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(54) SUITE OF CONFIGURABLE SUPPLY CHAIN INFRASTRUCTURE MODULES FOR DEPLOYING COLLABORATIVE E-MANUFACTURING SOLUTIONS

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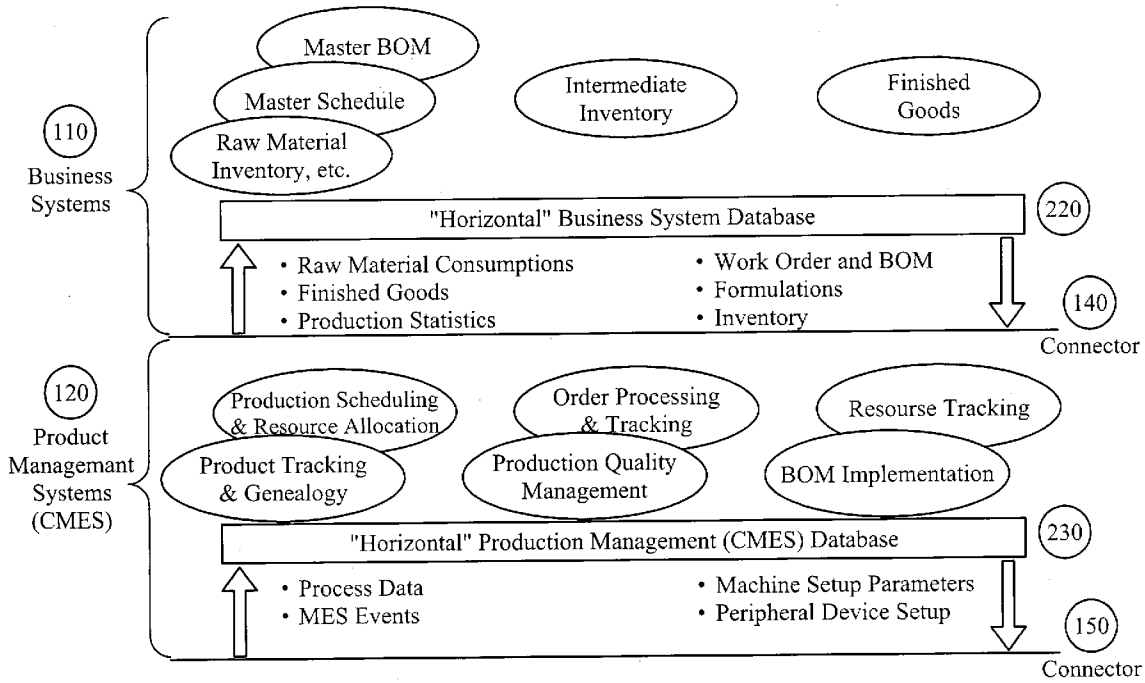
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(51) **Int. Cl.**[7] **G06F 17/60**

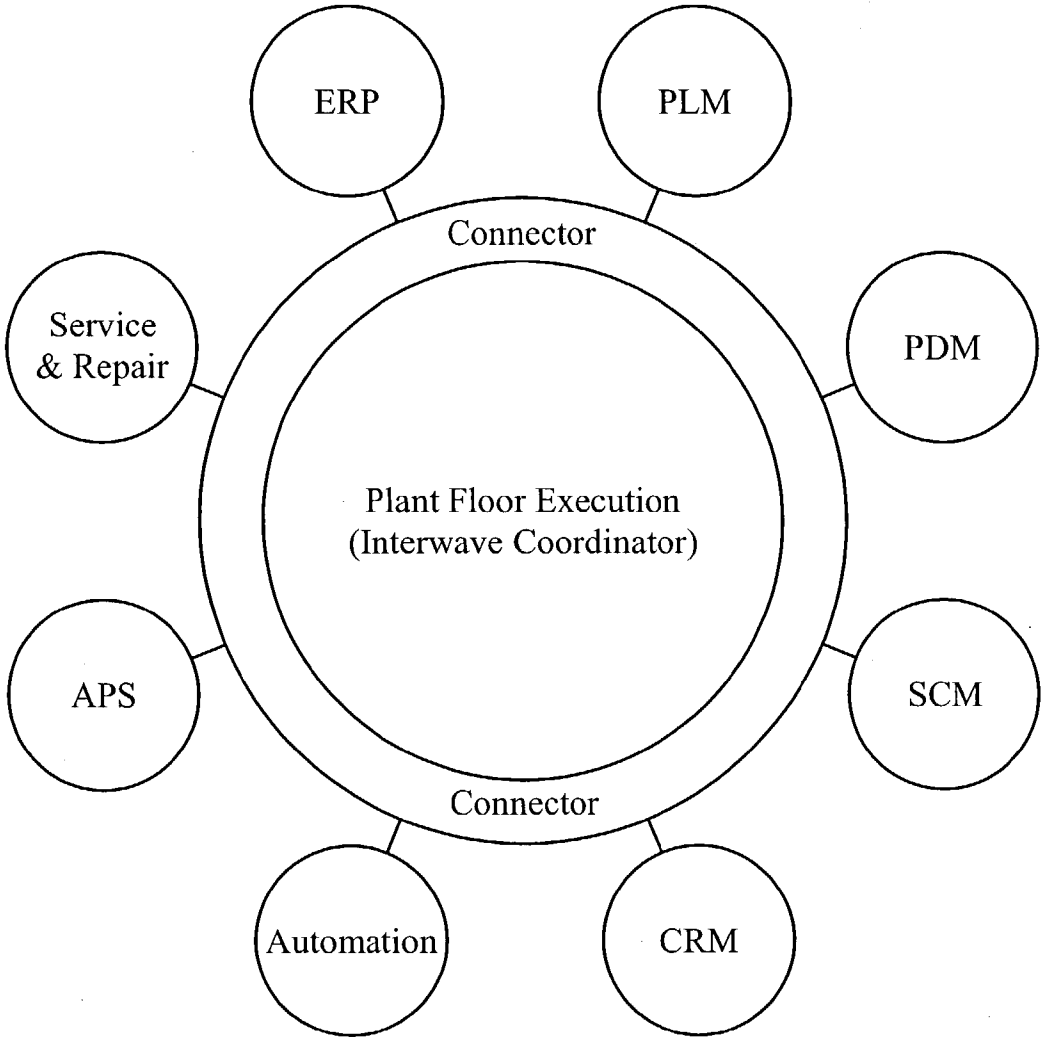
(52) **U.S. Cl.** **705/8**; 700/99

(57) **ABSTRACT**

A suite of configurable supply chain infrastructure modules provides the "collective manufacturing management infrastructure" necessary to support a high velocity e-business initiative. At the core of the collaboration scheme is the Business Process Modeling Module. The Business Modeling Module consists of two components: Business Process Event Coordinator, and Business Process Modeler. To further support the collaborative scheme, a suite of highly configurable application templates and pre-configured industry applications provide an interface or wrapper around the business rules. The application templates are designed to be used as stand-alone components, or can be assembled/configured into a cohesive solution to provide a basic foundation layer for a Collaborative Manufacturing Execution System (CMES). To address the connectivity of the CMES layer to the business layer and the shop floor automation layer, an Extensible Markup Language (XML) Business Connector and Optical Photo Conductor (OPC) Shop Floor Connector fulfill the interface needs required to support a collaborative infrastructure.



Manufacturing Information System Architecture



Legend:
ERP - Enterprise Resource Planning
PLM - Product Life Cycle Management
PDM - Product Data Management
SCM - Supply Chain Management
CRM - Customer Relations Management
Automation - PLC, DCS, etc.
APS - Advanced Planning & Scheduling

Fig. 1

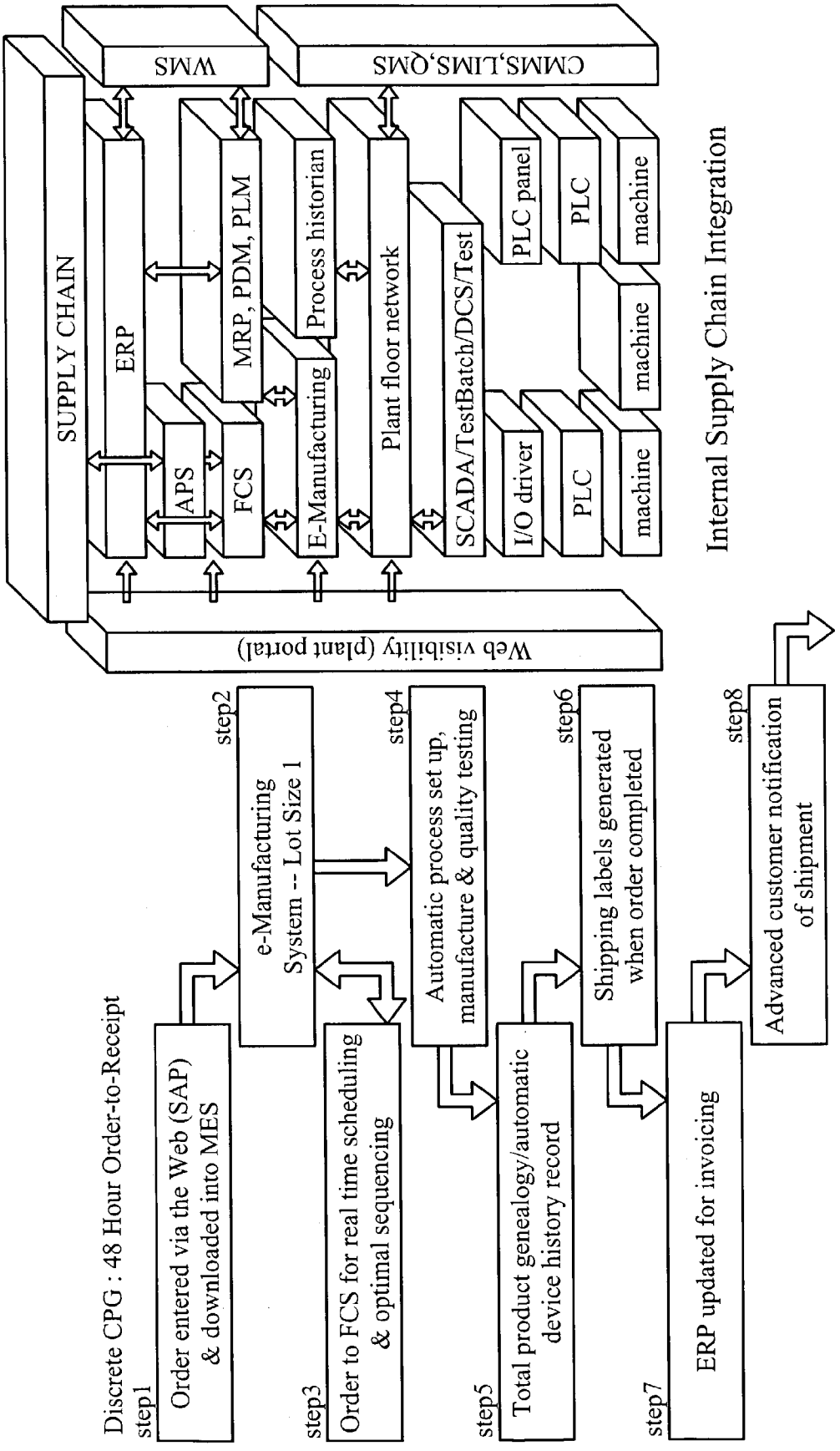

Internal Supply Chain Integration
SUPPLY CHAIN
ERP
APS
FCS
MRP, PDM, PLM
E-Manufacturing
Process historian
Plant floor network
SCADA/TestBatch/DCS/Test
I/O driver
PLC
machine
PLC panel
PLC
machine
machine
WMS
CMMS,LIMS,QMS
Web visibility (plant portal)
Discrete CPG : 48 Hour Order-to-Receipt
step1
Order entered via the Web (SAP) & downloaded into MES
step2
e-Manufacturing System -- Lot Size 1
step3
Order to FCS for real time scheduling & optimal sequencing
step4
Automatic process set up, manufacture & quality testing
step5
Total product genealogy/automatic device history record
step6
Shipping labels generated when order completed
step7
ERP updated for invoicing
step8
Advanced customer notification of shipment
Shipping via overnight from plant- 48 hrs order to receipt!

Fig. 2

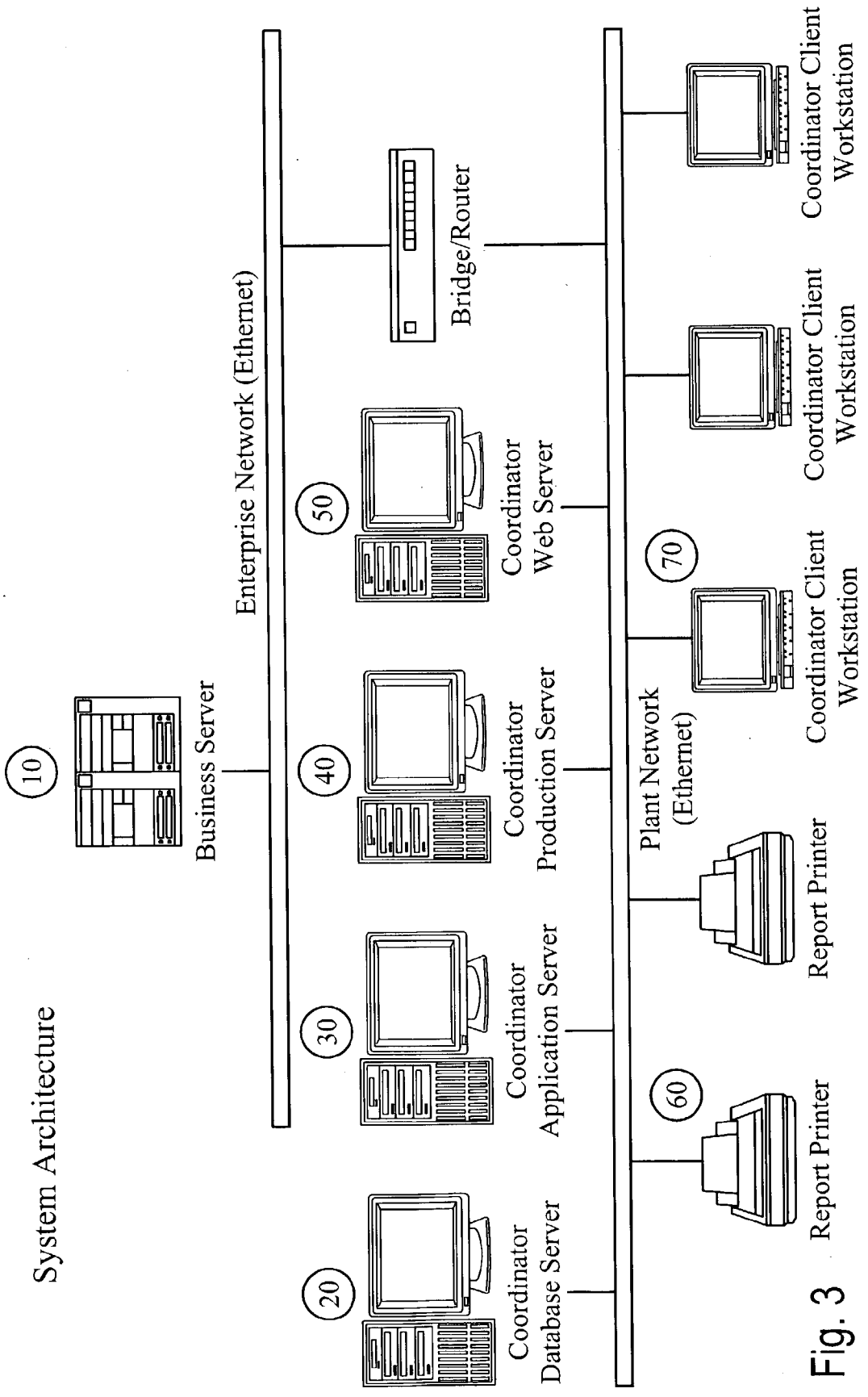

System Architecture
10
Business Server
Enterprise Network (Ethernet)
Bridge/Router
50
Coordinator
Web Server
40
Coordinator
Production Server
30
Coordinator
Application Server
20
Coordinator
Database Server
Plant Network
(Ethernet)
70
Coordinator Client
Workstation
Coordinator Client
Workstation
Coordinator Client
Workstation
60
Report Printer
Report Printer

