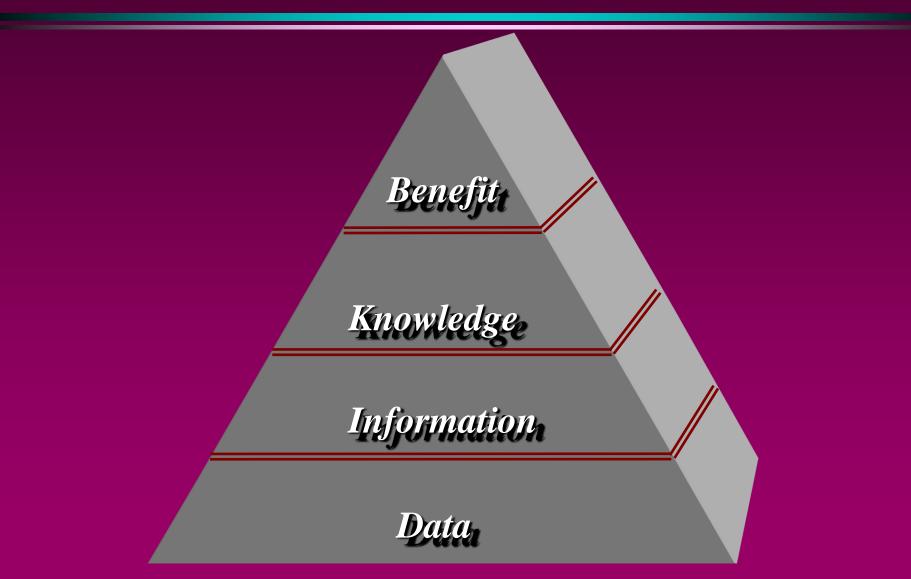
The Application of Process Monitoring and Key Performance Index in Polyethylene Plant

International Innotech, Inc. Ricky Hsu *Inspiration System, Inc.* Jialin Liu, M. F. Yau

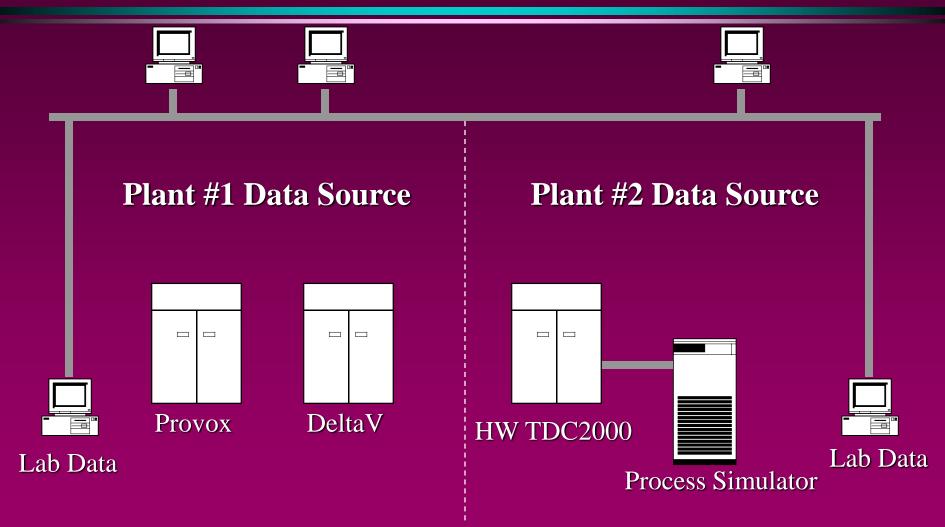
How to Make Your Data Valuable?



