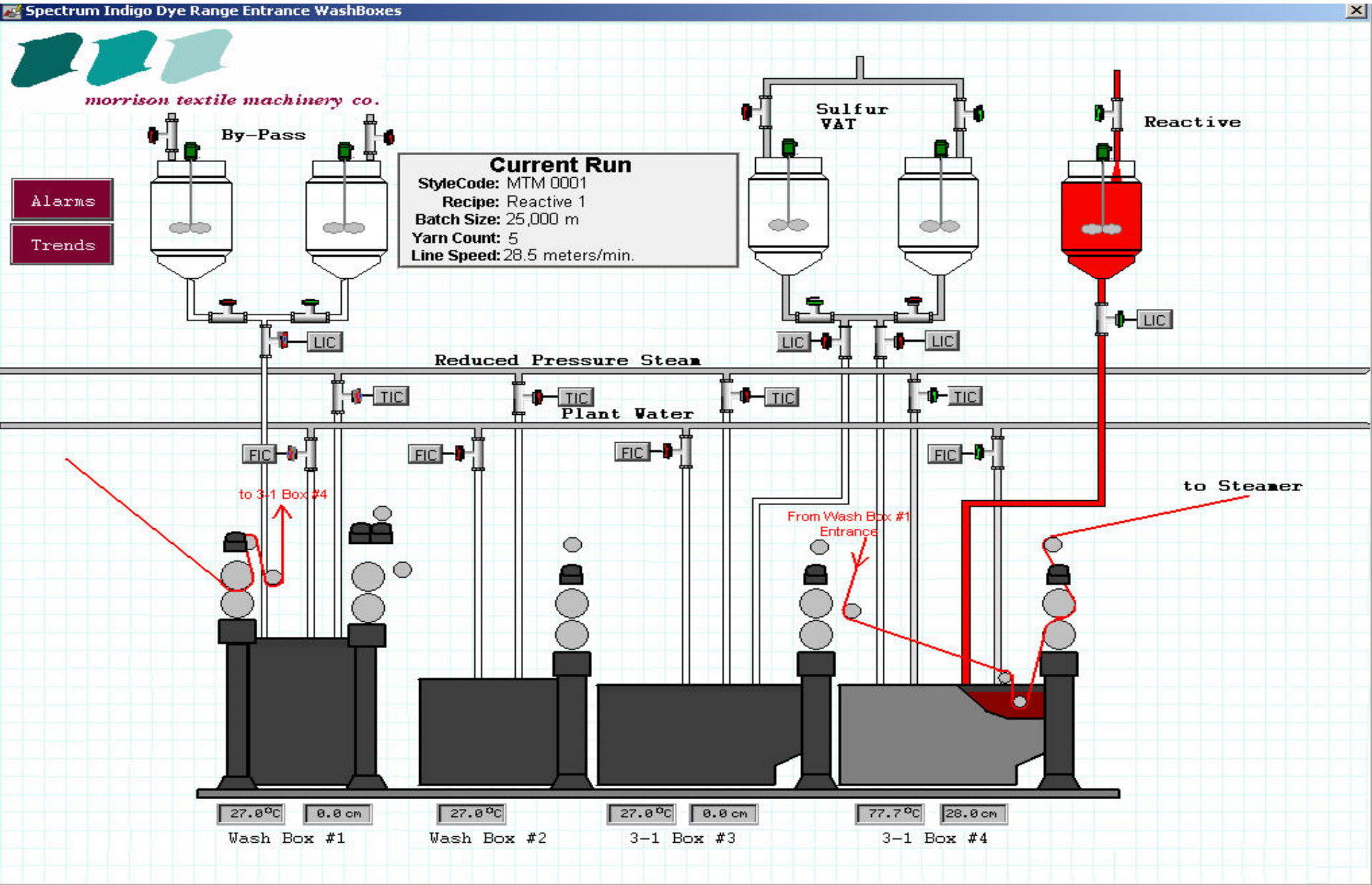
Multiple data bases yield multiple chances for errors

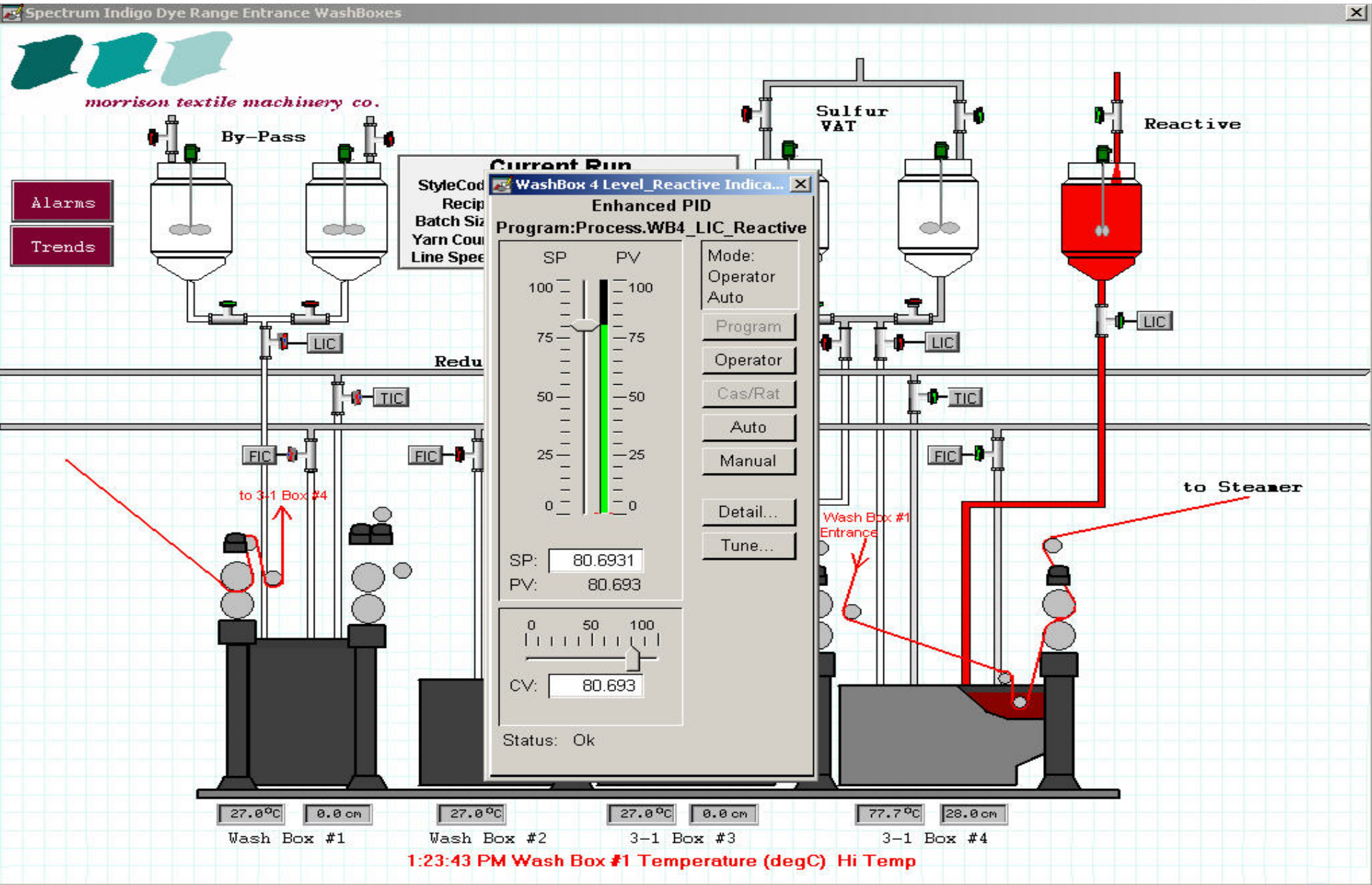
- Even when a control loop is used to set concentration or temperature, is it the right value for the product being run.
- Multiple data bases yield multiple changes for errors
- Take Temperature Control – The easiest
  - Sometimes Single Loop Controllers were used to maintain temperatures
    - Often set for wrong product being run
  - Manual Controls with temperature read out
    - Cannot be monitored 100%
  - Temperatures Drifted from beginning to end of the same lot of fabric
  - No Chance to repeat the next time a product is run