Fig. 3

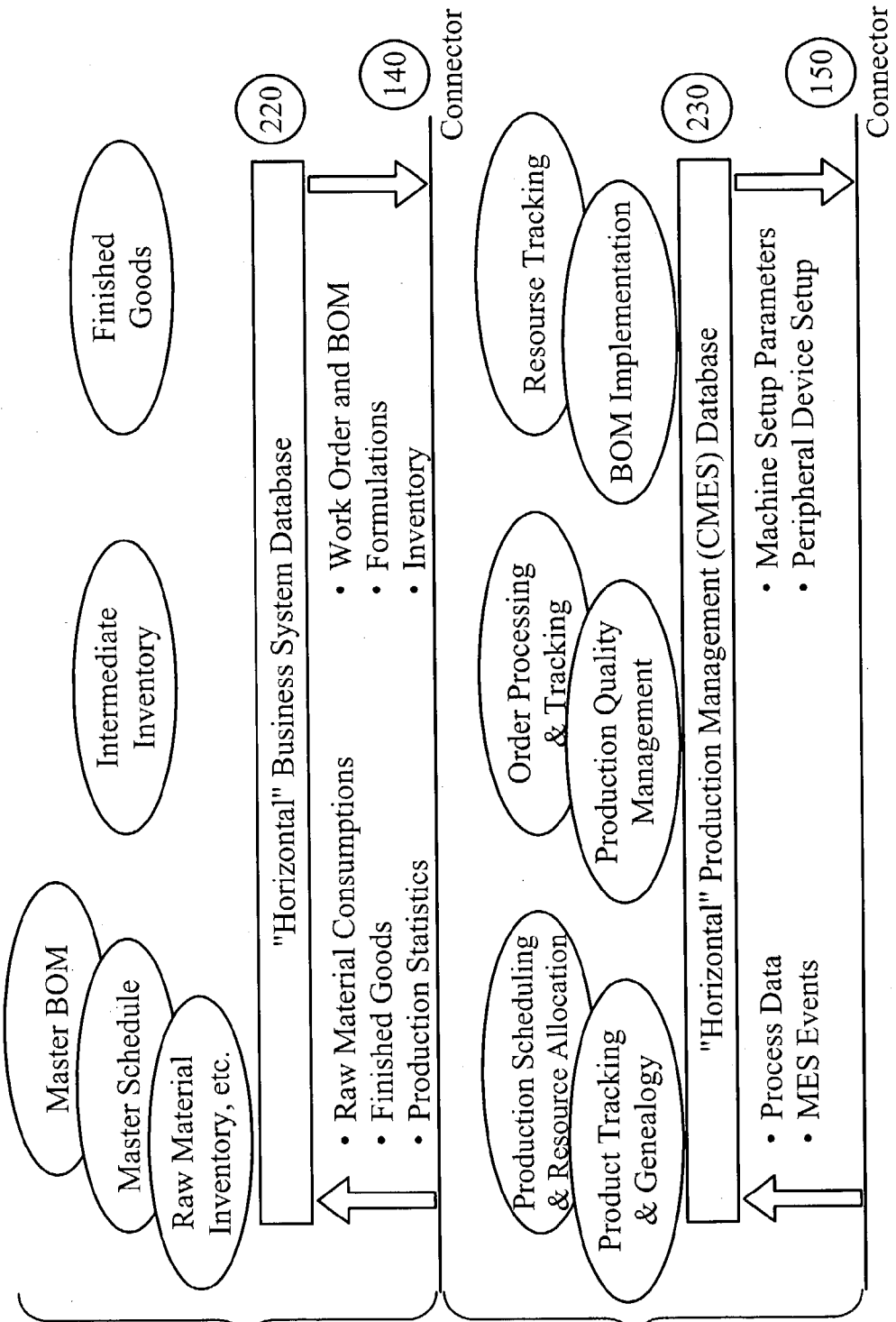


Fig. 4A Manufacturing Information System Architecture

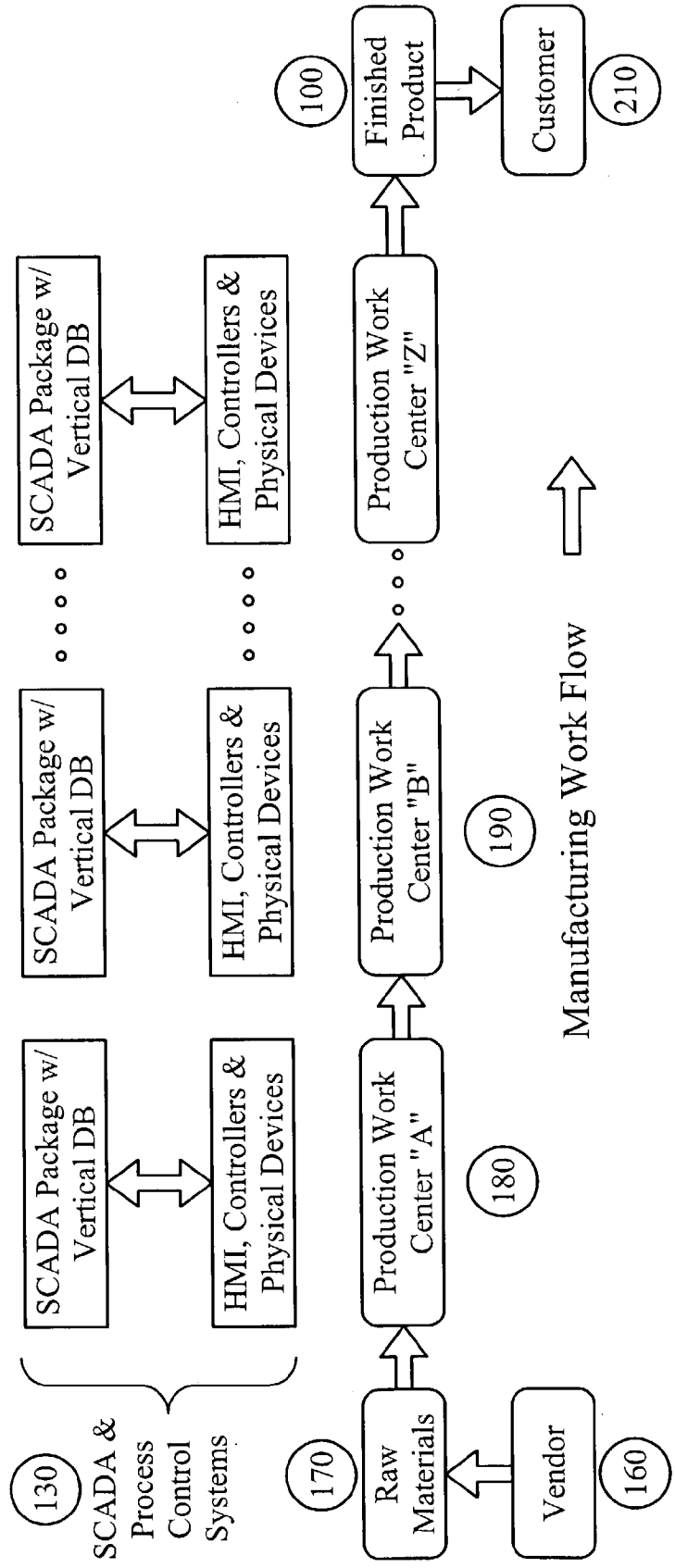


Fig. 4B

Manufacturing Information System Architecture

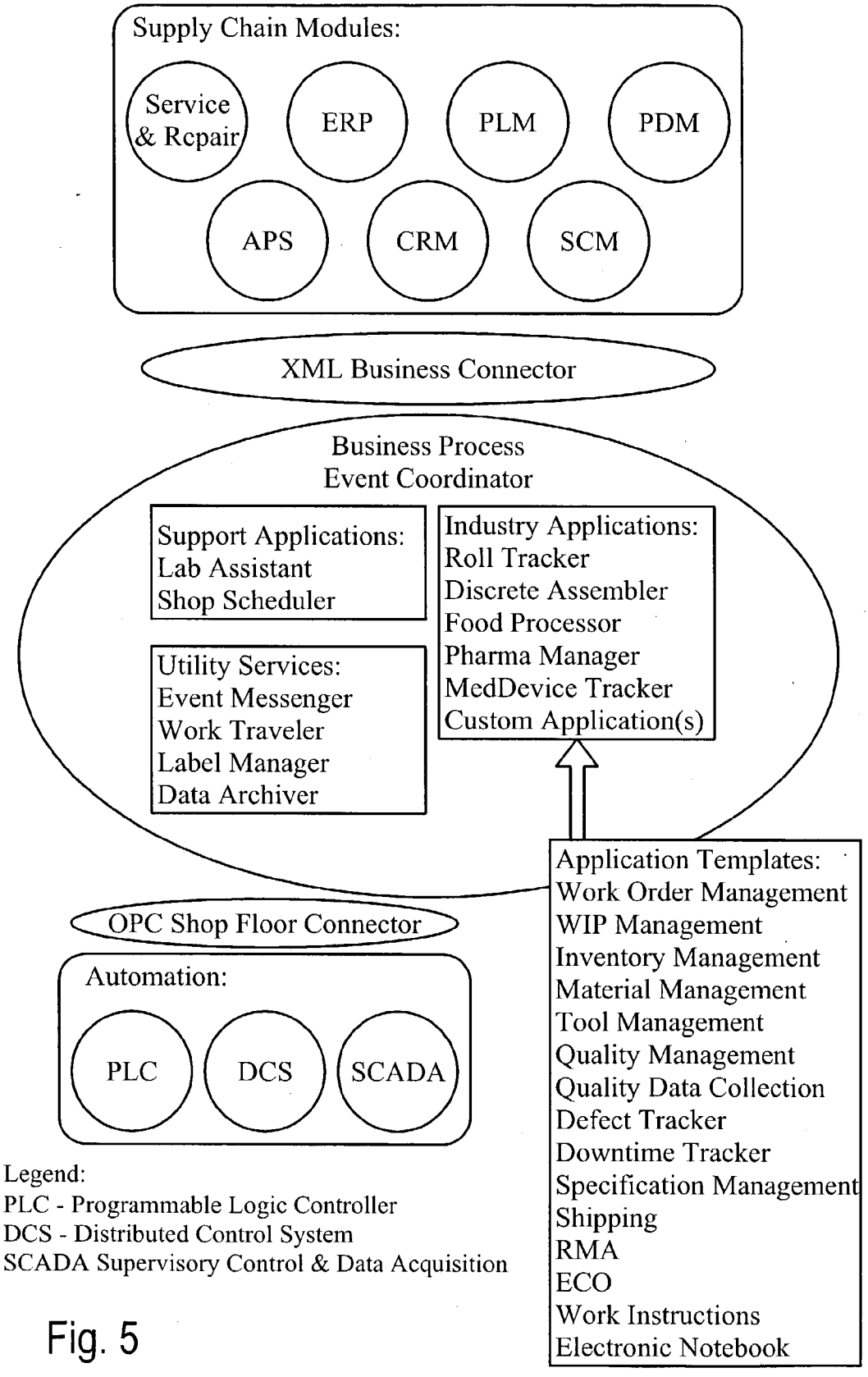

Supply Chain Modules:
Service & Repair
ERP
PLM
PDM
APS
CRM
SCM
XML Business Connector
Business Process Event Coordinator
Support Applications:
Lab Assistant
Shop Scheduler
Utility Services:
Event Messenger
Work Traveler
Label Manager
Data Archiver
Industry Applications:
Roll Tracker
Discrete Assembler
Food Processor
Pharma Manager
MedDevice Tracker
Custom Application(s)
Application Templates:
Work Order Management
WIP Management
Inventory Management
Material Management
Tool Management
Quality Management
Quality Data Collection
Defect Tracker
Downtime Tracker
Specification Management
Shipping
RMA
ECO
Work Instructions
Electronic Notebook
OPC Shop Floor Connector
Automation:
PLC
DCS
SCADA
Legend:
PLC - Programmable Logic Controller
DCS - Distributed Control System
SCADA Supervisory Control & Data Acquisition

Fig. 5

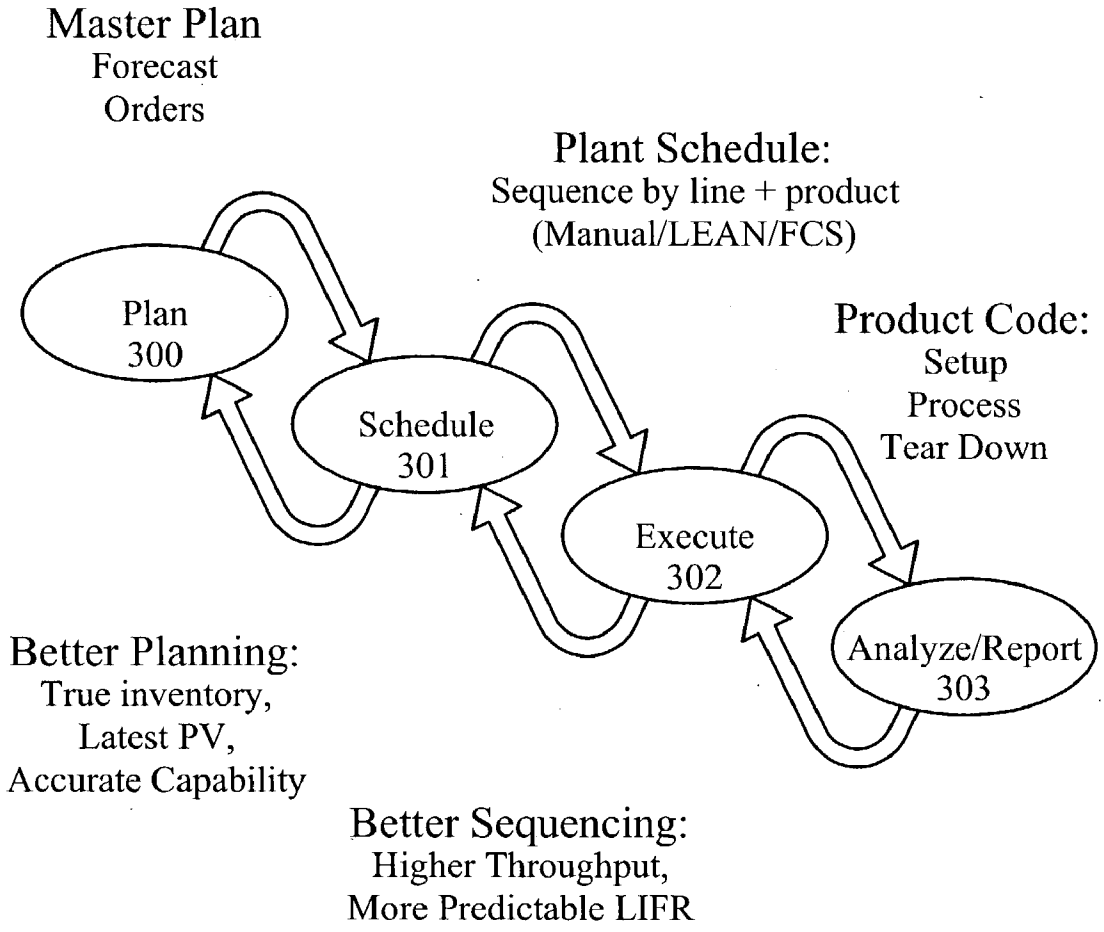

Master Plan
Forecast
Orders
Plant Schedule:
Sequence by line + product
(Manual/LEAN/FCS)
Plan
300
Schedule
301
Execute
302
Analyze/Report
303
Product Code:
Setup
Process
Tear Down
Better Planning:
True inventory,
Latest PV,
Accurate Capability
Better Sequencing:
Higher Throughput,
More Predictable LIFR
Better Process:
Lower Waste,
Higher Utilization,
Process Excellence

Fig. 6

Fig. 7

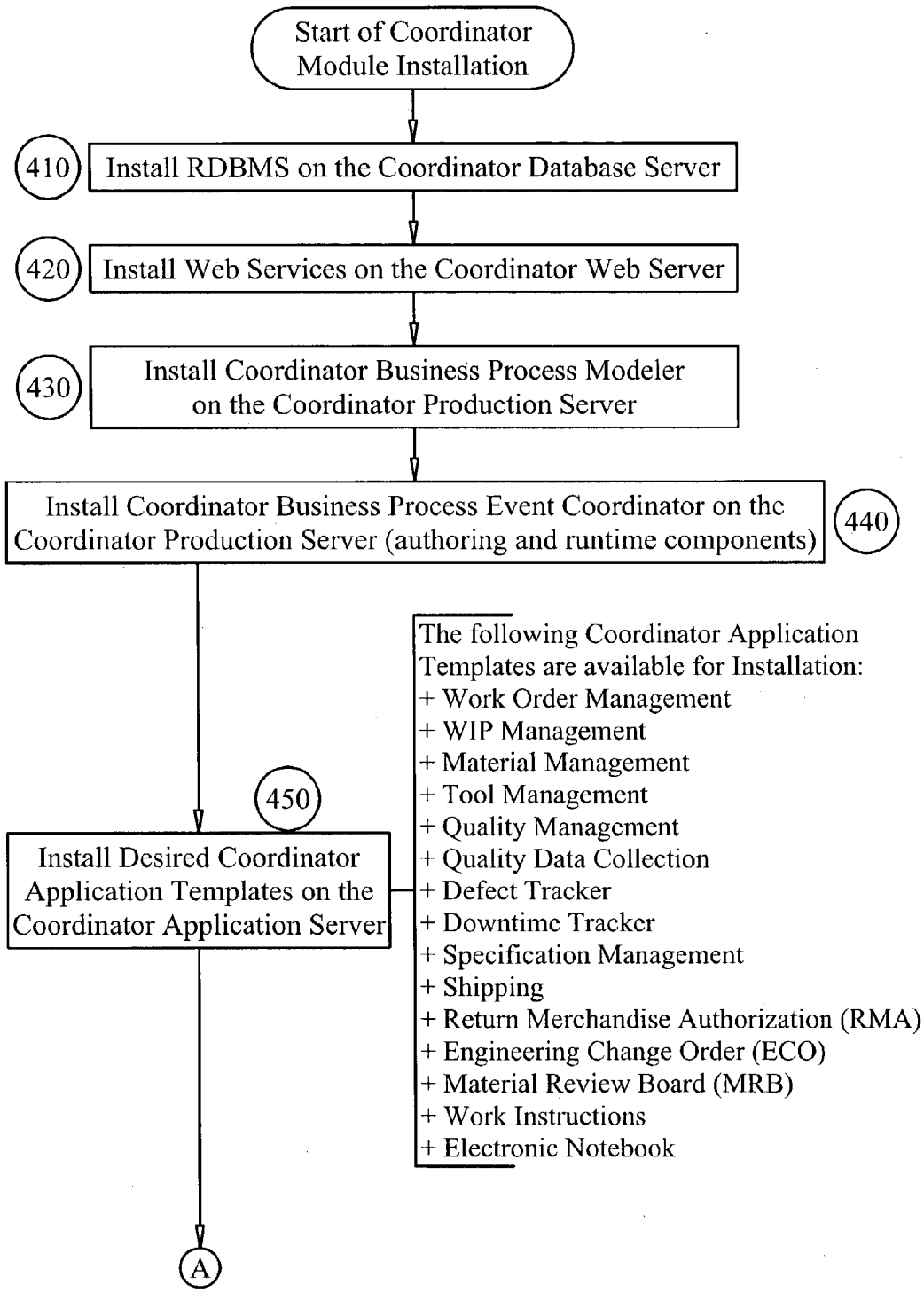
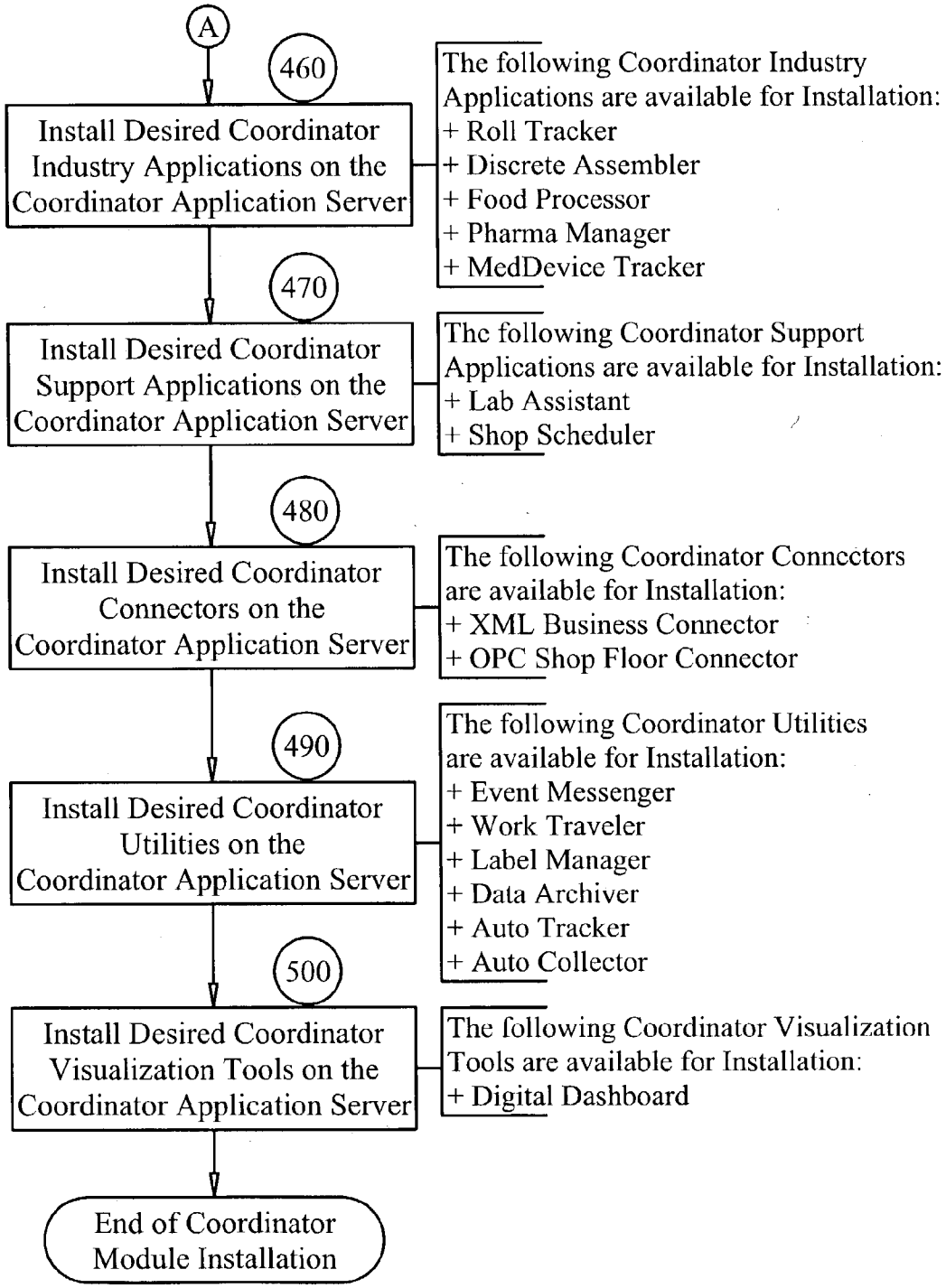