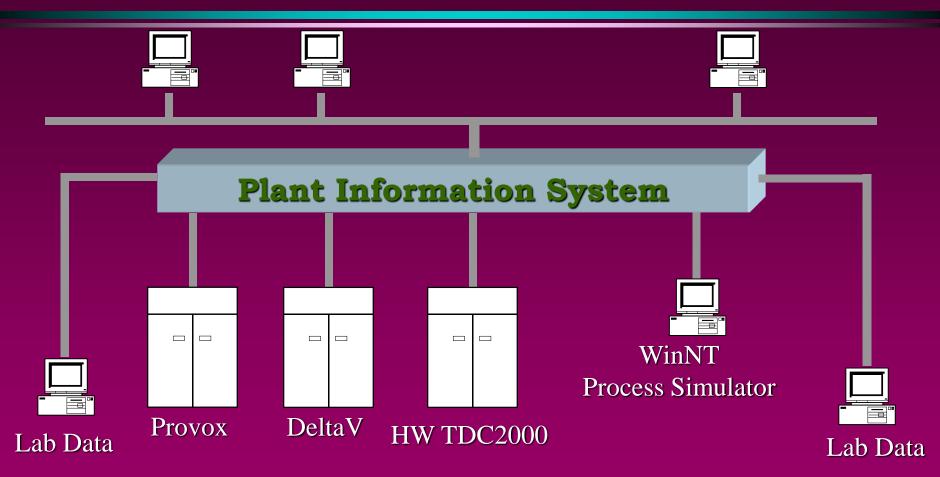
Introduction

- Implement Process Data Infrastructure
 - □ Integrated HW TDC2000、 Fisher Provox and DeltaV
 - □ Link Lab QC data
 - □ Compile the process simulator
- Process Monitoring System
 - Statistical Process Control
 - Multivariate Statistical Process Control
 - □ Computerize Operator Experience
- Key Performance Index
 - Production Performance Index
 - Operation Performance Index
 - Equipment Performance Index

Platform Backbone (Before)



Platform Backbone (Now)



Process Monitoring System

Statistical Process Control

- □ Why Do We Need SPC
- Cause Effect Diagram, Fishbone Diagram
- □ Set up XB/Range control limit
- □ On line monitoring
- □ Off line analysis

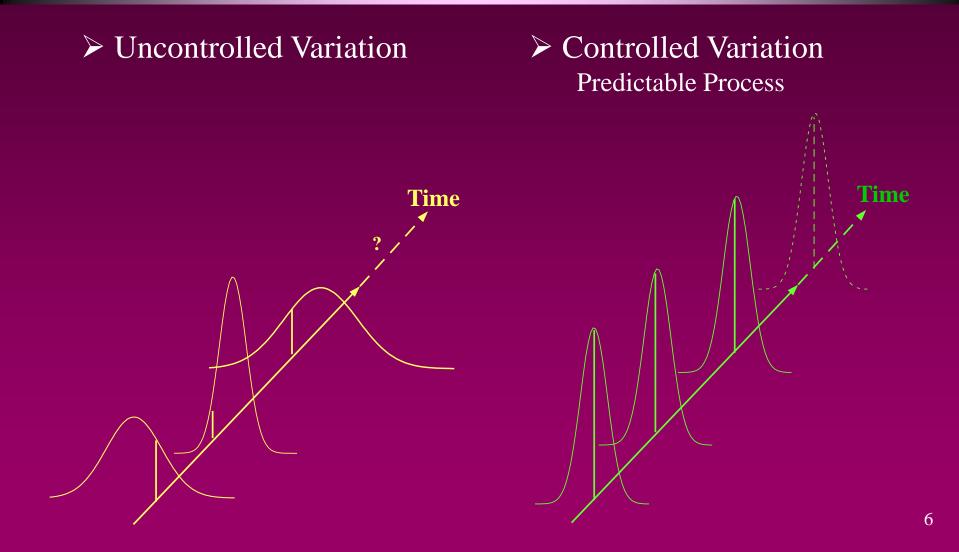
Multivariate Statistical Process Control

- □ Why Do We Need MSPC
- □ Set up PCA control limit
- □ On line monitoring
- □ Contribution plot

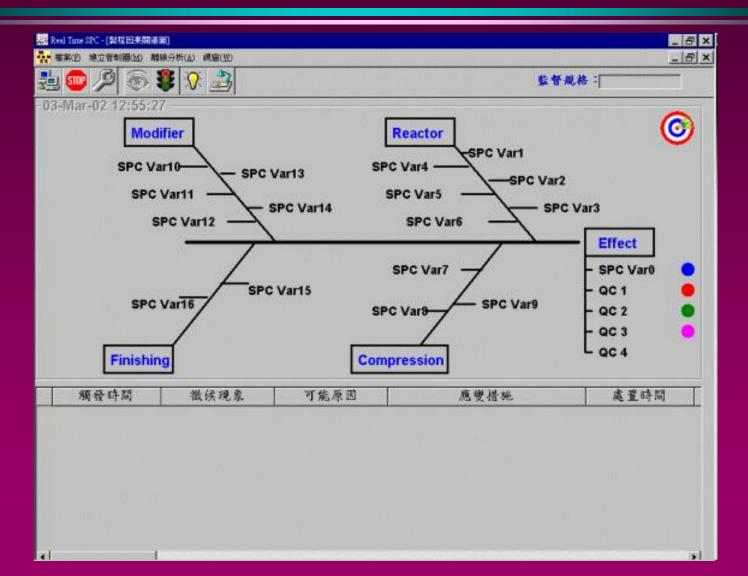
Computerize Operator Experience

- □ If Then architecture
- □ Recording symptom and trigger time
- Display predefined SOP