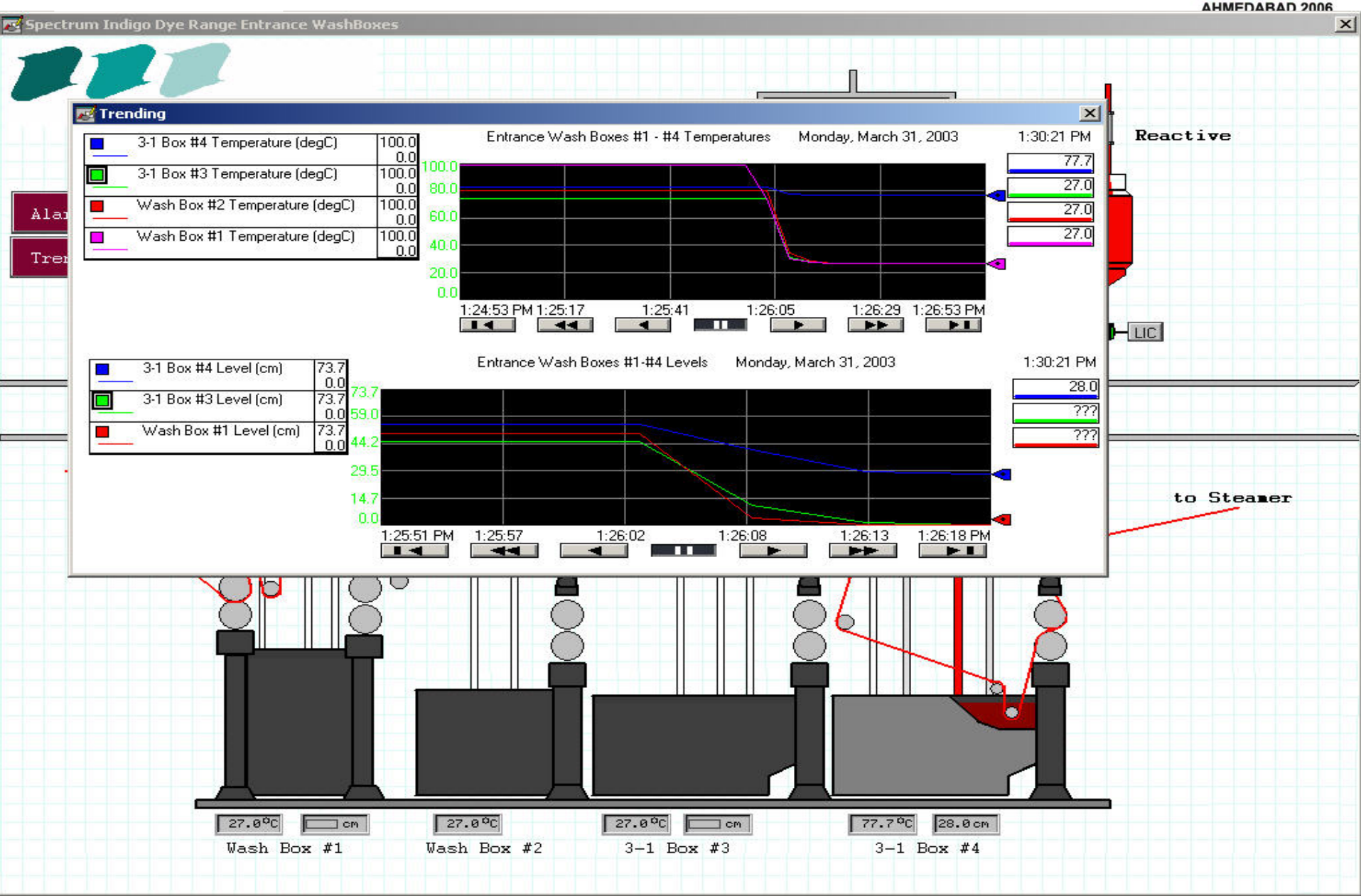

Spectrum Indigo Dye Range
1:31:19 PM 3-1 Box #4 Temperature (degC) Hi Temp
morrison textile machinery co.
4.2 BAR
4.2 BAR
187.2°C
187.2°C
DryStack#1
DryStack#2
Steamer
WashBox#1
WashBox#2
3-1Box#3
3-1Box#4
DyeBox#1
DyeBox#2
DyeBox#3
DyeBox#4
DyeBox#5
DyeBox#6
DyeBox#7
DyeBox#8
WashBox#5
WashBox#6
91.5°C
55.1 cm
86.6°C
100.0°C
46.3 cm
95.5°C
44.2 cm
90.5°C
90.5°C
75.0 cm
90.5°C
90.0°C
Current Run
StyleCode: MTM 0019
Recipe: Indigo
Batch Size: 30,500 m
Yarn Count: 5
Line Speed: 28.5 meters/min.
Production
Drive Overview
Alarms
Batch Report
Dancer Positions
Trends
Batch Notes
Downtime Report
Home
Exit Moisture
6.4 %
WashBox#7
WashBox#8
DryStack3
DryStack4
DryStack5
90.0°C
90.0°C
4.2 BAR
4.2 BAR
4.2 BAR
Monday, March 31, 2003 1:33:35 PM