Start of Coordinator Module Installation
410
Install RDBMS on the Coordinator Database Server
420
Install Web Services on the Coordinator Web Server
430
Install Coordinator Business Process Modeler on the Coordinator Production Server
Install Coordinator Business Process Event Coordinator on the Coordinator Production Server (authoring and runtime components)
440
450
Install Desired Coordinator Application Templates on the Coordinator Application Server
The following Coordinator Application Templates are available for Installation:
+ Work Order Management
+ WIP Management
+ Material Management
+ Tool Management
+ Quality Management
+ Quality Data Collection
+ Defect Tracker
+ Downtime Tracker
+ Specification Management
+ Shipping
+ Return Merchandise Authorization (RMA)
+ Engineering Change Order (ECO)
+ Material Review Board (MRB)
+ Work Instructions
+ Electronic Notebook
A

Fig. 8


A
460
Install Desired Coordinator Industry Applications on the Coordinator Application Server
The following Coordinator Industry Applications are available for Installation:
+ Roll Tracker
+ Discrete Assembler
+ Food Processor
+ Pharma Manager
+ MedDevice Tracker
470
Install Desired Coordinator Support Applications on the Coordinator Application Server
The following Coordinator Support Applications are available for Installation:
+ Lab Assistant
+ Shop Scheduler
480
Install Desired Coordinator Connectors on the Coordinator Application Server
The following Coordinator Connectors are available for Installation:
+ XML Business Connector
+ OPC Shop Floor Connector
490
Install Desired Coordinator Utilities on the Coordinator Application Server
The following Coordinator Utilities are available for Installation:
+ Event Messenger
+ Work Traveler
+ Label Manager
+ Data Archiver
+ Auto Tracker
+ Auto Collector
500
Install Desired Coordinator Visualization Tools on the Coordinator Application Server
The following Coordinator Visualization Tools are available for Installation:
+ Digital Dashboard
End of Coordinator Module Installation

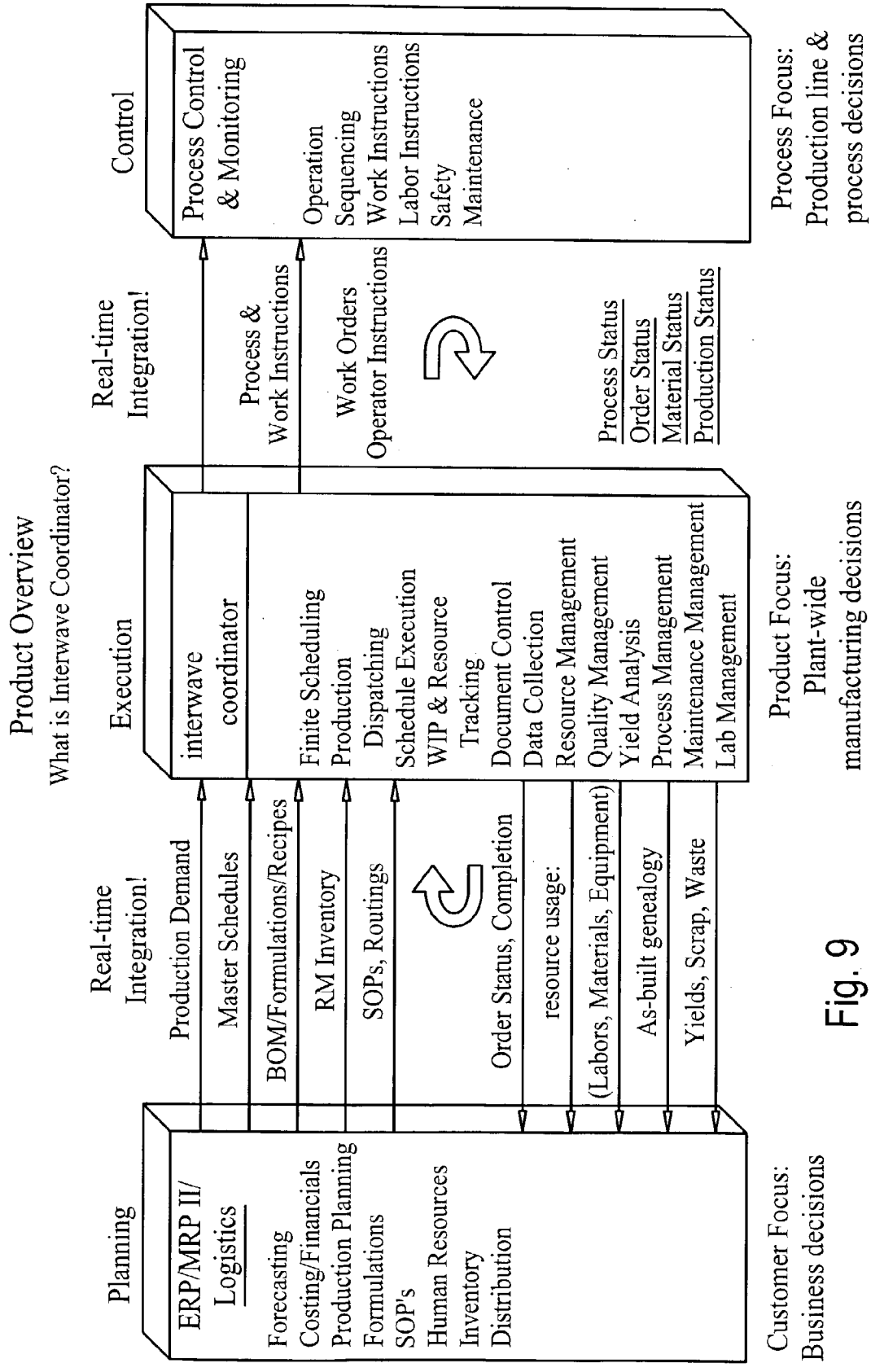

Product Overview
What is Interwave Coordinator?
Planning
ERP/MRP II/
Logistics
Forecasting
Costing/Financials
Production Planning
Formulations
SOP's
Human Resources
Inventory
Distribution
Customer Focus:
Business decisions
Real-time
Integration!
Production Demand
Master Schedules
BOM/Formulations/Recipes
RM Inventory
SOPs, Routings
Order Status, Completion
resource usage:
(Labors, Materials, Equipment)
As-built genealogy
Yields, Scrap, Waste
Execution
interwave
coordinator
Finite Scheduling
Production
Dispatching
Schedule Execution
WIP & Resource
Tracking
Document Control
Data Collection
Resource Management
Quality Management
Yield Analysis
Process Management
Maintenance Management
Lab Management
Product Focus:
Plant-wide
manufacturing decisions
Real-time
Integration!
Process &
Work Instructions
Work Orders
Operator Instructions
Process Status
Order Status
Material Status
Production Status
Control
Process Control
& Monitoring
Operation
Sequencing
Work Instructions
Labor Instructions
Safety
Maintenance
Process Focus:
Production line &
process decisions

Fig. 9

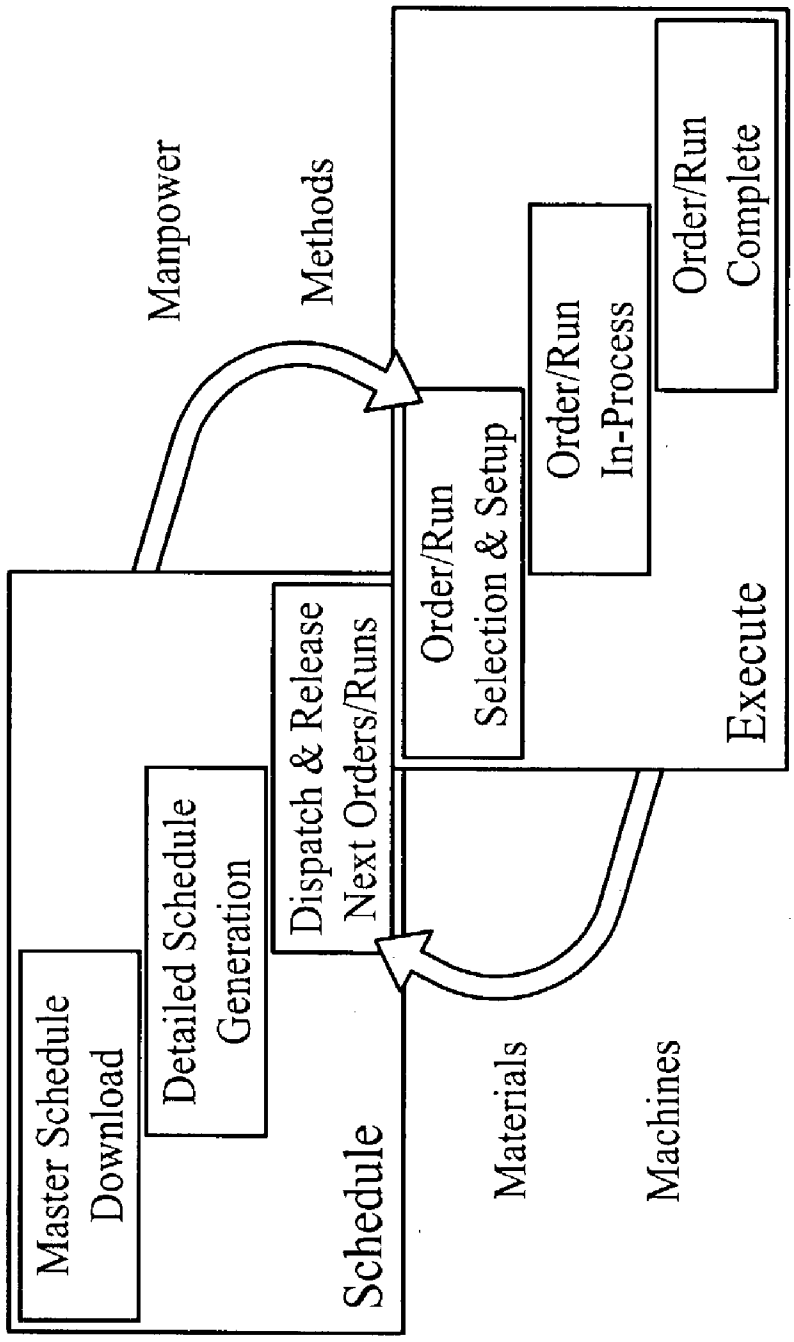

Manpower
Methods
Master Schedule Download
Detailed Schedule Generation
Dispatch & Release Next Orders/Runs
Schedule
Order/Run Selection & Setup
Order/Run In-Process
Order/Run Complete
Execute
Materials
Machines
Performance Reporting & Analysis

Fig. 10

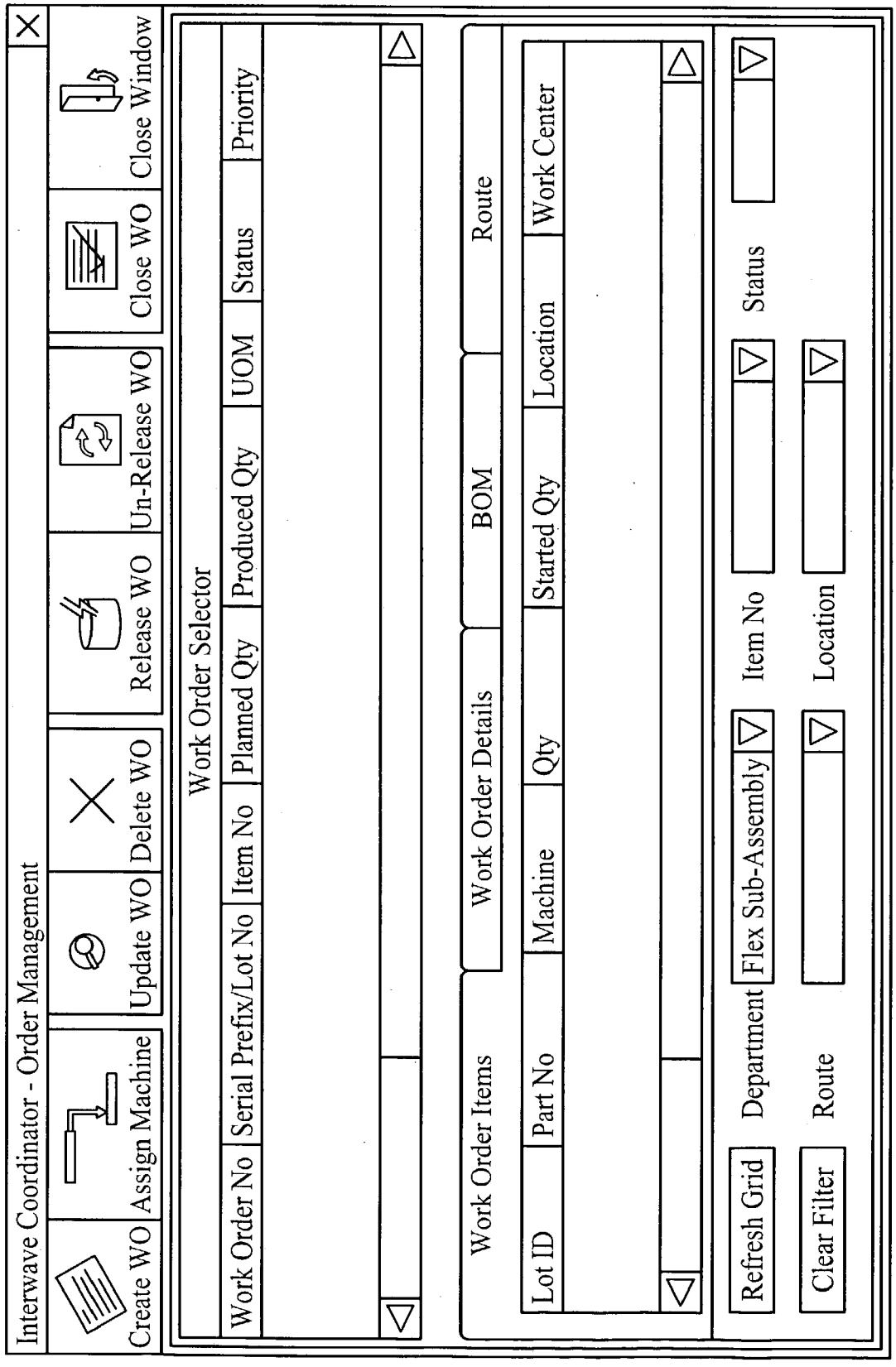

Interwave Coordinator - Order Management
Create WO
Assign Machine
Update WO
Delete WO
Release WO
Un-Release WO
Close WO
Close Window
Work Order Selector
Work Order No
Serial Prefix/Lot No
Item No
Planned Qty
Produced Qty
UOM
Status
Priority
Work Order Items
Work Order Details
BOM
Route
Lot ID
Part No
Machine
Qty
Started Qty
Location
Work Center
Refresh Grid
Department
Flex Sub-Assembly
Item No
Status
Clear Filter
Route
Location