Process Variation



Overview - Cause Effect Diagram



Set Up Control Limit

🚜 Real Time SPC - [C	ff-Line Modelling]									_ 8 ×
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管制上限	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
平均值	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
管制下限	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
規格下限										
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操作範圍	SPC Var0	SPC Var1	PC Var	SPC Var3	SPC Var4	SPC Var5	SPC Var6	SPC Var7	PC Va	SPC
管制上限	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
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管制下限	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.

Control Limit Management

📩 Define Resine Typ	e Spec.					_	
Resin Type	管制模式	SPCVar1.USL	SPCVar1.LSL	SPCVar2.USL	SPCVar2.LSL	SPCVar3.USL	SP_
Type01	Type01.spc	1	-1	1	-1	1	
Type02	Type02.spc	2	-2	2	-2	2	
Type03	Type03.spc	3	-3	3	-3	3	
Type04	Type04.spc	4	-4	4	-4	4	
Type05	Type05.spc	5	-5	5	-5	5	
Type06	Type06.spc	6	-6	6	-6	6	
Type07	Type07.spc	7	-7	7	-7	7	
Type08	Type08.spc	8	-8	8	-8	8	
Type09	Type09.spc	9	-9	9	-9	9	
Type10	Type10.spc	10	-10	10	-10	10	
Type11	Type11.spc	11	-11	11	-11	11	
Type12	Type12.spc	12	-12	12	-12	12	
Type13	Type13.spc	13	-13	13	-13	13	
Type14	Type14.spc	14	-14	14	-14	14	
Type15	Type15.spc	15	-15	15	-15	15	
Type16	Type16.spc	16	-16	16	-16	16	
Type17	Type17.spc	17	-17	17	-17	17	
Type18	Type18.spc	18	-18	18	-18	18	
Type19	Type19.spc	19	-19	19	-19	19	
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On Line Monitoring (XB/Range)

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2001/6/13 13:43:28 每分鐘平均值大於管制上展			可能原因	處理程序	處理時間	
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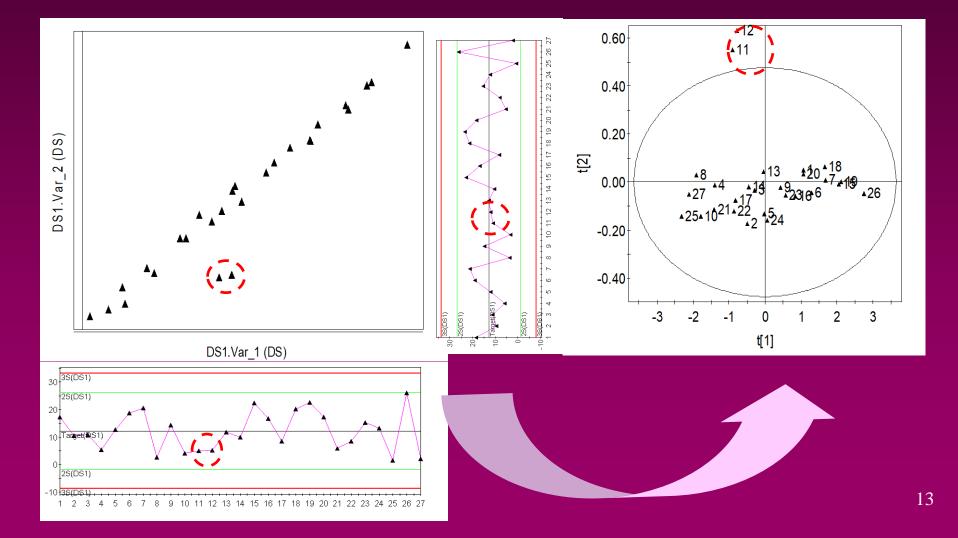
Offline Analysis