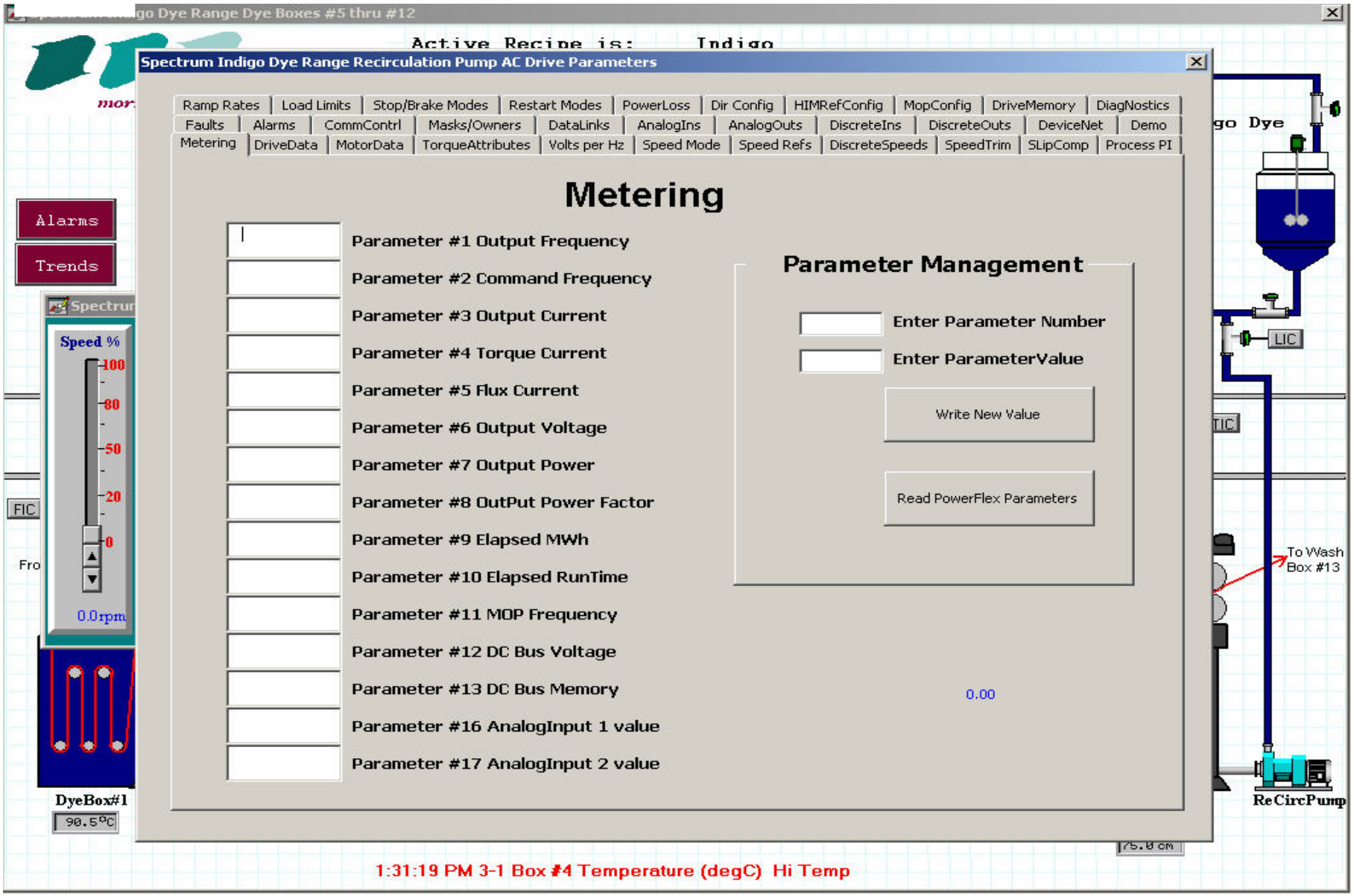

Spectrum Indigo Dye Range
1:23:43 PM Wash Box #1 Temperature (degC) Hi Temp
morrison textile machinery co.
4.2 BAR
4.2 BAR
187.2°C
187.2°C
DryStack#1
DryStack#2
Scheduled Production Spectrum Indigo Dye Range
MTM 0001 Due:10/18/03
MTM 0019 Due10/18/03
MTM 0004 Due10/19/03
MTM 0020 Due10/19/03
MTM 0011 Due10/20/03
Style Code
MTM 0011
Order #
R1-4R2344399
Recipe
Reactive 1
Yarn Count
7
Batch Size
13,500 m
Scheduled Ship
10/19/03
Run Date
3/31/2003
SetUp
WashBox#1
WashBox#2
3-1Box#3
3-1Box#4
99.5°C
80.5°C
75.2°C
83.2°C
50.4 cm
45.4 cm
55.0 cm
DyeBox#6
DyeBox#7
DyeBox#8
WashBox#5
WashBox#6
83.2°C
83.2°C
83.2°C
75.0 cm
Current Run
StyleCode:
Recipe: None Selected
Batch Size:
Yarn Count: 0
Line Speed: Idle
Production
Drive Overview
Alarms
Batch Report
Dancer Positions
Trends
Batch Notes
Downtime Report
Home
Exit Moisture
6.4 %
WashBox#7
WashBox#8
DryStack3
DryStack4
DryStack5
83.2°C
83.2°C
4.2 BAR
4.2 BAR
4.2 BAR
Monday, March 31, 2003 1:24:46 PM


Spectrum Indigo Dye Range
1:23:43 PM Wash Box #1 Temperature (degC) Hi Temp
morrison textile machinery co.
4.2 BAR
4.2 BAR
187.2 °C
187.2 °C
Morrison Textile Rope Range Recipe Management Screen
Style Code
Order Number
Recipe Type
Yarn Count
Batch Size
Scheduled Ship Date
MTM 0011
R1-4R2344399Z
Reactive 1
7
13,500 m
10/19/03
Reactive 1 is Ready to Download
Indigo
Mercerizer
Sulfur Bottom
Reactive 1
Reactive 2
Sulfur Top
Sulfur 1
Sulfur 2
Vat
Idle
Reactive 1 Batch Recipe SetPoints
Description
SetPoint
Limits
Wash Box #1 Temp 27 degC 10 - 110 degC
Wash Box #1 Level 0 cm 0 - 150cm
Wash Box #2 Temp 27 degC 10 - 110 degC
3-1 Box #3 Level 0 cm 0 - 150cm
3-1 Box #3 Temp 27 degC 10 - 110 degC
3-1 Box #4 Level 28 cm 0 - 150cm
3-1 Box #4 Temp 77.7 degC 10 - 110 degC
Indigo Box #1 Temp 27 degC 10 - 110 degC
Indigo Box #8 Temp 80 degC 10 - 110 degC
Description
SetPoint
Limits
Steamer Temp 1 95.5 degC 10 - 110 degC
Steamer Temp 2 95.5 degC 10 - 110 degC
Wash Box #5 Temp 80 degC 10 - 110 degC
Wash Box #6 Temp 80 degC 10 - 110 degC
Wash Box #7 Temp 80 degC 10 - 110 degC
Wash Box #8 Temp 80 degC 10 - 110 degC
DryStack #3 Press 5 BAR 0 - 5 BAR
DryStack #4 Press 5 BAR 0 - 5 BAR
DryStack #5 Press 5 BAR 0 - 5 BAR
DownLoad Reactive 1
WashBox#1
99.5 °C
50.4 cm
WashBox#5
83.2 °C
WashBox#6
83.2 °C
Current
StyleCode: MTM 001
Recipe: Reactive
Batch Size: 13,500 m
Yarn Count: 7
Line Speed: 28.5 mete
Production
Drive Overview
Alarms
Batch Report
Dancer Positions
Trends
Batch Notes
Downtime Report
Home
WashBox#7
83.2 °C
WashBox#8
83.2 °C
DryStack3
4.2 BAR
DryStack4
4.2 BAR
DryStack5
4.2 BAR
Monday, March 31, 2003 1:25:13 PM