Fig. 11A

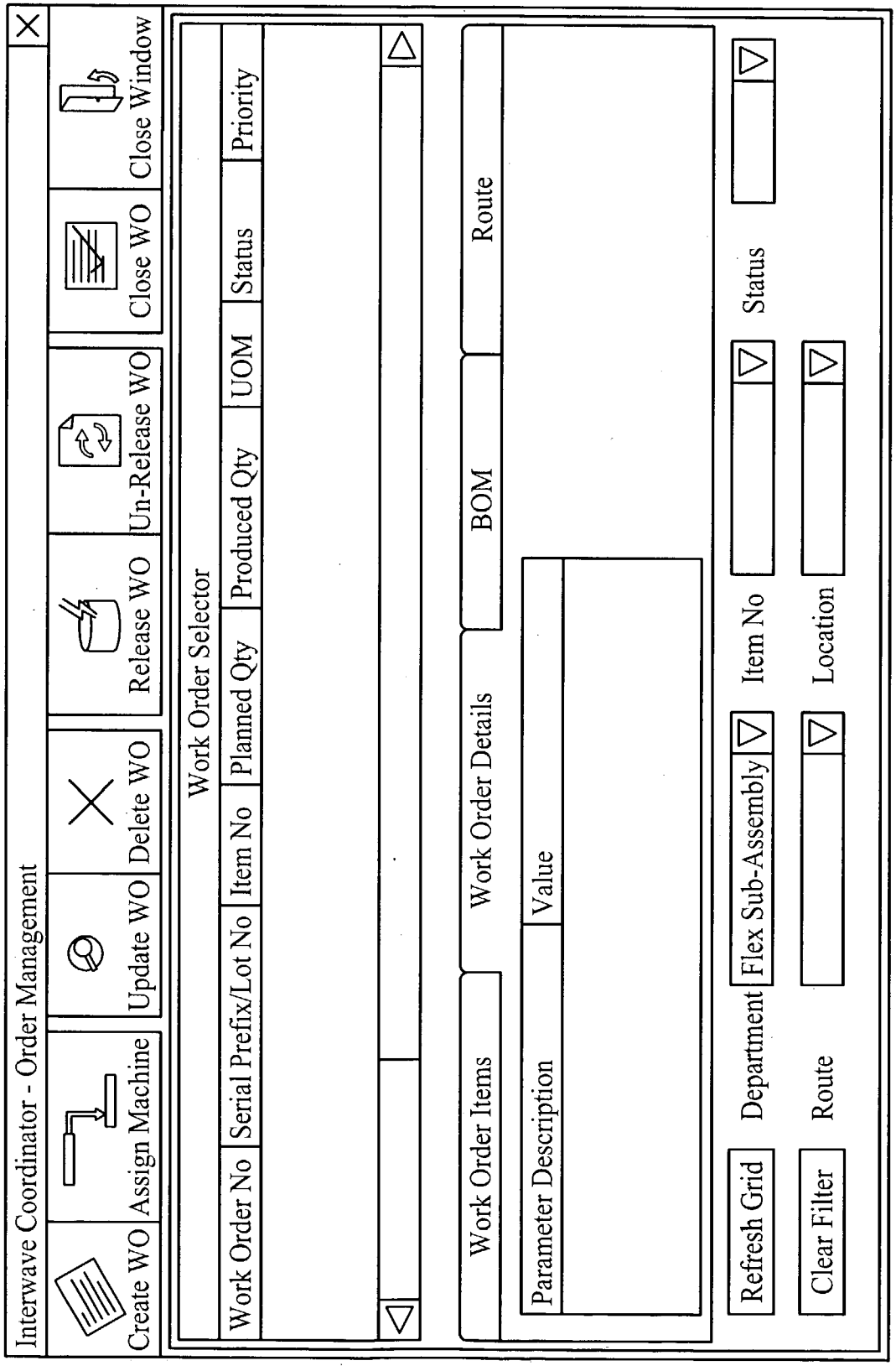

Interwave Coordinator - Order Management
Create WO
Assign Machine
Update WO
Delete WO
Release WO
Un-Release WO
Close WO
Close Window
Work Order Selector
Work Order No
Serial Prefix/Lot No
Item No
Planned Qty
Produced Qty
UOM
Status
Priority
Work Order Items
Work Order Details
BOM
Route
Parameter Description
Value
Refresh Grid
Department
Flex Sub-Assembly
Item No
Status
Clear Filter
Route
Location

Fig. 11B

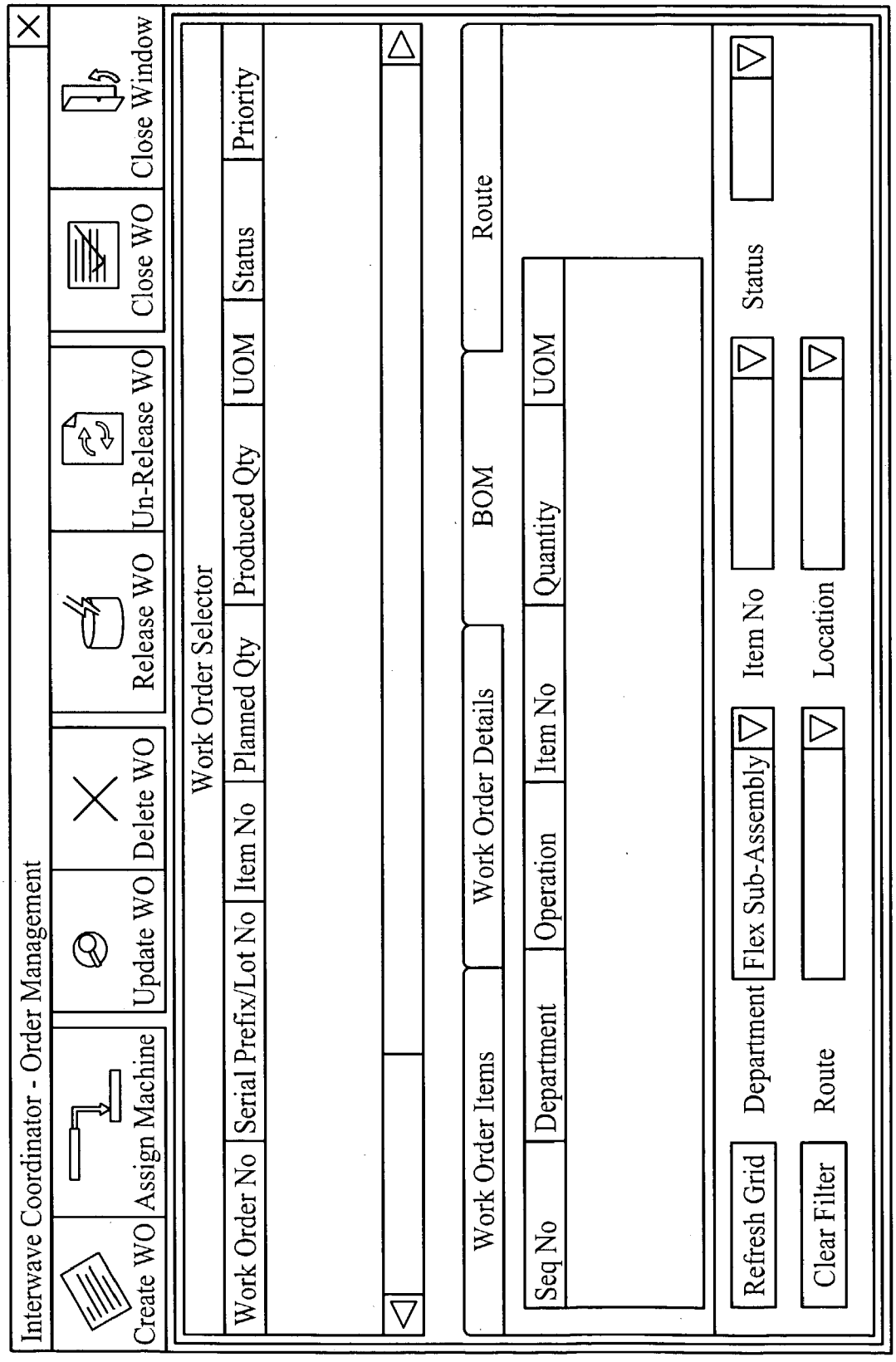

Interwave Coordinator - Order Management
Create WO
Assign Machine
Update WO
Delete WO
Release WO
Un-Release WO
Close WO
Close Window
Work Order Selector
Work Order No
Serial Prefix/Lot No
Item No
Planned Qty
Produced Qty
UOM
Status
Priority
Work Order Items
Work Order Details
BOM
Route
Seq No
Department
Operation
Item No
Quantity
UOM
Refresh Grid
Department
Flex Sub-Assembly
Item No
Status
Clear Filter
Route
Location

Fig. 12A

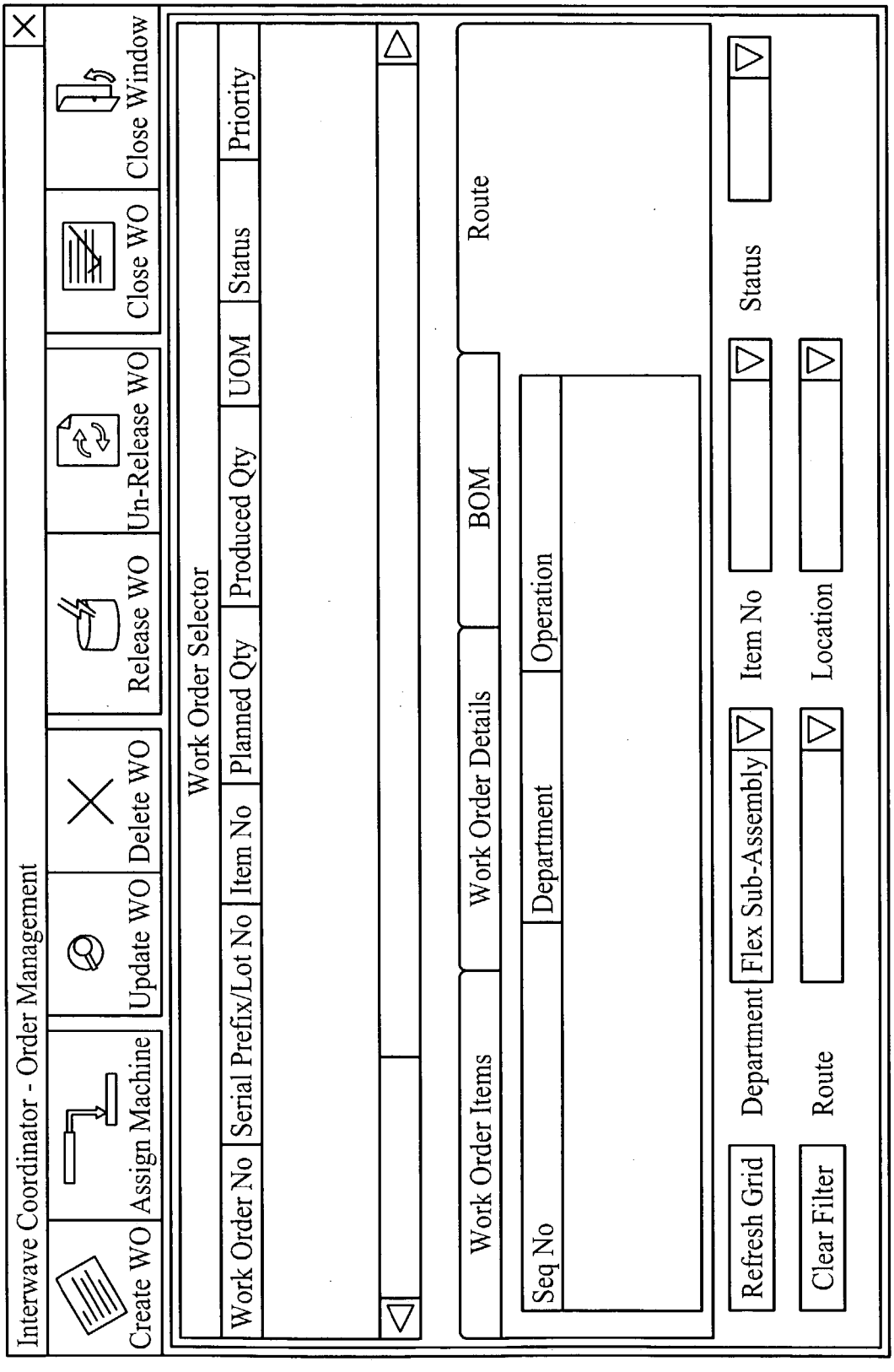

Interwave Coordinator - Order Management
Create WO
Assign Machine
Update WO
Delete WO
Release WO
Un-Release WO
Close WO
Close Window
Work Order Selector
Work Order No
Serial Prefix/Lot No
Item No
Planned Qty
Produced Qty
UOM
Status
Priority
Work Order Items
Work Order Details
BOM
Route
Seq No
Department
Operation
Refresh Grid
Department
Flex Sub-Assembly
Item No
Status
Clear Filter
Route
Location

Fig. 12B

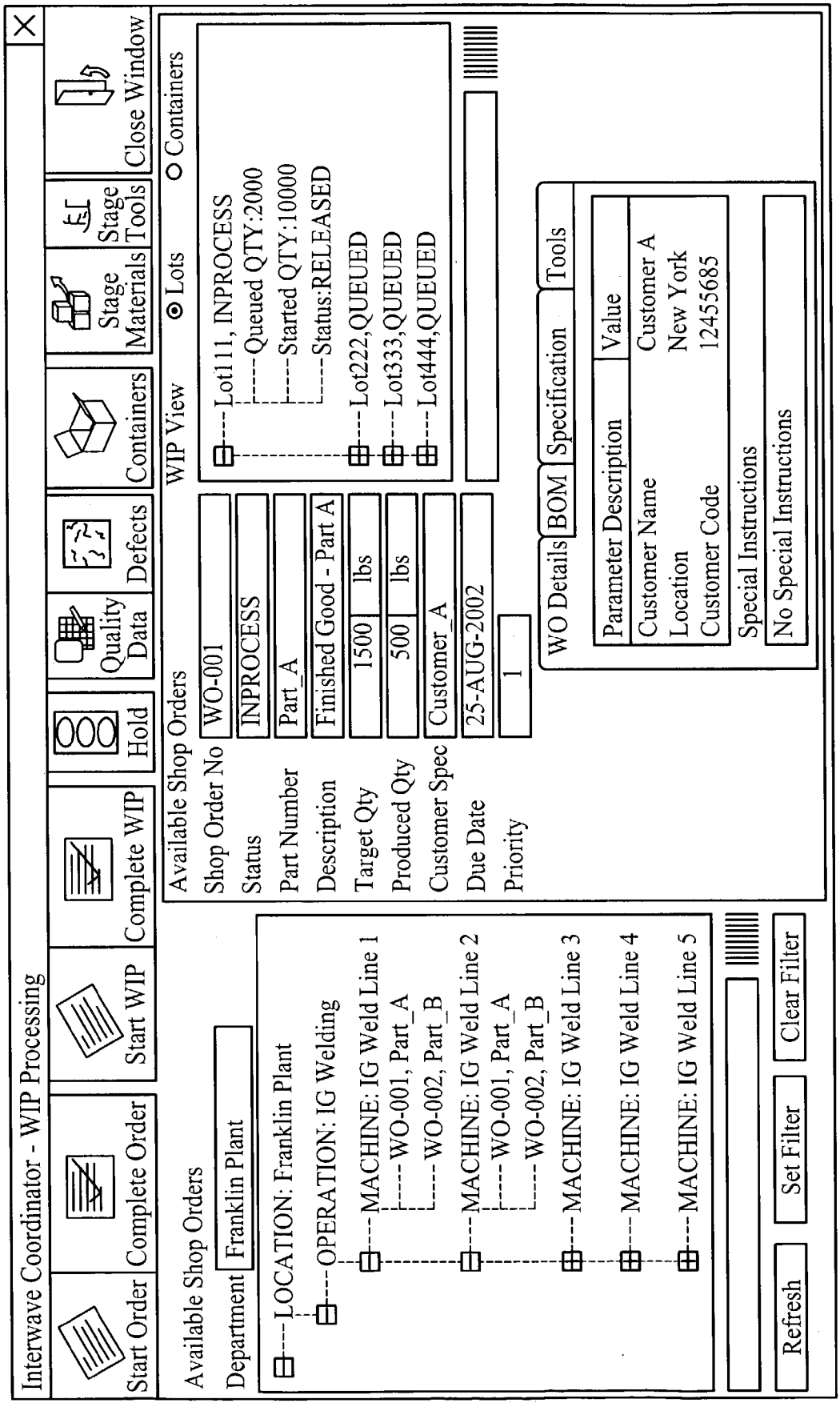

Interwave Coordinator - WIP Processing
Start Order
Complete Order
Start WIP
Complete WIP
Hold
Quality Data
Defects
Containers
Stage Materials
Stage Tools
Close Window
Available Shop Orders
Department
Franklin Plant
LOCATION: Franklin Plant
OPERATION: IG Welding
MACHINE: IG Weld Line 1
WO-001, Part_A
WO-002, Part_B
MACHINE: IG Weld Line 2
WO-001, Part_A
WO-002, Part_B
MACHINE: IG Weld Line 3
MACHINE: IG Weld Line 4
MACHINE: IG Weld Line 5
Refresh
Set Filter
Clear Filter
Available Shop Orders
WIP View
Lots
Containers
Shop Order No
WO-001
Status
INPROCESS
Part Number
Part_A
Description
Finished Good - Part A
Target Qty
1500
lbs
Produced Qty
500
lbs
Customer Spec
Customer_A
Due Date
25-AUG-2002
Priority
1
Lot111, INPROCESS
Queued QTY:2000
Started QTY:10000
Status:RELEASED
Lot222,QUEUED
Lot333,QUEUED
Lot444,QUEUED
WO Details
BOM
Specification
Tools
Parameter Description
Value
Customer Name
Customer A
Location
New York
Customer Code
12455685
Special Instructions
No Special Instructions