	Real Time SPC - [TIC-605C] 檔案(F) 建立管制图(M) 離線分析(A) 親窗(M)											5 ×
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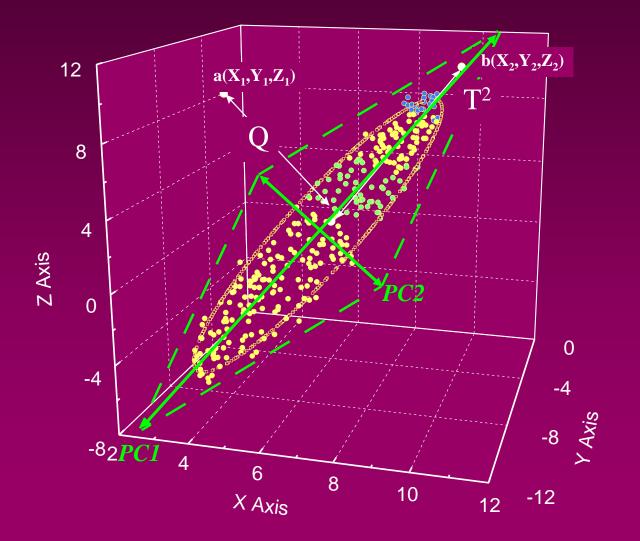
SPC Summary

				Plant No.1 SPC Daily Summary	×
				Date: 2001/3/27 ; Alarm Trigger: SPC Varl	
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		ୁକ୍କ୍ <u>ଲ୍ଲ୍</u> 100% <u>କ୍</u> ଲ୍ଲ୍ ≊ � [a = ଘରସ ⊝ M :			
Rule 1:		請選擇日期	: 🗲 2001/3/27		
Rule 2			Alarm Trigger %		
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執行時間	First Shift (08:00~16:00)	Second Shift (16:00~24:00)	Third Shift (00:00~08:00 8 Hr 0 Min		
积打时间	7 Hr 55 Min	8 Hr 0 Min			
違反規則					
Rule 1	7 Hr 50 Min	7 Hr 55 Min	7 Hr 55 Min		
Rule 2	0 Hr 0 Min	0 Hr 0 Min	0 Hr 0 Min		
Rule 3	0 Hr 0 Min	0 Hr 0 Min	0 Hr 0 Min	27-Mar-01 08:00:00 ~ 27-Mar-01 09:00:00 Alarm Triggered : 00:00 % 27-Mar-01 09:00:00 ~ 27-Mar-01 10:00:00 Alarm Triggered : 41.67 %	÷
Rule 4	7 Hr 50 Min	7 Hr 55 Min	7 Hr 55 Min	27-Mar-01 10:00:00 ~ 27-Mar-01 11:00:00 Alarm Triggered : 100.00 % 27-Mar-01 11:00:00 ~ 27-Mar-01 12:00:00 Alarm Triggered : 100.00 %	
Rule 5	4 Hr 35 Min	0 Hr 10 Min	0 Hr 0 Min	27-Mar-01 12:00:00 ~ 27-Mar-01 13:00:00 Alarm Triggered : 100:00 %	
				27-Mar-01 13:00:00 ~ 27-Mar-01 14:00:00 Alarm Triggered : 86.67 % 27-Mar-01 14:00:00 ~ 27-Mar-01 15:00:00 Alarm Triggered : 36.67 %	
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SPC Var3	7 Hr 29 Min	4 Hr 28 Min	0 Hr 0 Min		
SPC Var4	8 Hr 0 Min	8 Hr 0 Min	8 Hr 0 Min		
SPC Var5					
SIC VAIS	8 Hr 0 Min	8 Hr 0 Min	8 Hr 0 Min		12
Ready					

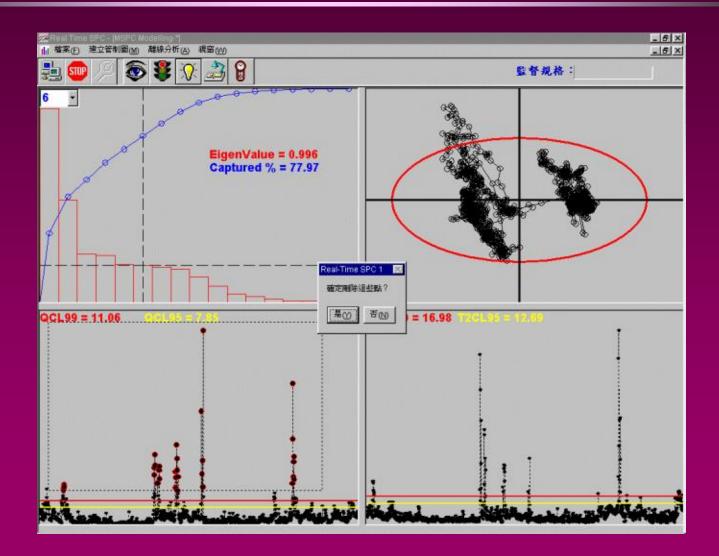
Why Do We Need MSPC?