Spectrum Indigo Dye Range Entrance WashBoxes
morrison textile machinery co.
Alarms
Trends
By-Pass
Current Run
StyleCode: MTM 0001
Recipe: Reactive 1
Batch Size: 25,000 m
Yarn Count: 5
Line Speed: 28.5 meters/min.
Sulfur VAT
Reactive
LIC
Reduced Pressure Steam
TIC
Plant Water
FIC
to 3-1 Box #4
From Wash Box #1 Entrance
to Steamer
27.0°C
0.0 cm
Wash Box #1
27.0°C
Wash Box #2
27.0°C
0.0 cm
3-1 Box #3
77.7°C
28.0 cm
3-1 Box #4


Spectrum Indigo Dye Range Entrance WashBoxes
morrison textile machinery co.
By-Pass
Sulfur VAT
Reactive
Alarms
Trends
Current Run
StyleCod
Recip
Batch Siz
Yarn Cou
Line Spee
WashBox 4 Level_Reactive Indica...
Enhanced PID
Program:Process.WB4_LIC_Reactive
SP
PV
100
75
50
25
0
Mode:
Operator
Auto
Program
Operator
Cas/Rat
Auto
Manual
Detail...
Tune...
SP: 80.6931
PV: 80.693
0
50
100
CV: 80.693
Status: Ok
LIC
TIC
FIC
Redu
to 3-1 Box #4
Wash Box #1 Entrance
to Steamer
27.0°C
0.0 cm
Wash Box #1
27.0°C
Wash Box #2
27.0°C
0.0 cm
3-1 Box #3
77.7°C
28.0 cm
3-1 Box #4
1:23:43 PM Wash Box #1 Temperature (degC) Hi Temp


Spectrum Indigo Dye Range Entrance WashBoxes
Trending
3-1 Box #4 Temperature (degC)
3-1 Box #3 Temperature (degC)
Wash Box #2 Temperature (degC)
Wash Box #1 Temperature (degC)
Entrance Wash Boxes #1 - #4 Temperatures
Monday, March 31, 2003
1:30:21 PM
100.0
80.0
60.0
40.0
20.0
0.0
1:24:53 PM
1:25:17
1:25:41
1:26:05
1:26:29
1:26:53 PM
77.7
27.0
27.0
27.0
3-1 Box #4 Level (cm)
3-1 Box #3 Level (cm)
Wash Box #1 Level (cm)
Entrance Wash Boxes #1-#4 Levels
Monday, March 31, 2003
1:30:21 PM
73.7
59.0
44.2
29.5
14.7
0.0
1:25:51 PM
1:25:57
1:26:02
1:26:08
1:26:13
1:26:18 PM
28.0
???
???
Reactive
LIC
to Steamer
27.0°C
cm
27.0°C
27.0°C
cm
77.7°C
28.0cm
Wash Box #1
Wash Box #2
3-1 Box #3
3-1 Box #4


go Dye Range Dye Boxes #5 thru #12
Active Recipe is: Indigo
Spectrum Indigo Dye Range Recirculation Pump AC Drive Parameters
Ramp Rates | Load Limits | Stop/Brake Modes | Restart Modes | PowerLoss | Dir Config | HIMRefConfig | MopConfig | DriveMemory | DiagNostics
Faults | Alarms | CommContrl | Masks/Owners | DataLinks | AnalogIns | AnalogOuts | DiscreteIns | DiscreteOuts | DeviceNet | Demo
Metering | DriveData | MotorData | TorqueAttributes | Volts per Hz | Speed Mode | Speed Refs | DiscreteSpeeds | SpeedTrim | SLipComp | Process PI
Metering
Parameter #1 Output Frequency
Parameter #2 Command Frequency
Parameter #3 Output Current
Parameter #4 Torque Current
Parameter #5 Flux Current
Parameter #6 Output Voltage
Parameter #7 Output Power
Parameter #8 OutPut Power Factor
Parameter #9 Elapsed MWh
Parameter #10 Elapsed RunTime
Parameter #11 MOP Frequency
Parameter #12 DC Bus Voltage
Parameter #13 DC Bus Memory
Parameter #16 AnalogInput 1 value
Parameter #17 AnalogInput 2 value
Parameter Management
Enter Parameter Number
Enter ParameterValue
Write New Value
Read PowerFlex Parameters
0.00
Alarms
Trends
Speed %
100
80
50
20
0
0.0rpm
DyeBox#1
90.5°C
FIC
LIC
TIC
To Wash Box #13
ReCircPump
1:31:19 PM 3-1 Box #4 Temperature (degC) Hi Temp

Spectrum Indigo Dye Range

Indigo Dye Range Drives Overview

Drive Name	HP	Amps	Rated RPM	Actual RPM	Drive Status
Wash Box #1	7.5	9.0	1750	1240	OK
Wash Box #2	10	12.9	1750	1725	OK
3-1 Box #3	7.5	9.0	1750	1589	motor thermostat trip
3-1 Box #4	5.0	7.0	1750	1666	OK
Dry Stack #1	1.0	1.3	1750	1750	OK
Dry Stack #2	7.5	9.0	1750	1750	motor overcurrent
Steamer	3.0	3.6	1750	1435	OK
Dye Box #5	7.5	9.0	1750	1767	OK
Dye Box #6	3.0	3.6	1750	1732	OK
Dye Box #7	7.5	9.0	1750	1200	OK
Dye Box #8	7.5	9.0	1750	1899	OK
Dye Box #9	5.0	7.0	1750	1344	OK
Dye Box #10	1.5	2.0	1750	1500	OK
Dye Box #11	7.5	9.0	1750	1599	OK
Dye Box #12	7.5	9.0	1750	1676	OK
Wash Box #13	10	12.9	1750	1568	OK
Wash Box #14	10	12.9	1750	1687	OK
Wash Box #15	10	12.9	1750	1750	OK
Wash Box #16	5.0	7.0	1750	1750	OK
Dry Stack #3	1.5	2.0	1750	1758	OK
Dry Stack #4	7.5	9.0	1750	1597	OK
Dry Stack #5	7.5	9.0	1750	1766	OK

Drive Speed Trends | Alarms | Alarm History

morrison textile machinery co.

WashBox#1 WashBox DyeBox#6 DyeBox#7 DyeBox#8 WashBox#5 WashBox#6
91.5°C 90.5°C 90.5°C 90.0°C
55.1 cm 46.3 cm 44.2 cm 75.0 cm

Current Run
StyleCode: MTM 0019
Recipe: Indigo
Batch Size: 30,500 m
Yarn Count: 5
Line Speed: 28.5 meters/min.