Fig. 13

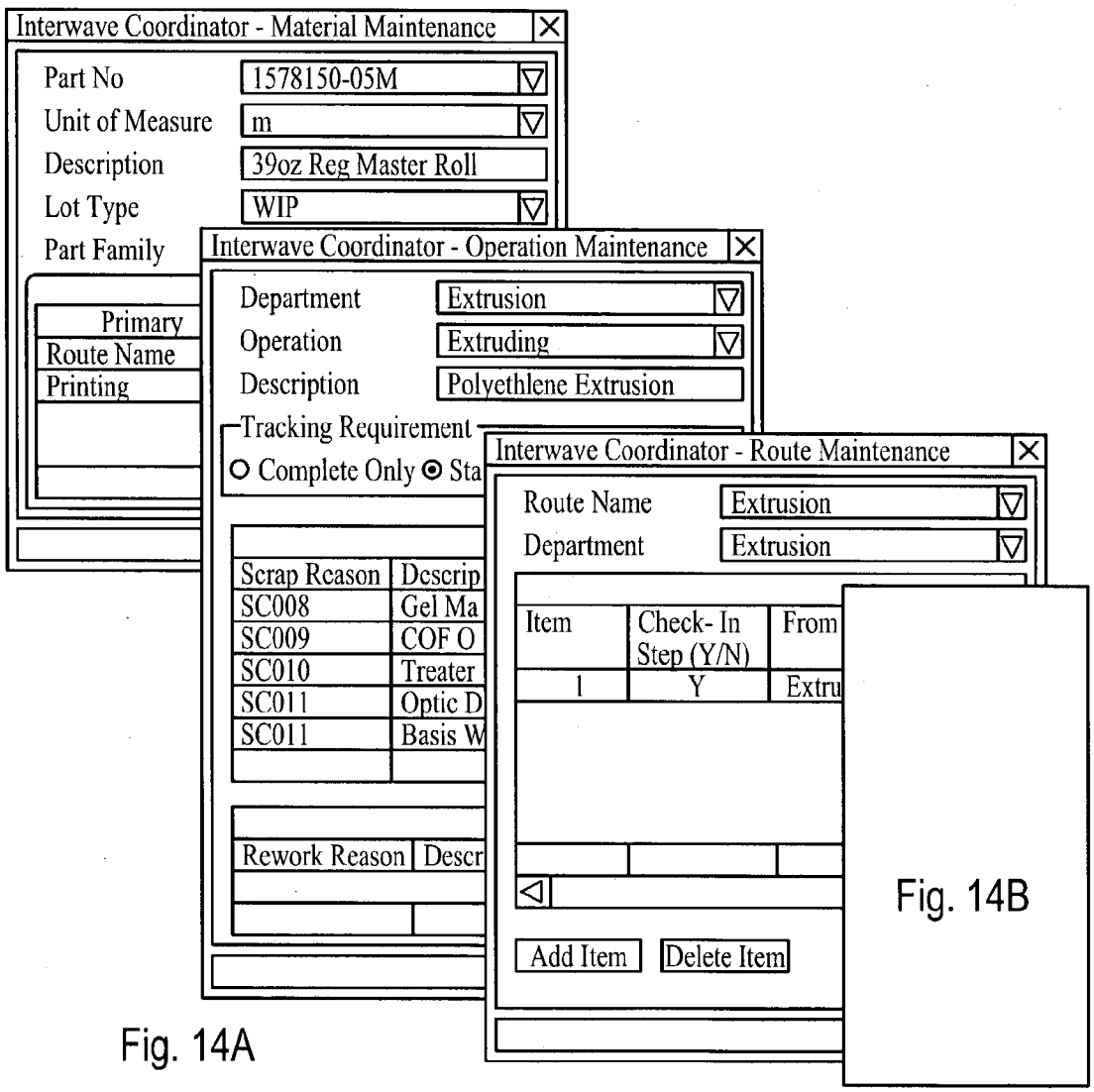


Fig. 14A

Fig. 14B

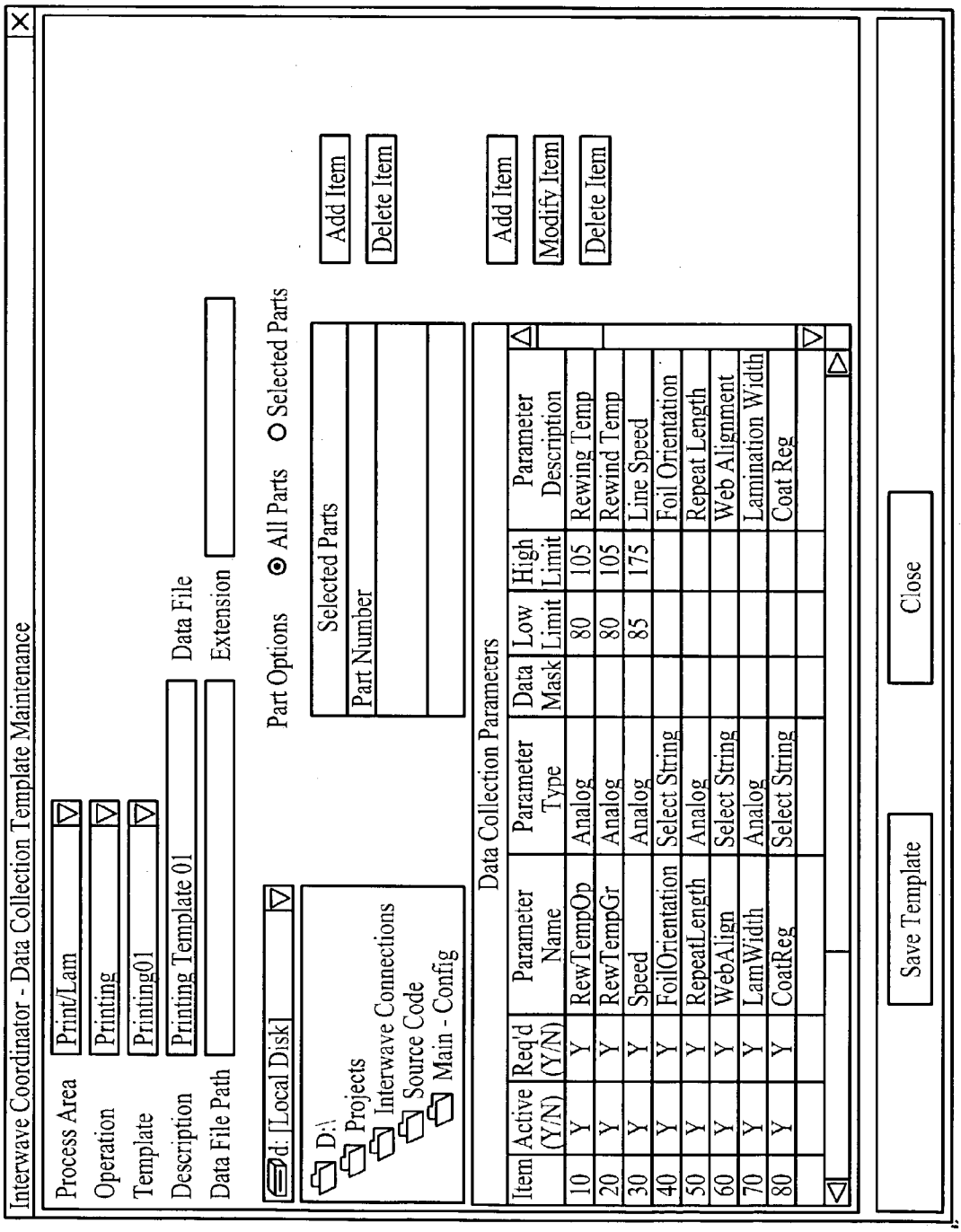

Interwave Coordinator - Data Collection Template Maintenance
Process Area
Print/Lam
Operation
Printing
Template
Printing01
Description
Printing Template 01
Data File
Data File Path
Extension
Part Options
All Parts
Selected Parts
d: [Local Disk]
D:\
Projects
Interwave Connections
Source Code
Main - Config
Selected Parts
Part Number
Add Item
Delete Item
Data Collection Parameters
Add Item
Modify Item
Delete Item
Item
Active (Y/N)
Req'd (Y/N)
Parameter Name
Parameter Type
Data Mask
Low Limit
High Limit
Parameter Description
10 Y Y RewTempOp Analog 80 105 Rewing Temp
20 Y Y RewTempGr Analog 80 105 Rewind Temp
30 Y Y Speed Analog 85 175 Line Speed
40 Y Y FoilOrientation Select String Foil Orientation
50 Y Y RepeatLength Analog Repeat Length
60 Y Y WebAlign Select String Web Alignment
70 Y Y LamWidth Analog Lamination Width
80 Y Y CoatReg Select String Coat Reg
Save Template
Close

Fig. 14B

WIP Status Report

Select Criteria

Department	
Operation	
Part No	
Location	Dept2_LocationWIP
Status	

LotID	Material Name	Lot Type	UDA Route	Route Name	Route Version	Route Step Name	Work State	Location	Queued Qty	Started Qty	Priority	WorkOr
11111	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	222	0	1	TestWor
121802Lot	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	250	0	0	121802
12344	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	2	0	1	TestWor
222	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	222	0	1	TestWor
33333	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	1	0	1	TestWor
L000000N1	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	8	0	1	WO0000
L000001-01	MaterialP	WIP	RoutePrimary	200OperationB	NONE	1	IN PROCESS	Dept2 LocationWIP	0	2	1	WO0000
L00000N2-01	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	2	0	1	WO0000
TestLot1	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	2	0	1	TestWor
TestWorkOrder5 Lot-02	MaterialP	WIP	ReworkRoute	200OperationRework1	NONE	1	IN PROCESS	Dept2 LocationWIP	0	1	0	TestWor
TestWorkOrder5 Lot-03	MaterialP	WIP	RoutePrimary	200OperationA	NONE	1	QUEUED	Dept2 LocationWIP	1	0	0	TestWor
TestWorkOrder5 Lot-04	MaterialP	WIP									0	TestWor
TestWorkOrder5 Lot-05	MaterialP	WIP									0	TestWor
WO00000N2 Lot-02	MaterialP	WIP									1	WO0000
WO00000N2 Lot-03	MaterialP	WIP									1	WO0000
WO00000N2 Lot-04	MaterialP	WIP									1	WO0000
WO00000N2 Lot-05	MaterialP	WIP									1	WO0000

Fig. 15B

Fig. 15A

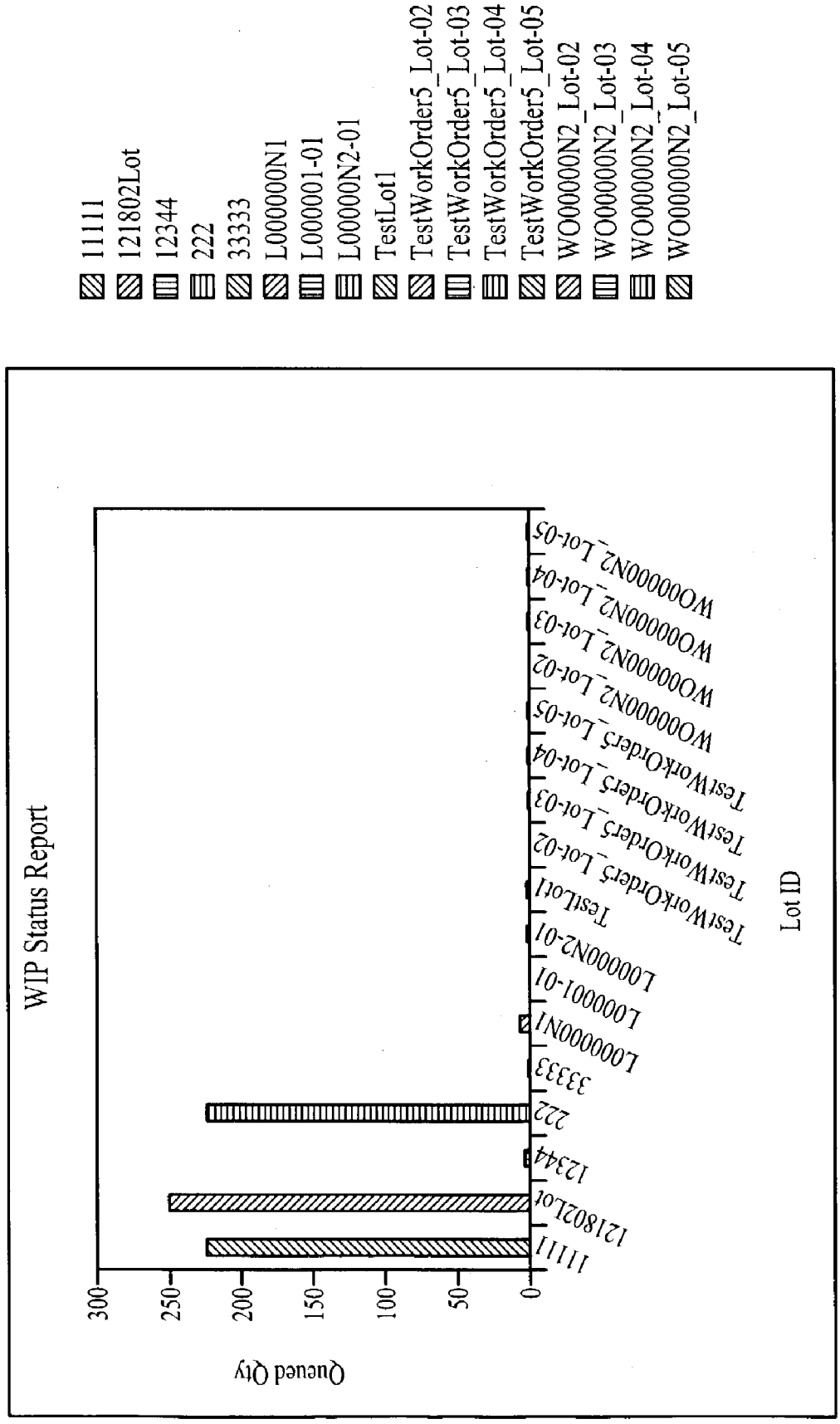

11111
121802Lot
12344
222
33333
L000000N1
L000001-01
L00000N2-01
TestLot1
TestWorkOrder5_Lot-02
TestWorkOrder5_Lot-03
TestWorkOrder5_Lot-04
TestWorkOrder5_Lot-05
WO00000N2_Lot-02
WO00000N2_Lot-03
WO00000N2_Lot-04
WO00000N2_Lot-05
WIP Status Report
Queued Qty
300
250
200
150
100
50
0
Lot ID

Fig. 15B

Material Genealogy Report
Select Criteria (LotID = L000000N1)

Consumed LotID	Consumed Material Name	Consumption Location	Quantity Consumed	Operation	Location
LMaterialA1-01	Material A	Dept2 LocationINV	1	OperationA	Dept2 LocationWIP
LMaterialA1-01	Material A	Dept2 LocationINV	1	OperationA	Dept2 LocationWIP
LMaterialA1-01	Material A	Dept2 LocationINV	1	OperationA	Dept2 LocationWIP
LMaterialB1-01	Material B	Dept2 LocationINV	1	OperationA	Dept2 LocationWIP
LMaterialB1-01	Material B	Dept2 LocationINV	1	OperationA	Dept2 LocationWIP
LMaterialB1-01	Material B	Dept2 LocationINV	1	OperationA	Dept2 LocationWIP
LMaterialC1-01	Material C	Dept2 LocationINV	1	OperationB	Dept2 LocationWIP
LMaterialD1-01	Material D	Dept2 LocationINV	1	OperationB	Dept2 LocationWIP
LMaterialE1-01	Material E				
LMaterialE1-01	Material E				