Principal Component Analysis



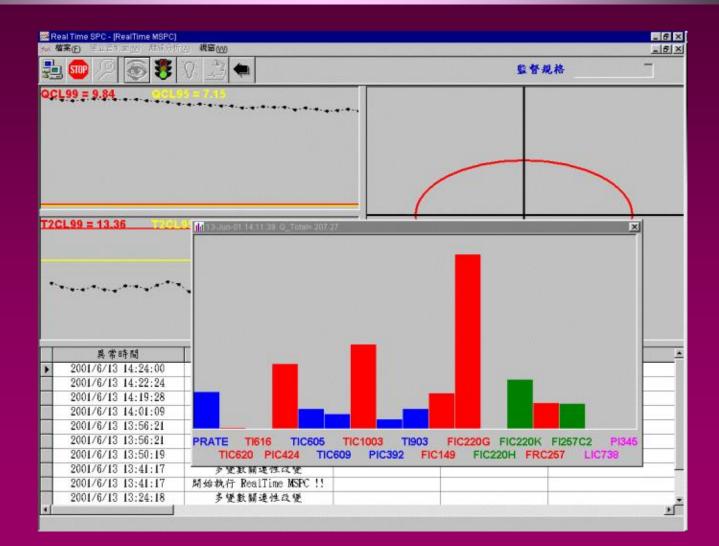
Set Up MSPC Control Limit



Real Time MSPC

	eal Time SPC - [RealTime MSPC] 會案(F) 三立立制度(2) 用級分析	720 親寄(00)				_ 6 ×
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•	2001/6/13 14:24:00 2001/6/13 14:22:24 2001/6/13 14:19:28 2001/6/13 14:01:09 2001/6/13 13:56:21 2001/6/13 13:56:21 2001/6/13 13:50:19 2001/6/13 13:41:17	開始執行 RealTime MSPC !! 暫時停止 RealTime MSPC !! 暫時停止 RealTime MSPC !! 暫時停止 RealTime MSPC !! 多望數關連性改變 開始執行 RealTime MSPC !! 暫時停止 RealTime MSPC !! 多望數關連性改變	**,	處理程序	處理時間	

Contribution Plot



Computerize Operator Experience

For Example: If (cooling water outlet temperature less than 55 degC) Then (step 1... step 2... :)

Trigger Time	Symptom	Possible Cause	Standard Operated Procedure	
觸發時間	徵候現象	可能原因	應變措施	\square
	最末 Cooler 出口水溫小別		1) 定期沖洗水側汙泥物 2) 熱交換器酸洗或	
2001/6/13 13:49:41	第一個 Cooler 進出氣體※	HX1 Fouling	1) 若 Recycle Cooler正常Fouling,則轉換備用	

Key Performance Index

- Production Performance Index
 - D Productivity Index
 - □ Raw Material Index
 - □ Utility Index
 - Production Rate Analysis
- Operation Performance Index
 - □ Real Time ISO Spec Monitoring
 - □ ISO Daily Report
 - □ Integrated ISO & SPC
- Equipment Performance Index
 - □ Critical Equipment Operated Time
 - □ Compressor Performance
 - Heat Exchanger Performance