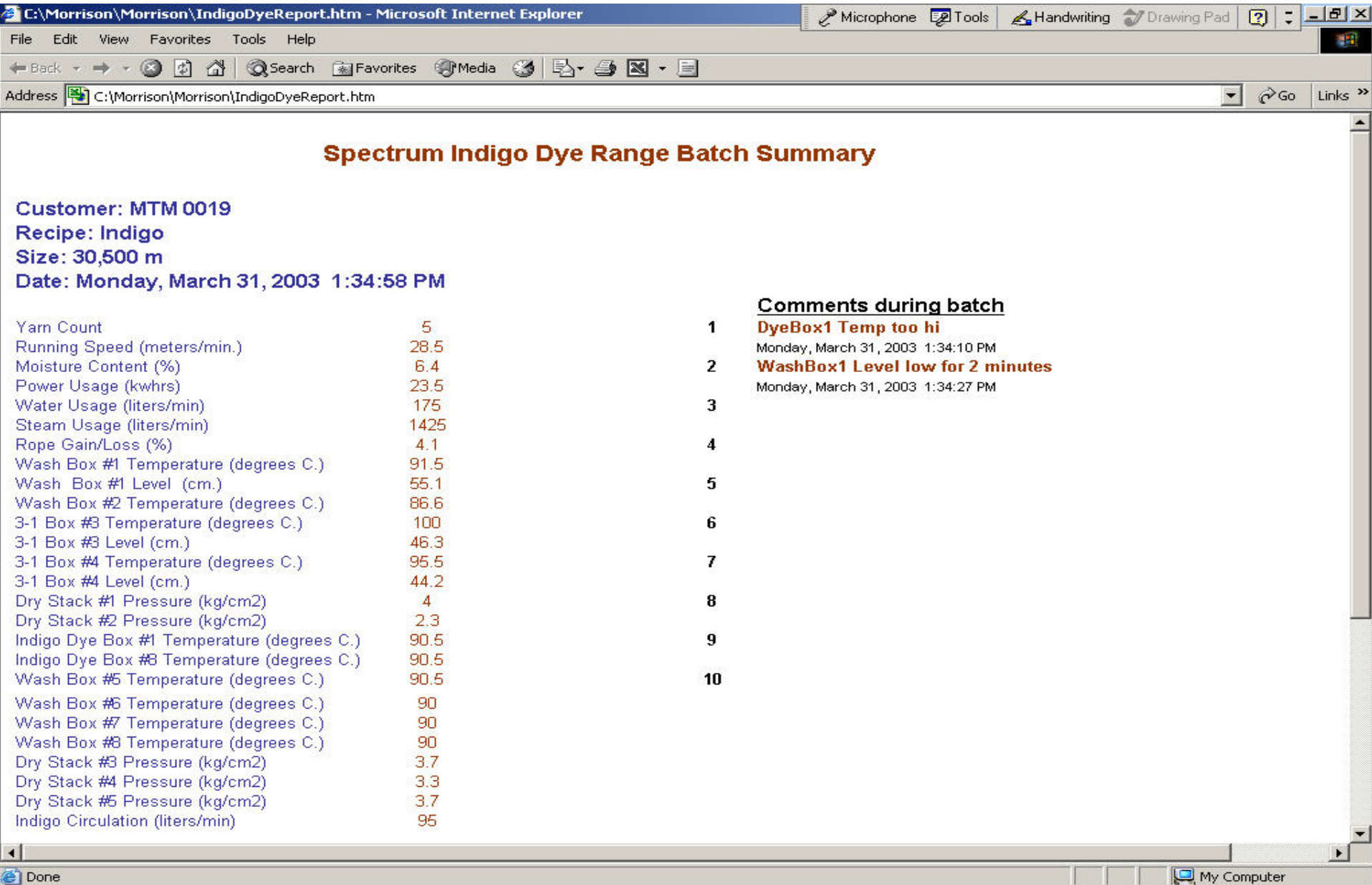
Production | Drive Overview | Alarms
Batch Report | Dancer Positions | Trends
Batch Notes | Downtime Report | Home

WashBox#7 WashBox#8 DryStack3 DryStack4 DryStack5
90.0°C 90.0°C 4.2 BAR 4.2 BAR 4.2 BAR

Exit Moisture
6.4%

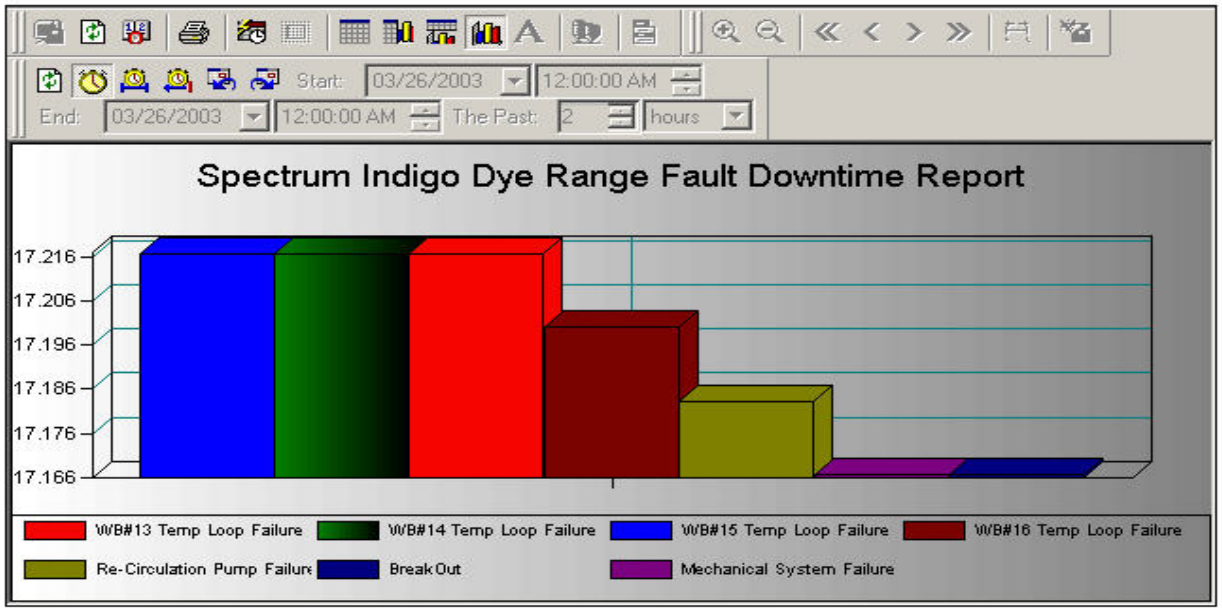
Monday, March 31, 2003 1:35:45 PM

WEB Based Reports



Reports can be show on the plant Email system

Morrison Textile ITMA 2003



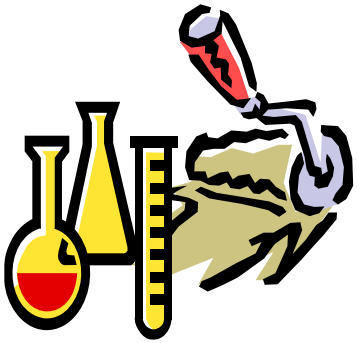
StyleCode: MTM 0019
Recipe: Indigo
Batch Size: 30,500 m
Yarn Count: 5
Line Speed: 28.5 meters/min.