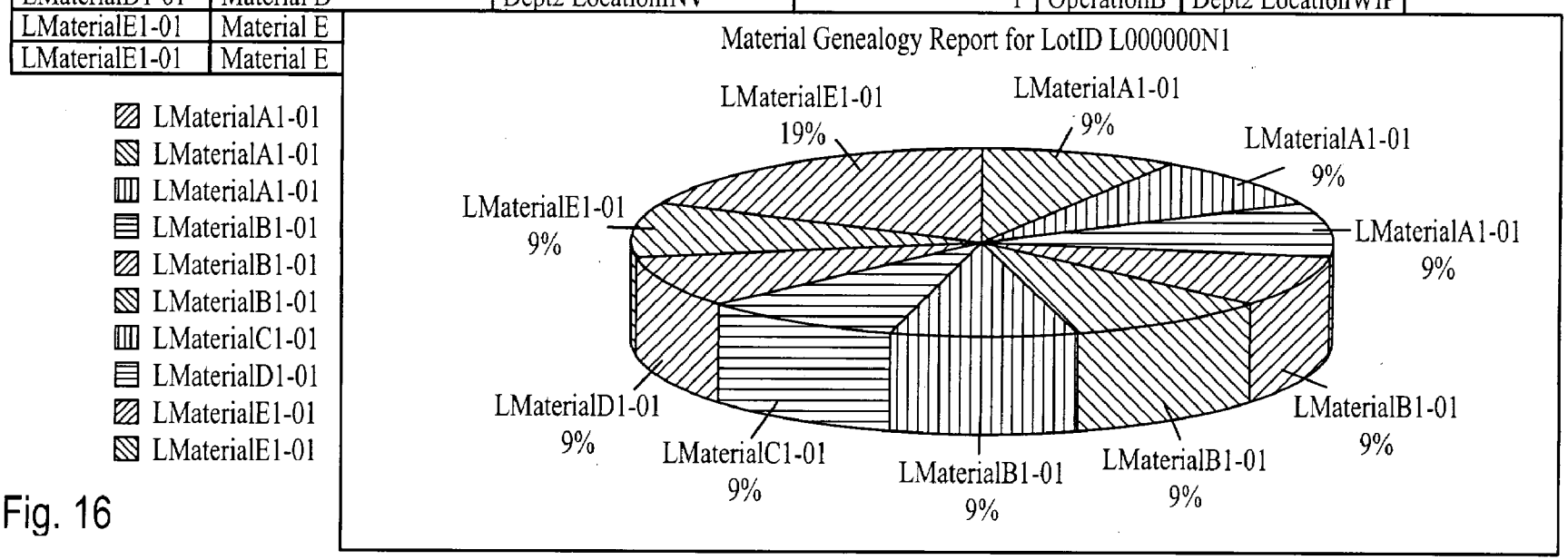


Fig. 16

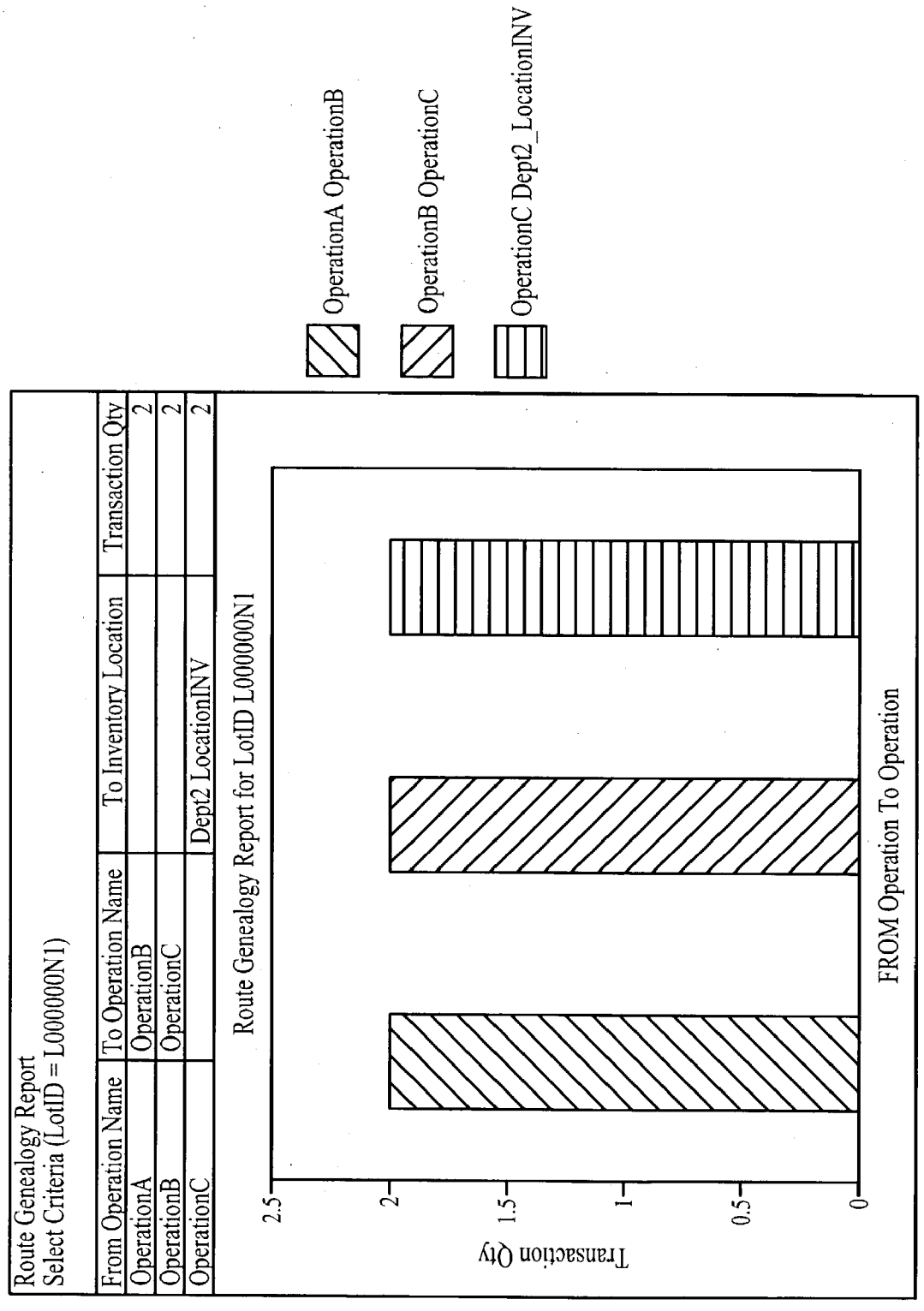

Route Genealogy Report
Select Criteria (LotID = L000000N1)
From Operation Name
To Operation Name
To Inventory Location
Transaction Qty
OperationA
OperationB
2
OperationB
OperationC
2
OperationC
Dept2 LocationINV
2
Route Genealogy Report for LotID L000000N1
OperationA OperationB
OperationB OperationC
OperationC Dept2_LocationINV
Transaction Qty
2.5
2
1.5
1
0.5
0
FROM Operation To Operation

Fig. 17

Work Order Status Report
Select Criteria (Material Name = MaterialP)

Work Order No	Material Name	Target Qty	Produced Qty	Status
121802	MaterialP	250	0	RELEASED
TestWorkOrder	MaterialP	4	0	RELEASED
TestWorkOrder2	MaterialP	2	0	RELEASED
TestWorkOrder3	MaterialP	2	0	RELEASED
TestWorkOrder4	Mat			
TestWorkOrder5	Mat			
WO00000N1	Mat			
WO00000N2	Mat			

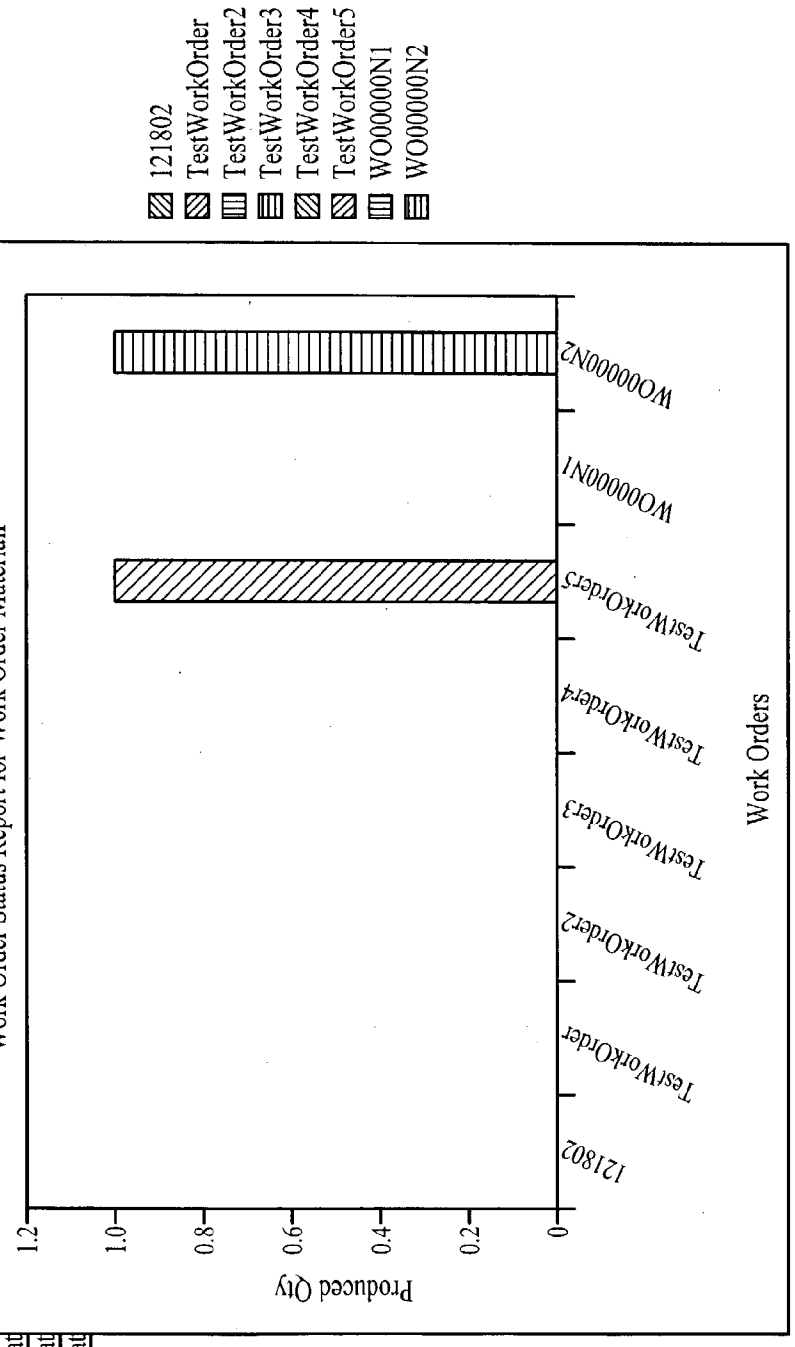


Fig. 18

Inventory Summary Report
Select Criteria (Location = Dept2_LocationINV)

LotID	Material Name	Location	Quantity
L000000N1	MaterialP	Dept2 LocationINV	2
LMaterialA1-01	MaterialA	Dept2 LocationINV	15
LMaterialA1-02	MaterialA	Dept2 LocationINV	20
LMaterialB1-01	MaterialB	Dept2 LocationINV	16
LMaterialB1-02	MaterialB	Dept2 LocationINV	20
LMaterialC1-01	MaterialC	Dept2 LocationINV	19
LMaterialC1-02	MaterialC	Dept2 LocationINV	20
LMaterialD1-01	MaterialD	Dept2 LocationINV	19
LMaterialD1-02	Mate		
LMaterialE1-01	Mate		
LMaterialE1-02	Mate		
TestWorkOrder5 Lot-01	Mate		
WO00000N2 Lot-01	Mate		

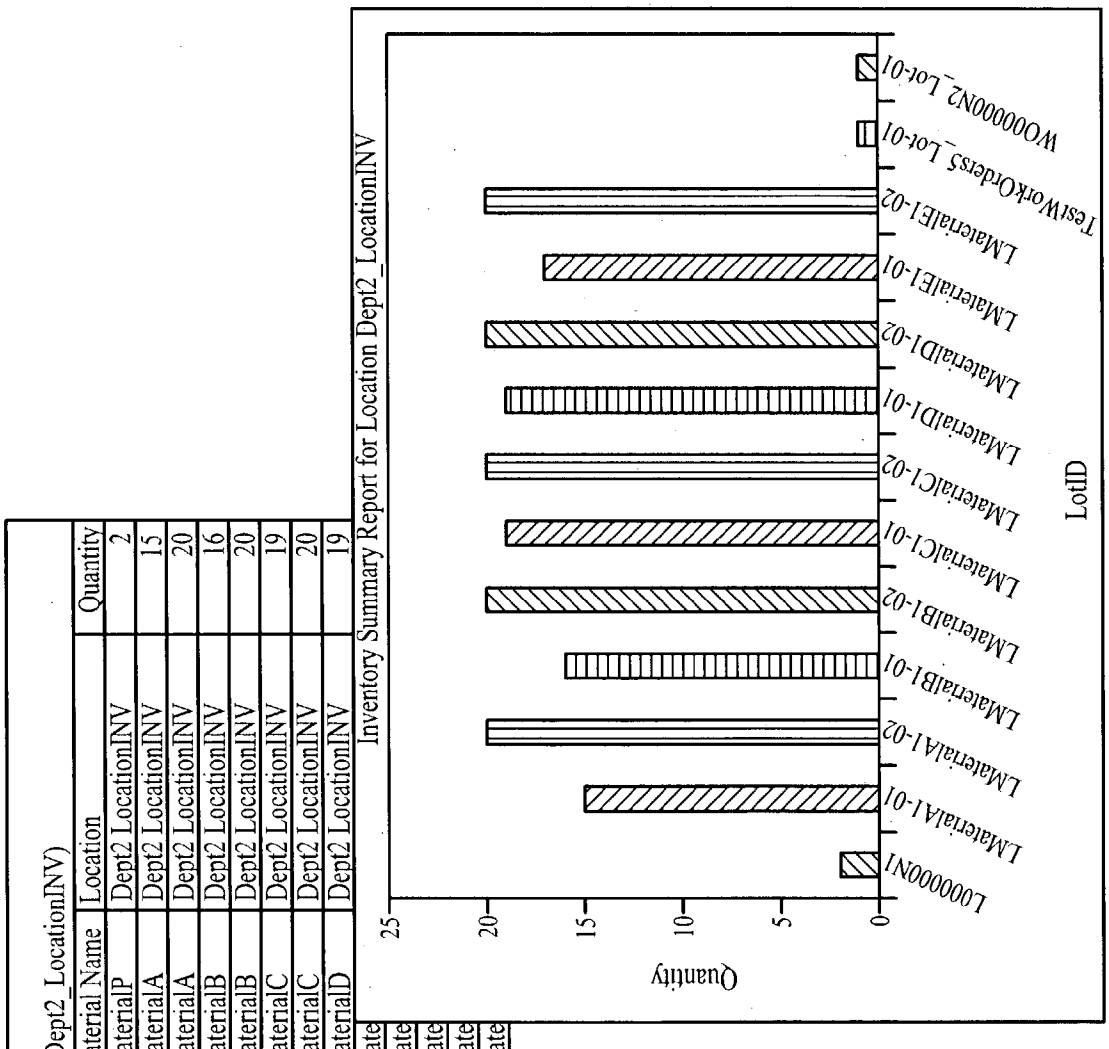


Fig. 19

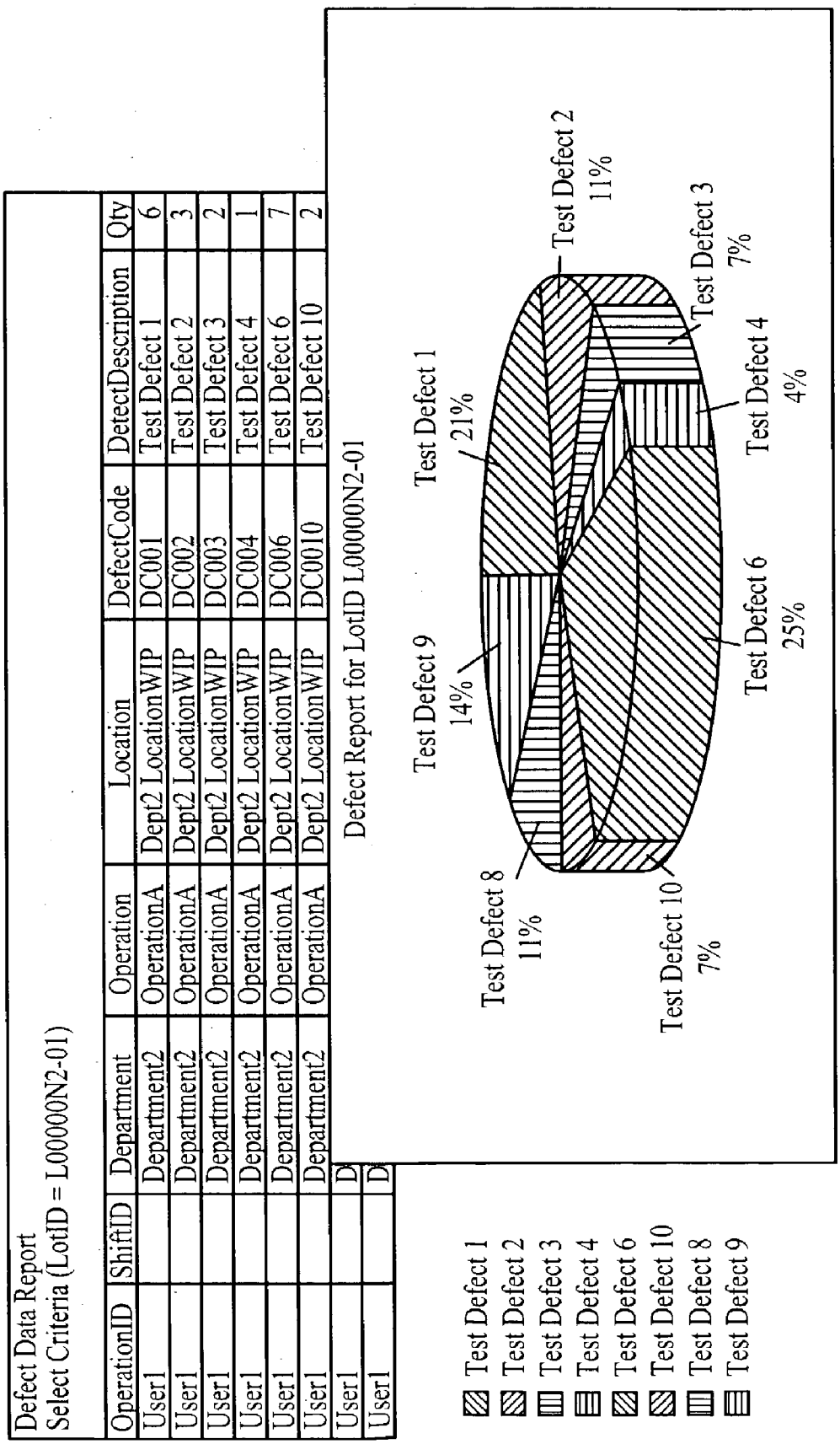
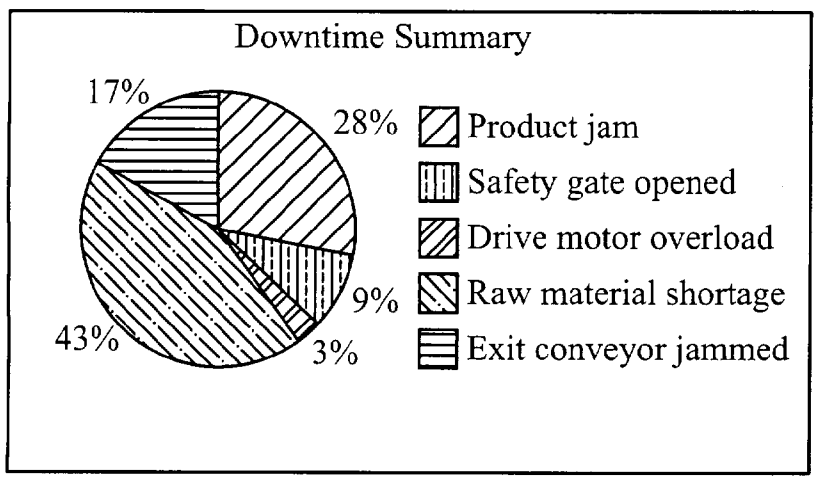