Productivity Index

Raw Material Index / Standard Consumption

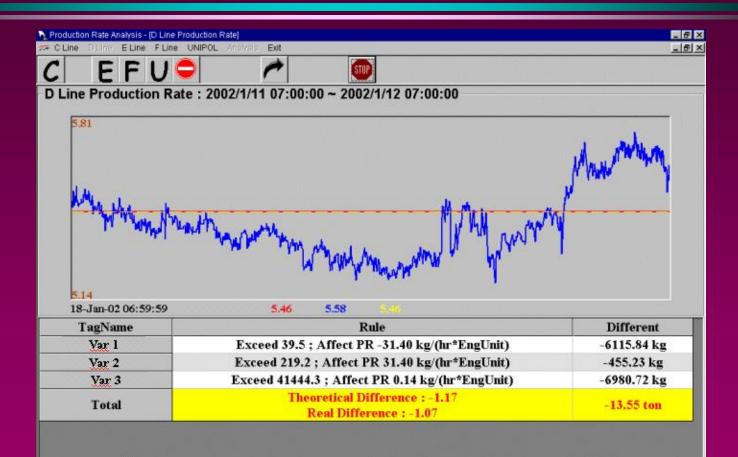
Raw Material Index / Unit Cost

KPI Daily Report

Production Rate Analysis Tool

	ate Analysis - (Productio Jine E Line F Line	UNIPOL AND						
CD	EFUS	2		STOP				
2002/1/	11 07:00:00	~ 2002/1	12 07:00:00					
First Sh	nift		Second Shift		h	Third Shift		
		14	3 %		146 %			147 %
99 %	99 % 96 %	96 %	98 % 97 %	6		98 % 101	⁹⁶ % 97	%
	20 /8	30 /0		93 %	94 %			
	First Shift		Second Shift		Third Shift		Total	
	First Shift Production	Target	Second Shift Production	Target	Third Shift Production	Target	Total Production	Target
C Line		Target 20		Target 20		Target 20		Target 20
	Production		Production		Production		Production	
) Line	Production 10	20	Production 10	20	Production 10	20	Production 10	20
C Line D Line E Line	Production 10 20	20 30	Production 10 20	20 30	Production 10 20	20 30	Production 10 20	20 30

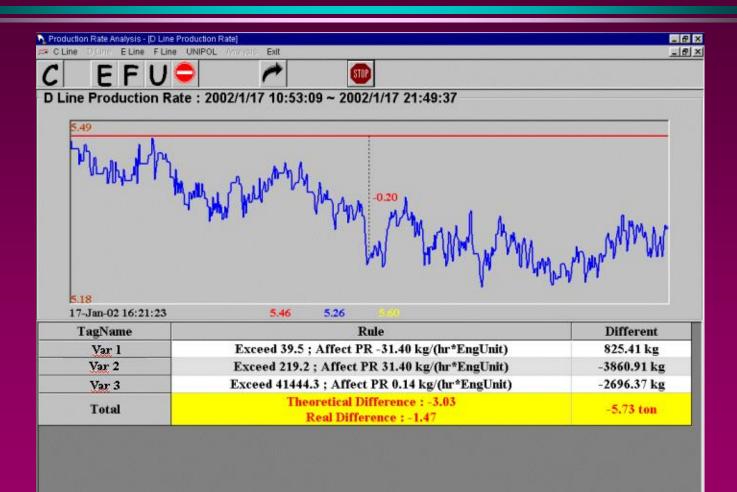
Calculated and Standard Production Rate



Selected Time Range for Analyzing



First Level Effect



Second Level Effect



Key Performance Index

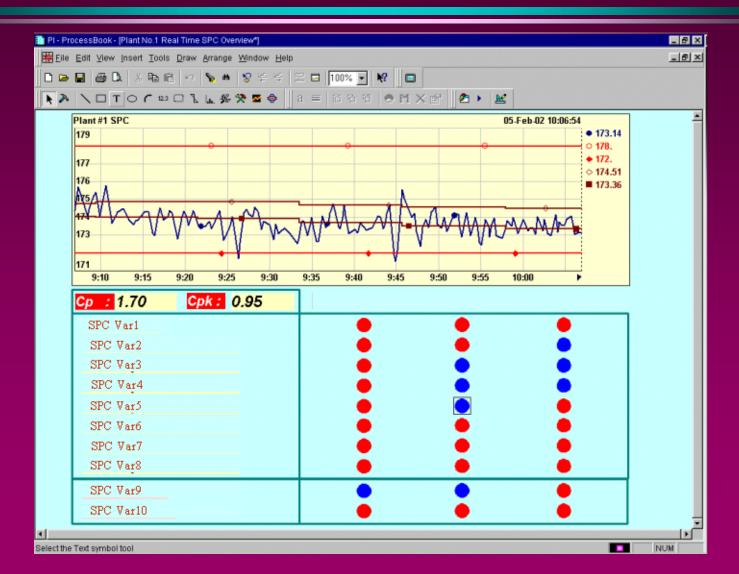
- Production Performance Index
 - Productivity Index
 - □ Raw Material Index
 - □ Utility Index
 - Production Rate Analysis

Operation Performance Index

- □ **Real Time ISO Spec Monitoring**
- □ ISO Daily Report
- □ Integrated ISO & SPC
- Equipment Performance Index
 - Critical Equipment Operated Time
 - □ Compressor Performance
 - Heat Exchanger Performance