Production | Drive Overview | Alarms
Batch Report | Dancer Positions | Trends
Batch Notes | Downtime Report | Home

WashBox#7 90.0°C
WashBox#8 90.0°C
DryStack3 4.2 BAR
DryStack4 4.2 BAR
DryStack5 4.2 BAR
Exit Moisture 6.4%
WashBox#6 90.0°C

Monday, March 31, 2003 1:37:25 PM

Case No. 3 — *ColorWorks Process Automation*



Dyeing

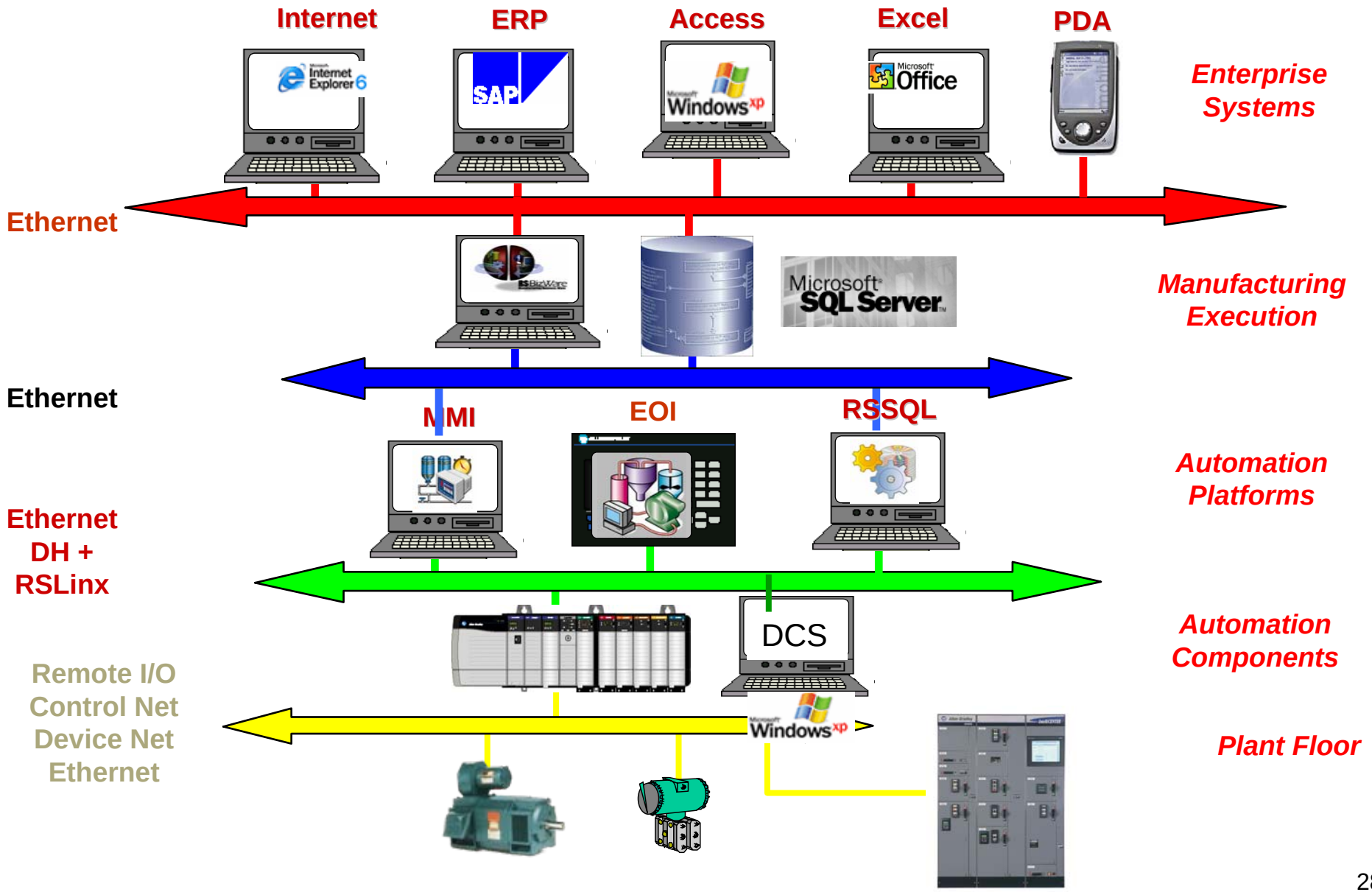
System Highlights:

- **Flexible** system able to accommodate all **new dyeing technology**
- Able to communicate with existing control systems and equipment
- Data collection
- Process monitoring
- Friendly system easy to expand and configure
- Low cost

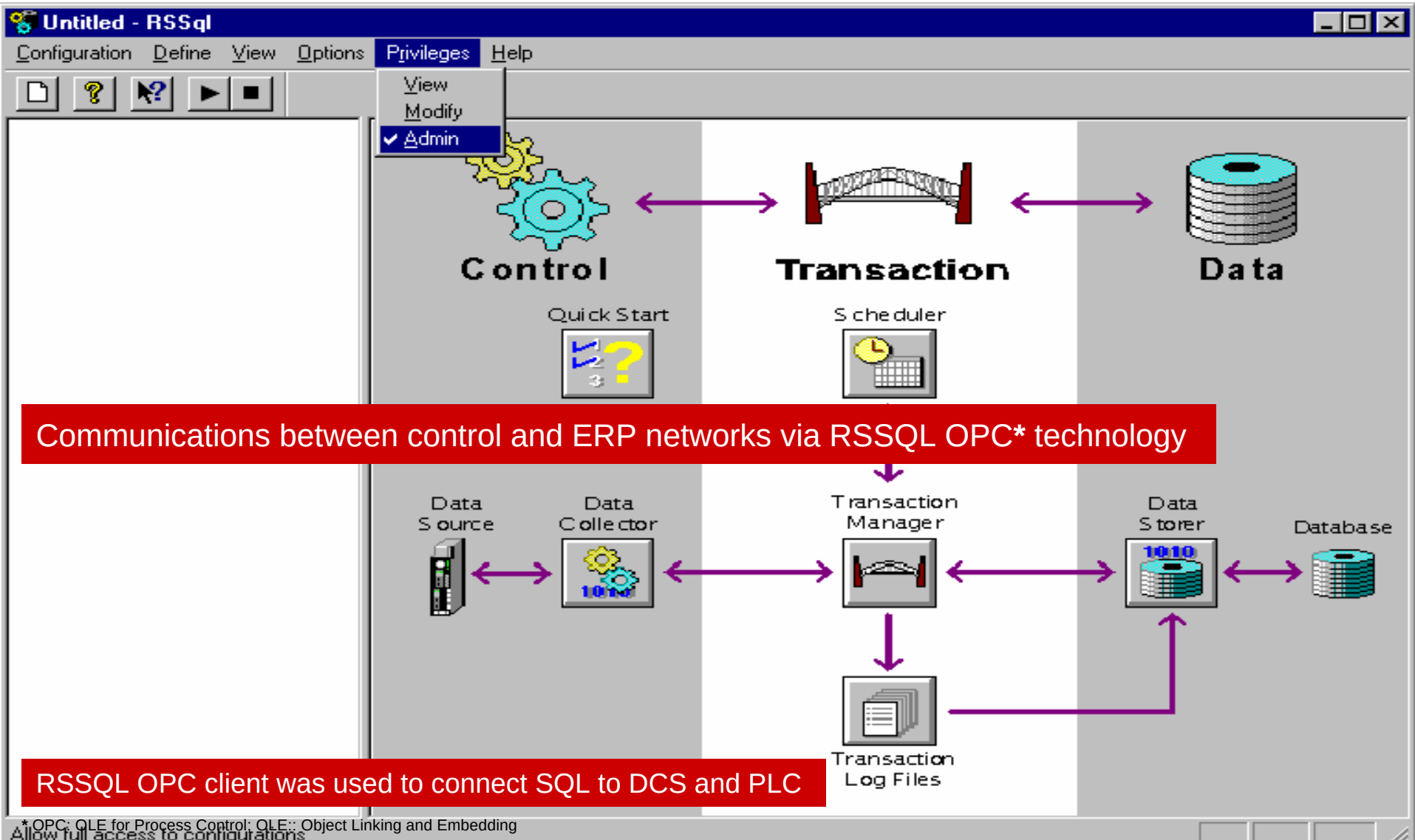
Process Benefits:

- Reduced process variation
- Increased efficiency
- Reduced process waste and rework
- Cost savings
- Process capable for all products

Enterprise / Control Integration

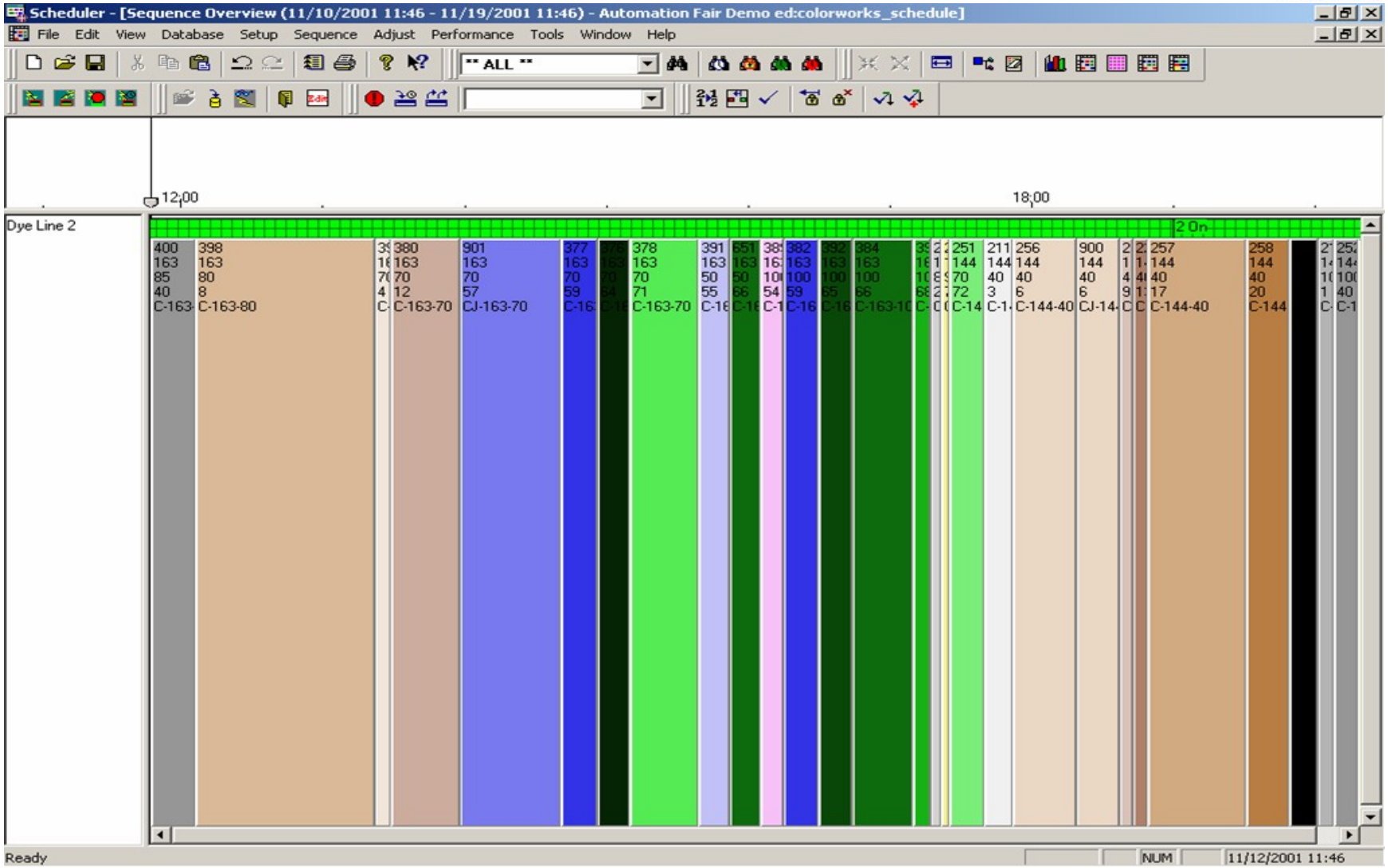


Data Exchange System View



* OPC: OLE for Process Control; OLE:: Object Linking and Embedding

Scheduler


Scheduler - [Sequence Overview (11/10/2001 11:46 - 11/19/2001 11:46) - Automation Fair Demo ed:colorworks_schedule]
File Edit View Database Setup Sequence Adjust Performance Tools Window Help
** ALL **
12:00
18:00
Dye Line 2
2 On
C-163-80
C-163-70
CJ-163-70
C-144-40
CJ-14
C-144-40
C-144
Ready
NUM
11/12/2001 11:46