Defect Data Report
Select Criteria (LotID = L00000N2-01)
OperationID | ShiftID | Department | Operation | Location | DefectCode | DetectDescription | Qty
User1 | | Department2 | OperationA | Dept2 LocationWIP | DC001 | Test Defect 1 | 6
User1 | | Department2 | OperationA | Dept2 LocationWIP | DC002 | Test Defect 2 | 3
User1 | | Department2 | OperationA | Dept2 LocationWIP | DC003 | Test Defect 3 | 2
User1 | | Department2 | OperationA | Dept2 LocationWIP | DC004 | Test Defect 4 | 1
User1 | | Department2 | OperationA | Dept2 LocationWIP | DC006 | Test Defect 6 | 7
User1 | | Department2 | OperationA | Dept2 LocationWIP | DC0010 | Test Defect 10 | 2
Defect Report for LotID L00000N2-01
Test Defect 1
Test Defect 2
Test Defect 3
Test Defect 4
Test Defect 6
Test Defect 10
Test Defect 8
Test Defect 9
Test Defect 1 21%
Test Defect 2 11%
Test Defect 3 7%
Test Defect 4 4%
Test Defect 6 25%
Test Defect 10 7%
Test Defect 8 11%
Test Defect 9 14%

Fig. 20

Downtime Report
Select Criteria
Work Order No = WO-200345
Lot No = ML201439
Item No = 42067

Shift	Department	Operation	Location	Machine	Reason Code	Reason Desc	Duration (mins)
1	Production	Food Prep	Food Prep Room	DSI 1	DT4003	Product jam	4.2
1	Production	Food Prep	Food Prep Room	DSI 1	DT4010	Safety gate opened	1.3
1	Production	Food Prep	Food Prep Room	DSI 1	DT4056	Drive motor overload	0.5
1	Production	Food Prep	Food Prep Room	DSI 1	DT4031	Raw material shortage	6.4
1	Production	Food Prep	Food Prep Room	DSI 1	DT4019	Exit conveyor jammed	2.5



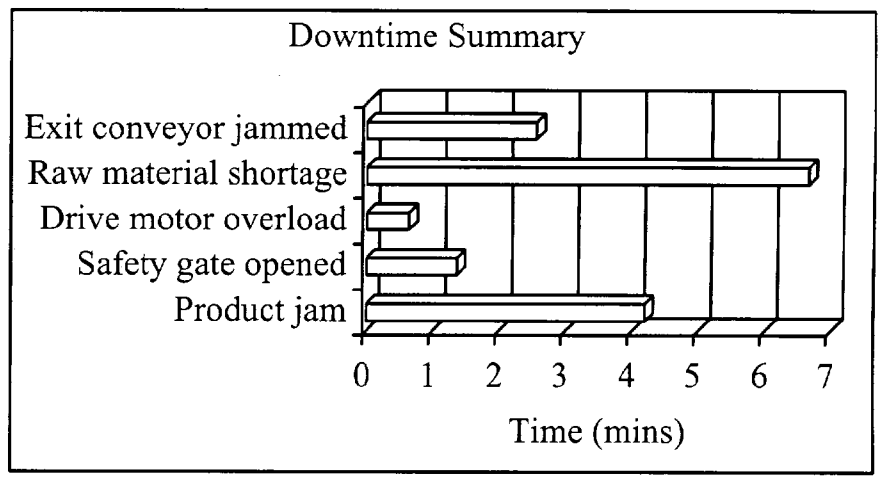


Fig. 21

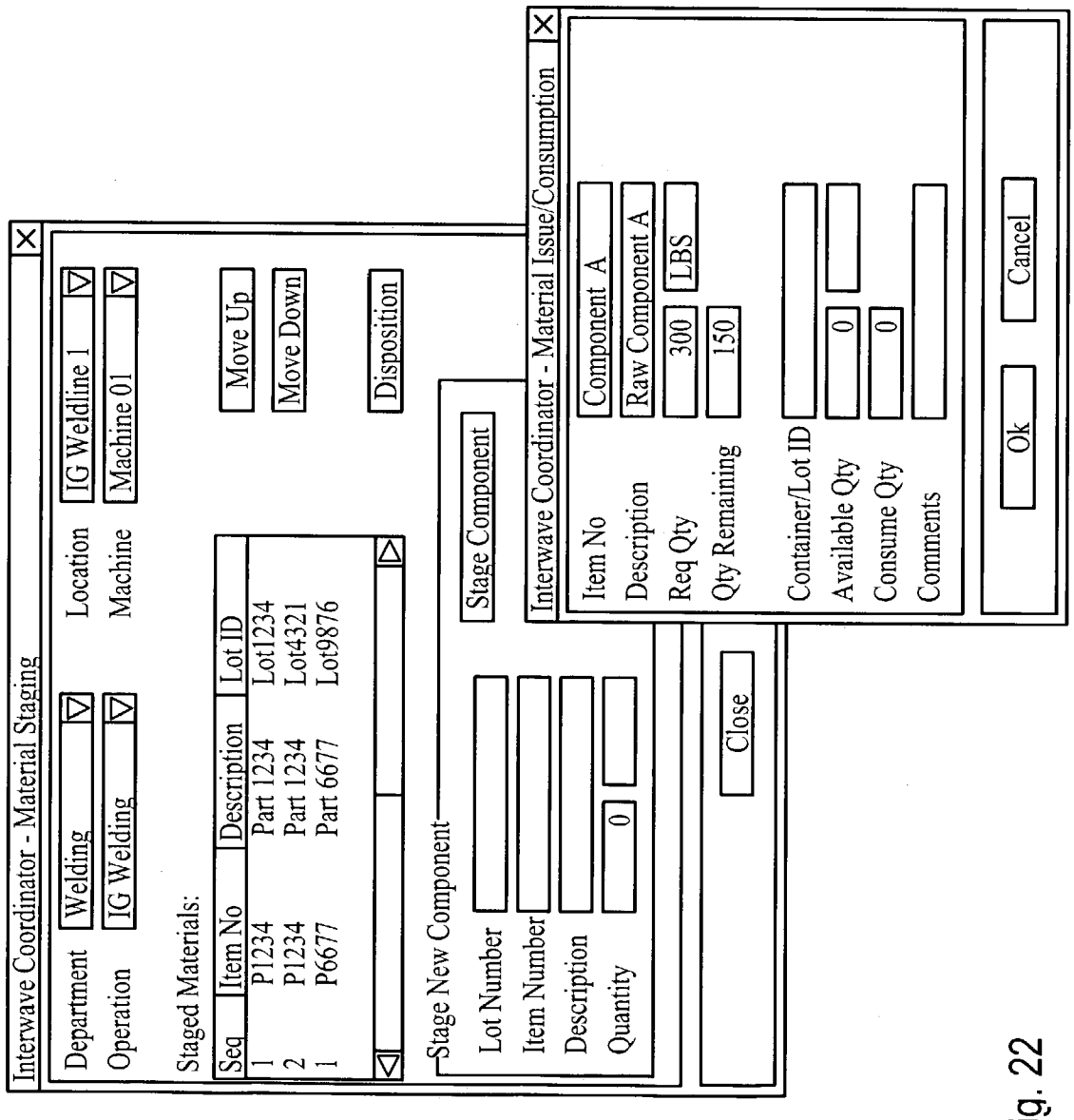

Interwave Coordinator - Material Staging
Department
Welding
Location
IG Weldline 1
Operation
IG Welding
Machine
Machine 01
Staged Materials:
Seq
Item No
Description
Lot ID
1
P1234
Part 1234
Lot1234
2
P1234
Part 1234
Lot4321
1
P6677
Part 6677
Lot9876
Move Up
Move Down
Disposition
Stage New Component
Lot Number
Item Number
Description
Quantity
0
Stage Component
Close
Interwave Coordinator - Material Issue/Consumption
Item No
Component A
Description
Raw Component A
Req Qty
300
LBS
Qty Remaining
150
Container/Lot ID
Available Qty
0
Consume Qty
0
Comments
Ok
Cancel

Fig. 22

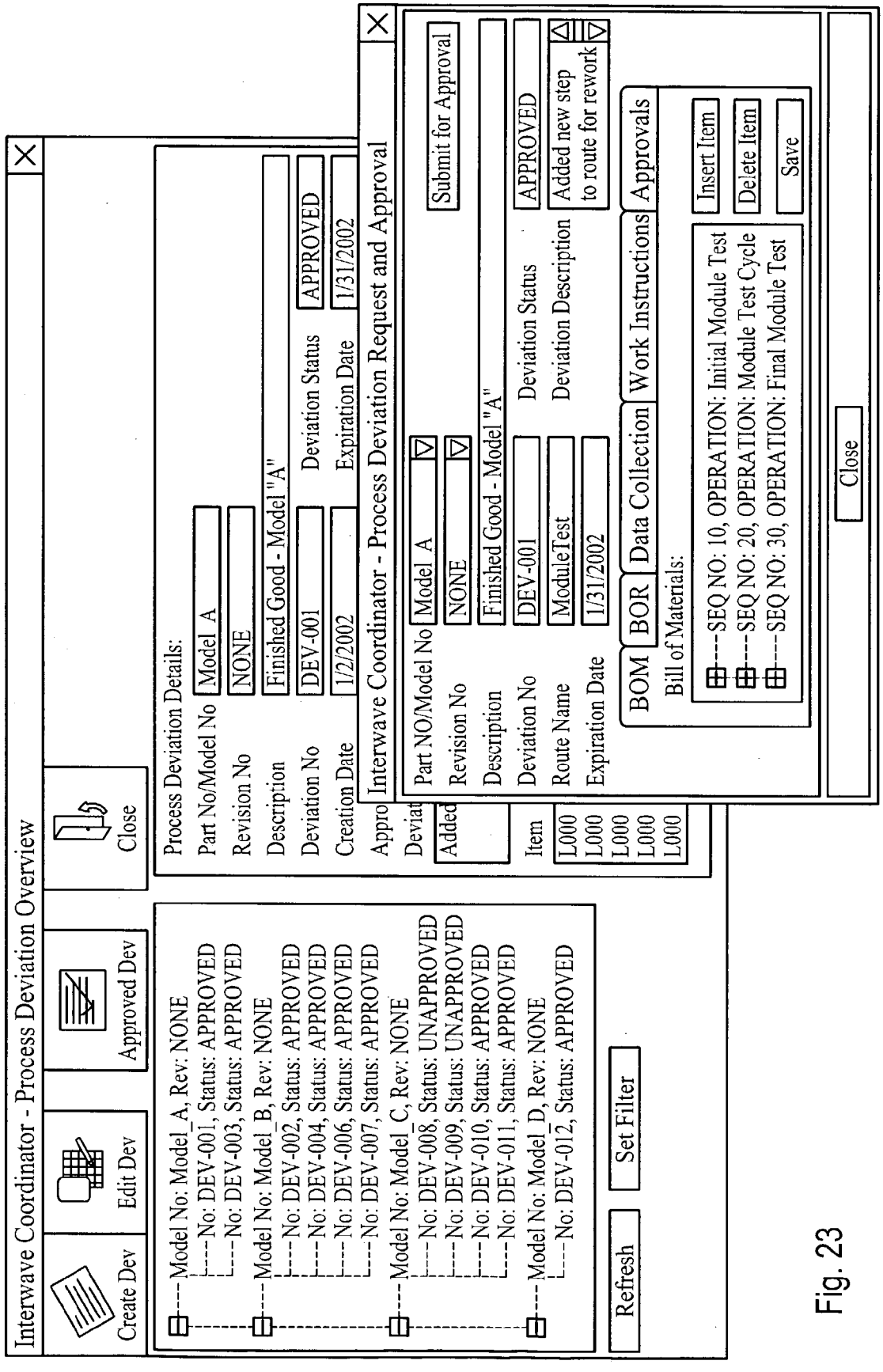

Interwave Coordinator - Process Deviation Overview
Create Dev
Edit Dev
Approved Dev
Close
Model No: Model_A, Rev: NONE
No: DEV-001, Status: APPROVED
No: DEV-003, Status: APPROVED
Model No: Model_B, Rev: NONE
No: DEV-002, Status: APPROVED
No: DEV-004, Status: APPROVED
No: DEV-006, Status: APPROVED
No: DEV-007, Status: APPROVED
Model No: Model_C, Rev: NONE
No: DEV-008, Status: UNAPPROVED
No: DEV-009, Status: UNAPPROVED
No: DEV-010, Status: APPROVED
No: DEV-011, Status: APPROVED
Model No: Model_D, Rev: NONE
No: DEV-012, Status: APPROVED
Refresh
Set Filter
Process Deviation Details:
Part No/Model No
Model A
Revision No
NONE
Description
Finished Good - Model "A"
Deviation No
DEV-001
Deviation Status
APPROVED
Creation Date
1/2/2002
Expiration Date
1/31/2002
Interwave Coordinator - Process Deviation Request and Approval
Part NO/Model No
Model A
Revision No
NONE
Description
Finished Good - Model "A"
Deviation No
DEV-001
Deviation Status
APPROVED
Route Name
ModuleTest
Deviation Description
Added new step to route for rework
Expiration Date
1/31/2002
Submit for Approval
BOM
BOR
Data Collection
Work Instructions
Approvals
Bill of Materials:
SEQ NO: 10, OPERATION: Initial Module Test
SEQ NO: 20, OPERATION: Module Test Cycle
SEQ NO: 30, OPERATION: Final Module Test
Insert Item
Delete Item
Save
Close
Item
L000
L000
L000
L000
L000

Fig. 23

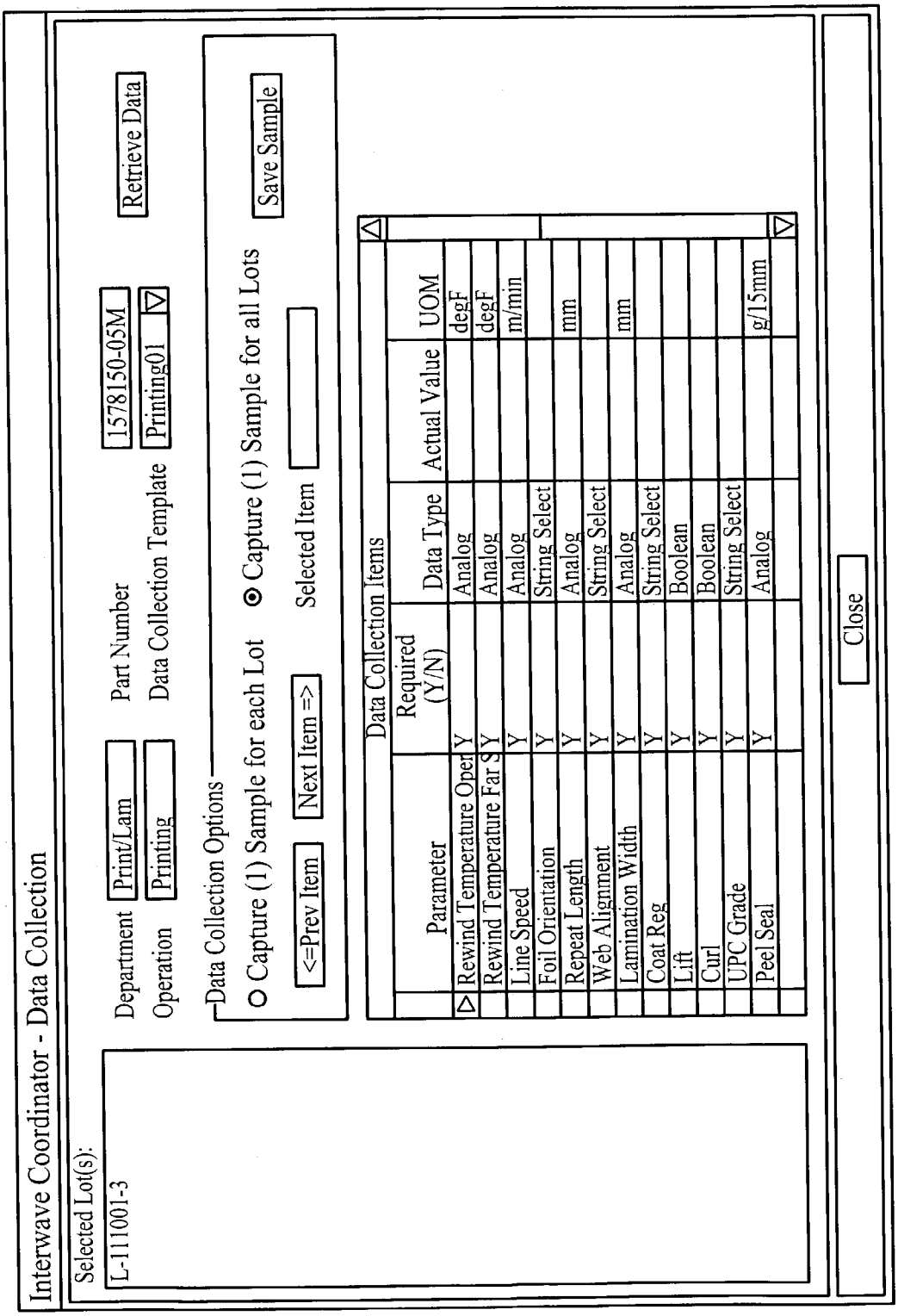

Interwave Coordinator - Data Collection
Selected Lot(s):
L-1111001-3
Department
Print/Lam
Operation
Printing
Part Number
1578150-05M
Data Collection Template
Printing01
Retrieve Data
Data Collection Options
Capture (1) Sample for each Lot
Capture (1) Sample for all Lots
Save Sample
<=Prev Item
Next Item =>
Selected Item
Data Collection Items
Parameter
Required (Y/N)
Data Type
Actual Value
UOM
Rewind Temperature Oper
Y
Analog
degF
Rewind Temperature Far S
Y
Analog
degF
Line Speed
Y
Analog
m/min
Foil Orientation
Y
String Select
Repeat Length
Y
Analog
mm
Web Alignment
Y
String Select
Lamination Width
Y
Analog
mm
Coat Reg
Y
String Select
Lift
Y
Boolean
Curl
Y
Boolean
UPC Grade
Y
String Select
Peel Seal
Y
Analog
g/15mm
Close