Real Time ISO Spec Monitoring

Real-Time SPC for Operator

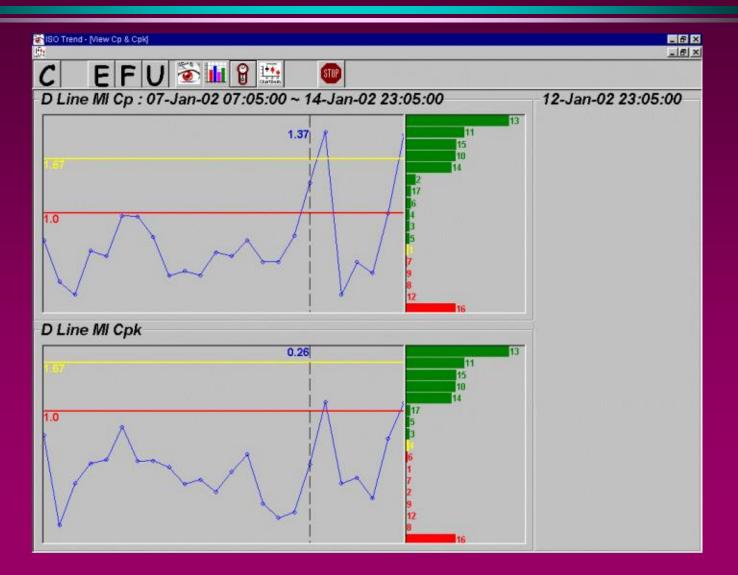


ISO Daily Report

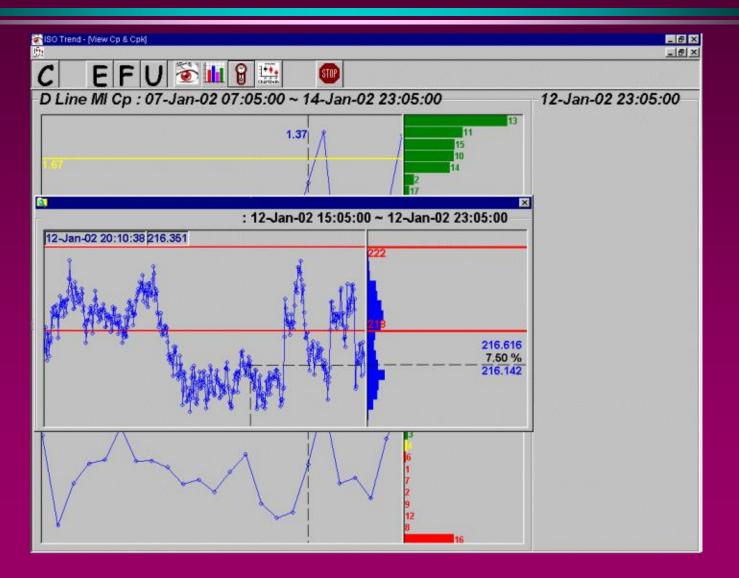
Integrated ISO & SPC

🛐 ISO Trend - [C Lin	ie : Off Line Analysis]		
*				
DE	FU	🏨 💽	ST Charthen	
Demo Tag			cumer	Off Lin
03-Mar-02		ر ۱:	374.627	2240.000
03-Mar-02	12:51:09		3-Mar-02 13:51	
	harrow harrow h		,	
1				
2100.000	700.000			546.000
TagName	Descriptor	Upper Spec	Lower Spec	Current Value
Demo Tag	For Demo	750.000	250.000	160.520
Demo Tag	For Demo	2100.000	700.000	1374.627
Demo Tag	For Demo	225.000	75.000	155.944
Demo Tag	For Demo	225.000	75.000	148.794
Demo Tag	For Demo	225.000	75.000	153.919
Demo Tag	For Demo	225.000	75.000	150.451
Demo Tag	For Demo	225.000	75.000	151.281
Demo Tag	For Demo	225.000	75.000	144.680
Demo Tag	For Demo	300.000	100.000	197.001
Demo Tag	For Demo	112.500	37.500	73.830
Demo Tag	For Demo	112.500	37.500	73.587
Demo Tag	For Demo	150.000	50.000	99.040
Demo Tag	For Demo	300.000	100.000	199.777