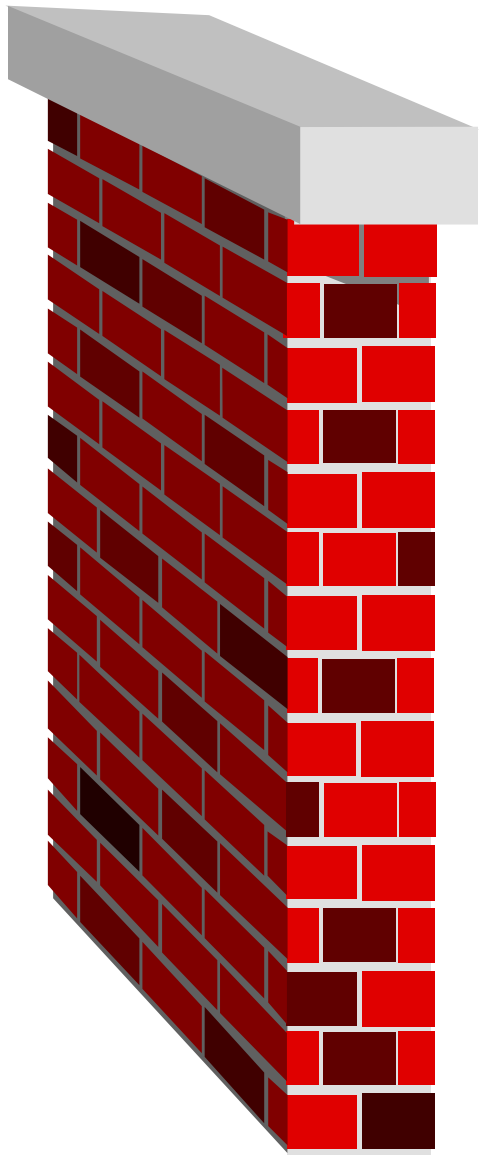
Enterprise / Control Integration

IT Culture

ERP

Planning and Scheduling

Inventory Control



Process Culture

Setpoints, Limits

Supervisory Control

Control

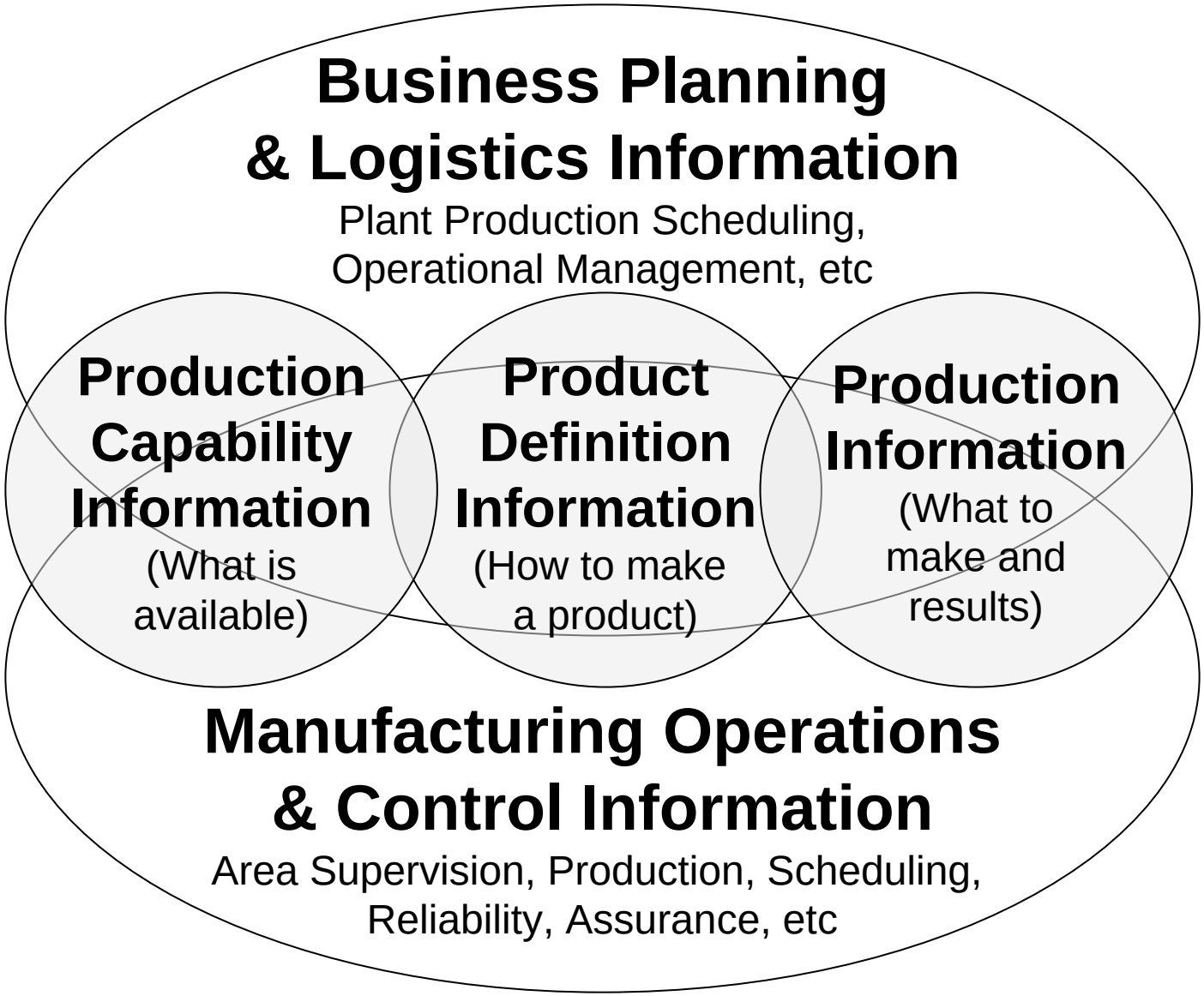
Analog, Digital Signals

What is S 95?

- A committee organized by ISA
- Members from end users, vendors, integrators and consultants
  - Dupont, Eli-Lilly, Hewlett-Packard, Dow Corning, Union Carbide, Lyondell Chemical, Honeywell, Bailey, Fisher Rosemont, Intellution, ABB, SAP, Moore, Yokogawa, OSI Software, Sequencia, Rockwell Automation
  - AMR, PriceWaterhouseCoopers
- Chartered with developing a standard for Enterprise System to Control System Integration

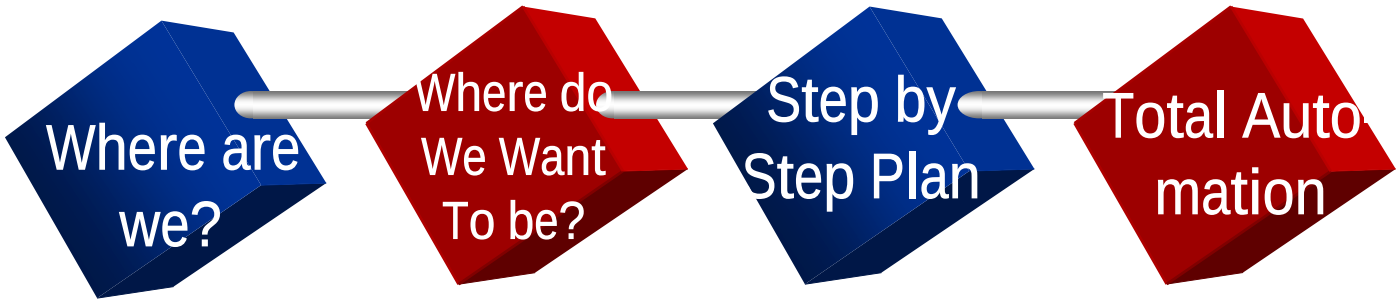
- ISA.ORG

S95 Three Categories of Information



Block Diagram Sample

- y



Where are we now in Total Automation	Where do we want to be in 5 Years?	Adopt a step by step approach one project at a time	If you do not have a plan for Automation you will never achieve your goal

The no. 1 result of automation

Is repeatable, higher quality

Have a plan for automation

and apply it on every project