Analyzing Process Capacity



Analyzing Process Capacity

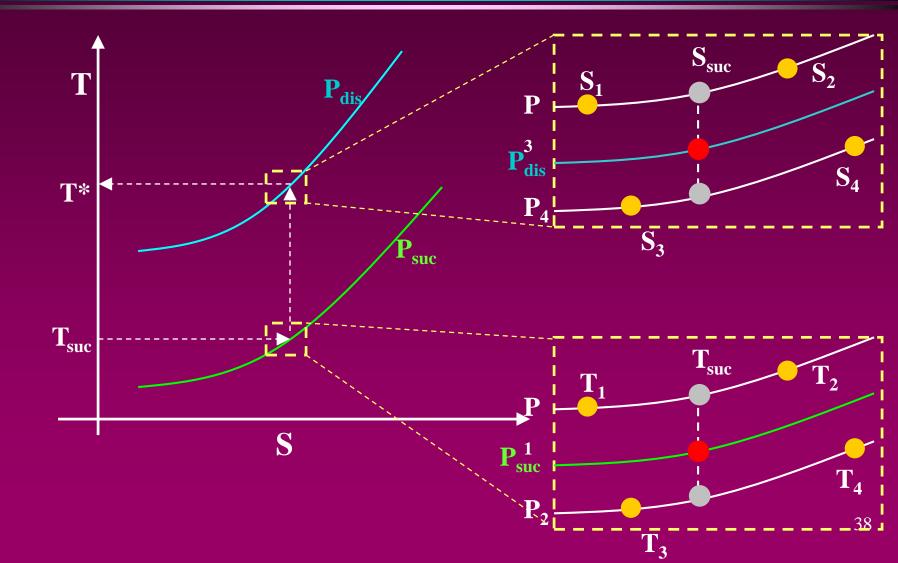


Key Performance Index

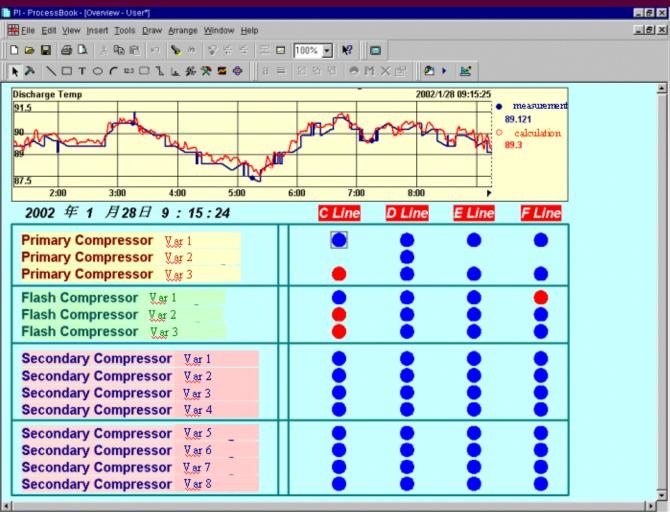
- Production Performance Index
 - Productivity Index
 - □ Raw Material Index
 - □ Utility Index
 - Production Rate Analysis
- Operation Performance Index
 - □ Real Time ISO Spec Monitoring
 - □ ISO Daily Report
 - □ Integrated ISO & SPC
- **Equipment Performance Index**
 - **Critical Equipment Operated Time**
 - Compressor Performance
 - Heat Exchanger Performance

Critical Equipment Operated Time

Adiabatic & Reversible Process



Compressor Performance Display



Calibrating Bias

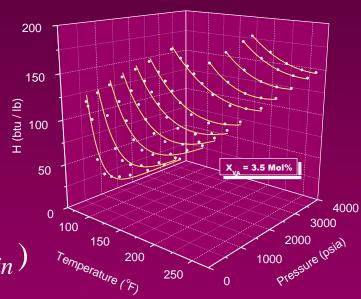
Heat Transfer Coefficient

Reactant Stream Temperature Known

 $q = UA(LMTD) = (H_{C2,out} - H_{C2,in})$

$$UA = \frac{(H_{C2,out} - H_{C2,in})}{(LMTD)}$$

Cooling Water Temperature Known $q = UA(LMTD) = (H_{Water,out} - H_{Water,in})$ $UA = \frac{(H_{Water,out} - H_{Water,in})}{(LMTD)}$



Heat Exchanger Performance

Summary

- Data infrastructure provide the powerful management tool for supervisor.
- Operator have to concern not only "Safety Alarm", but also "Quality Alarm".
- When the performance can be defined and evaluated, there is some way to control it.

Any Question ?