Fig. 24

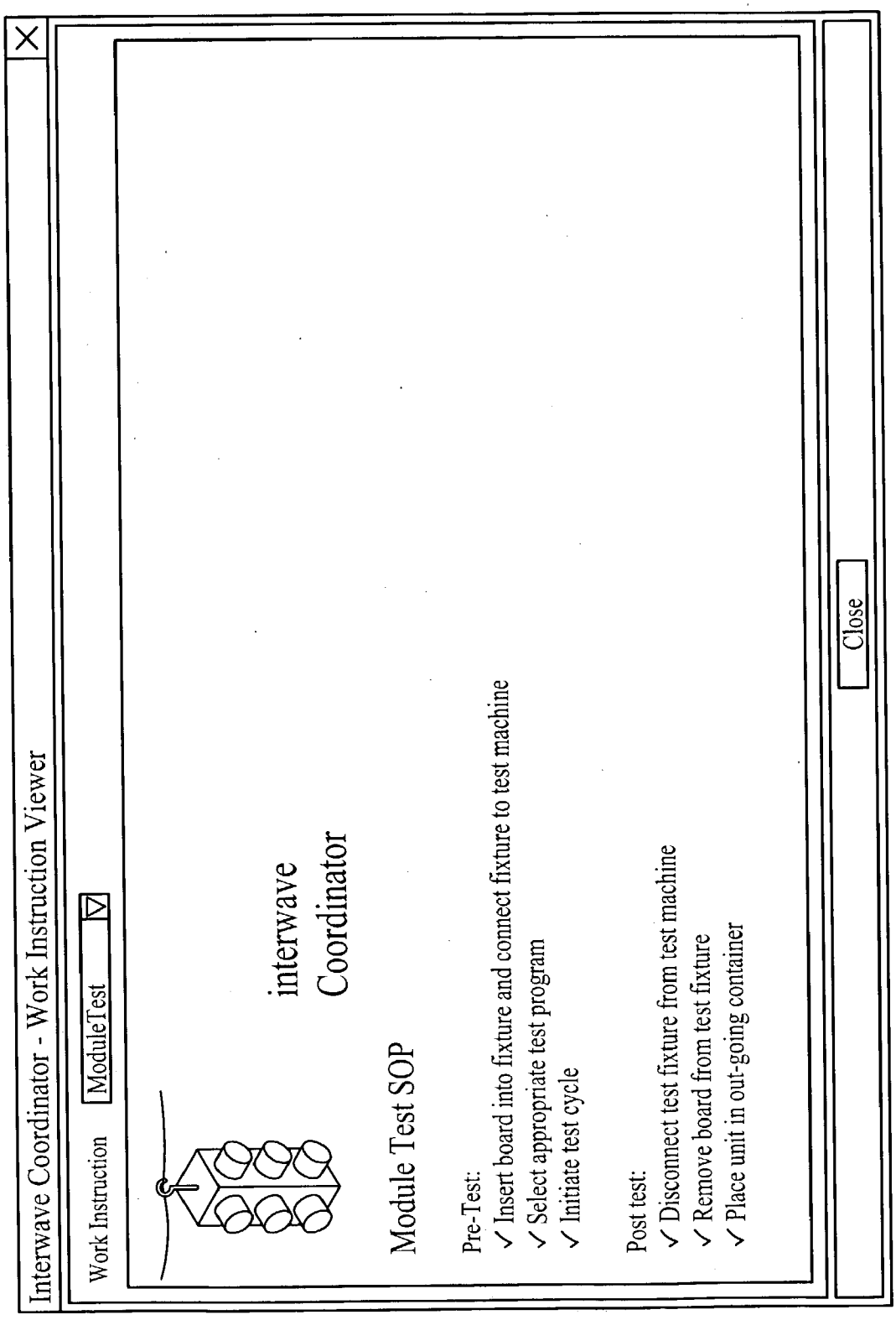

Interwave Coordinator - Work Instruction Viewer
Work Instruction
ModuleTest
interwave
Coordinator
Module Test SOP
Pre-Test:
✓ Insert board into fixture and connect fixture to test machine
✓ Select appropriate test program
✓ Initiate test cycle
Post test:
✓ Disconnect test fixture from test machine
✓ Remove board from test fixture
✓ Place unit in out-going container
Close

Fig. 25

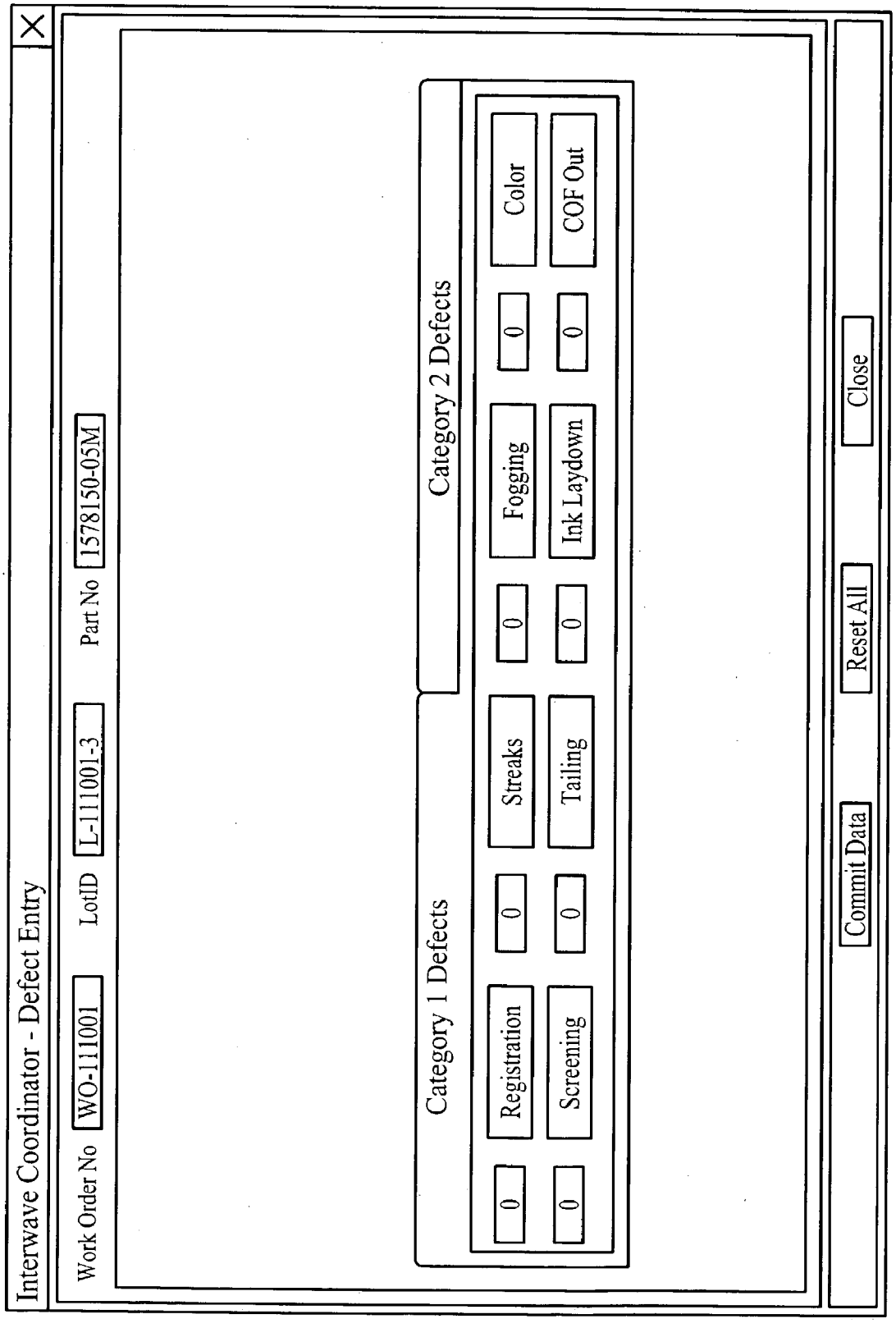

Interwave Coordinator - Defect Entry
Work Order No
WO-111001
LotID
L-111001-3
Part No
1578150-05M
Category 1 Defects
Registration
Screening
Streaks
Tailing
Category 2 Defects
Fogging
Ink Laydown
Color
COF Out
0
Commit Data
Reset All
Close

Fig. 26

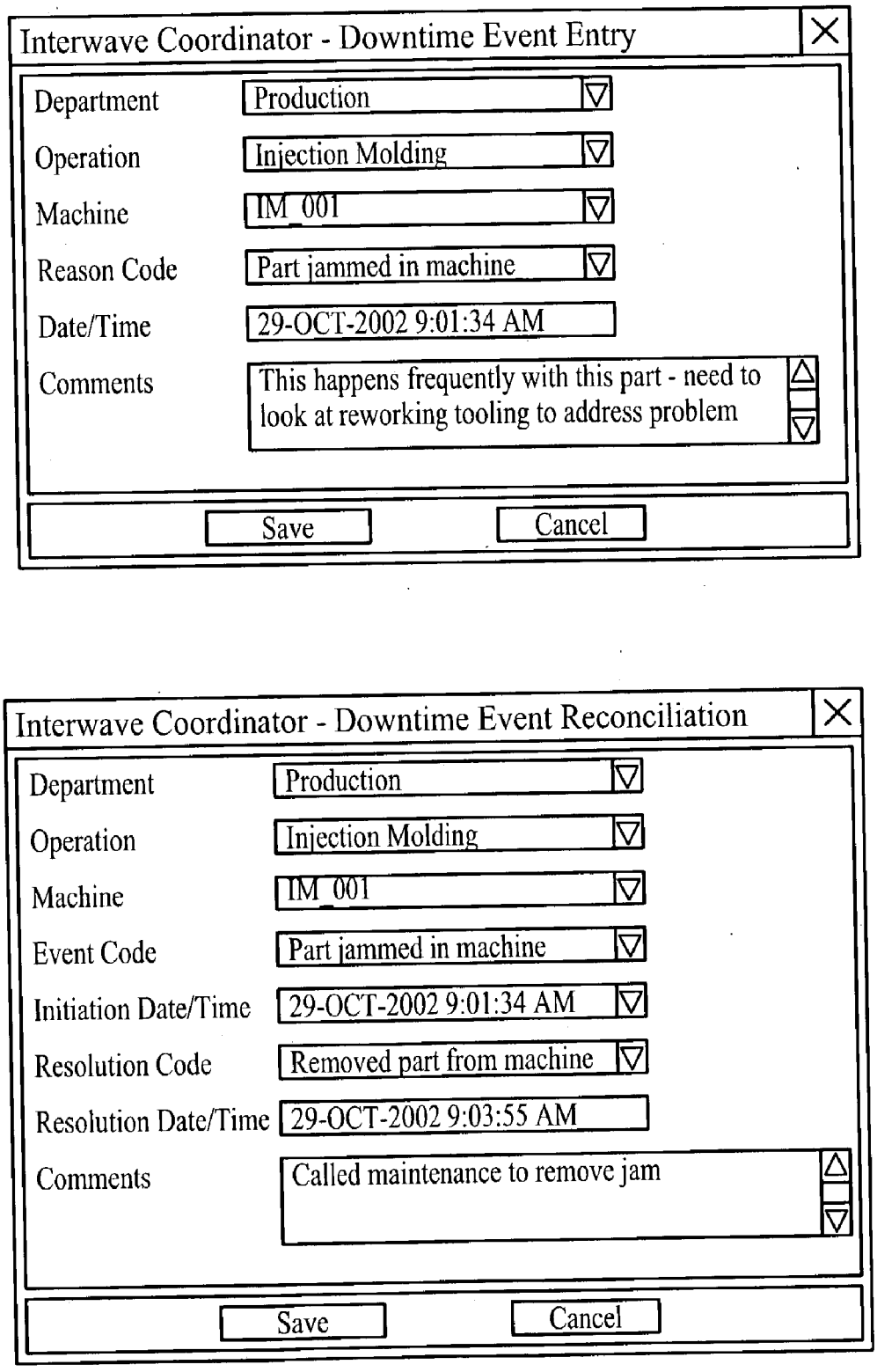

Interwave Coordinator - Downtime Event Entry
Department
Production
Operation
Injection Molding
Machine
IM_001
Reason Code
Part jammed in machine
Date/Time
29-OCT-2002 9:01:34 AM
Comments
This happens frequently with this part - need to look at reworking tooling to address problem
Save
Cancel
Interwave Coordinator - Downtime Event Reconciliation
Department
Production
Operation
Injection Molding
Machine
IM_001
Event Code
Part jammed in machine
Initiation Date/Time
29-OCT-2002 9:01:34 AM
Resolution Code
Removed part from machine
Resolution Date/Time
29-OCT-2002 9:03:55 AM
Comments
Called maintenance to remove jam
Save
Cancel

Fig. 27

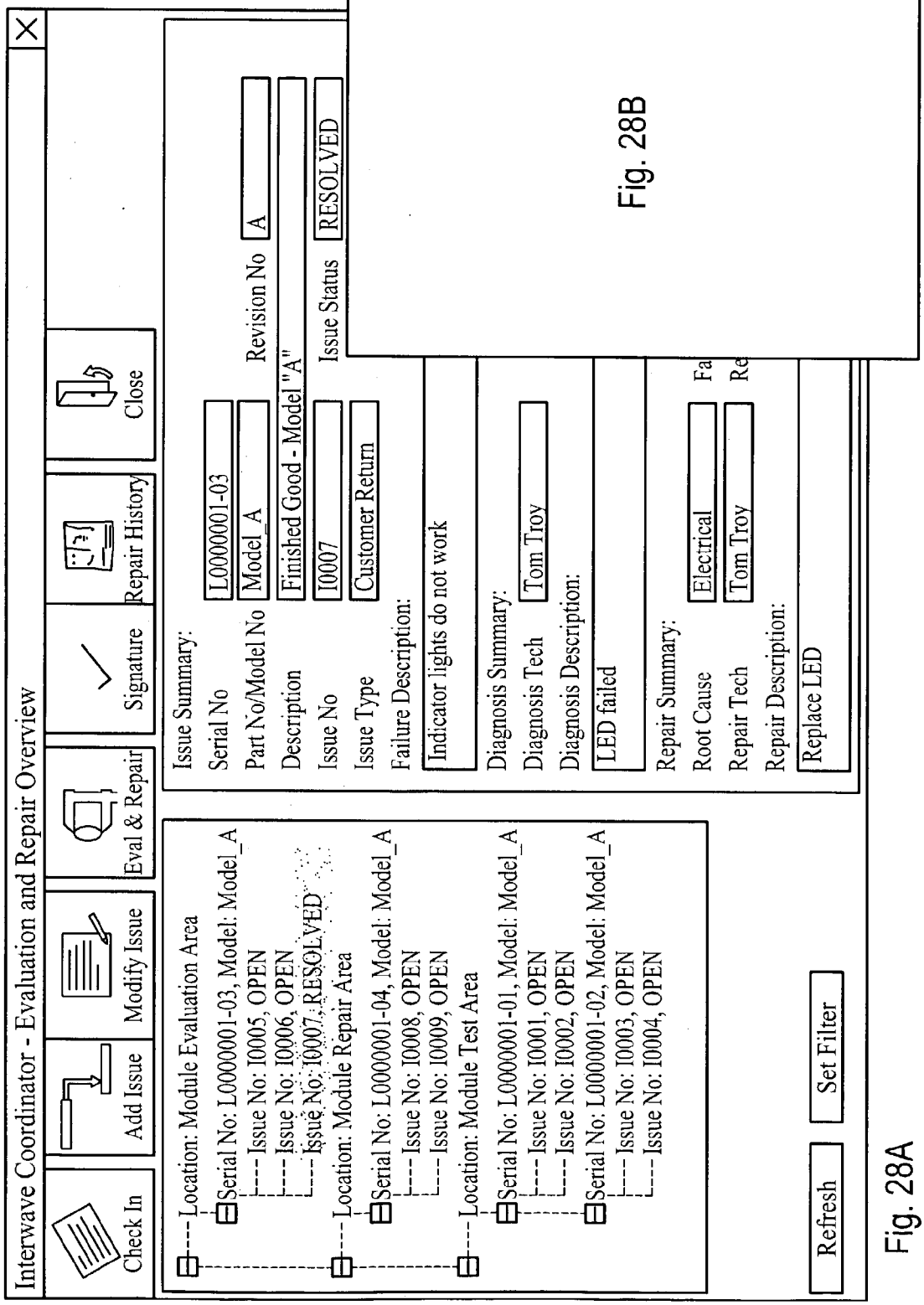


Fig. 28A

Fig. 28B

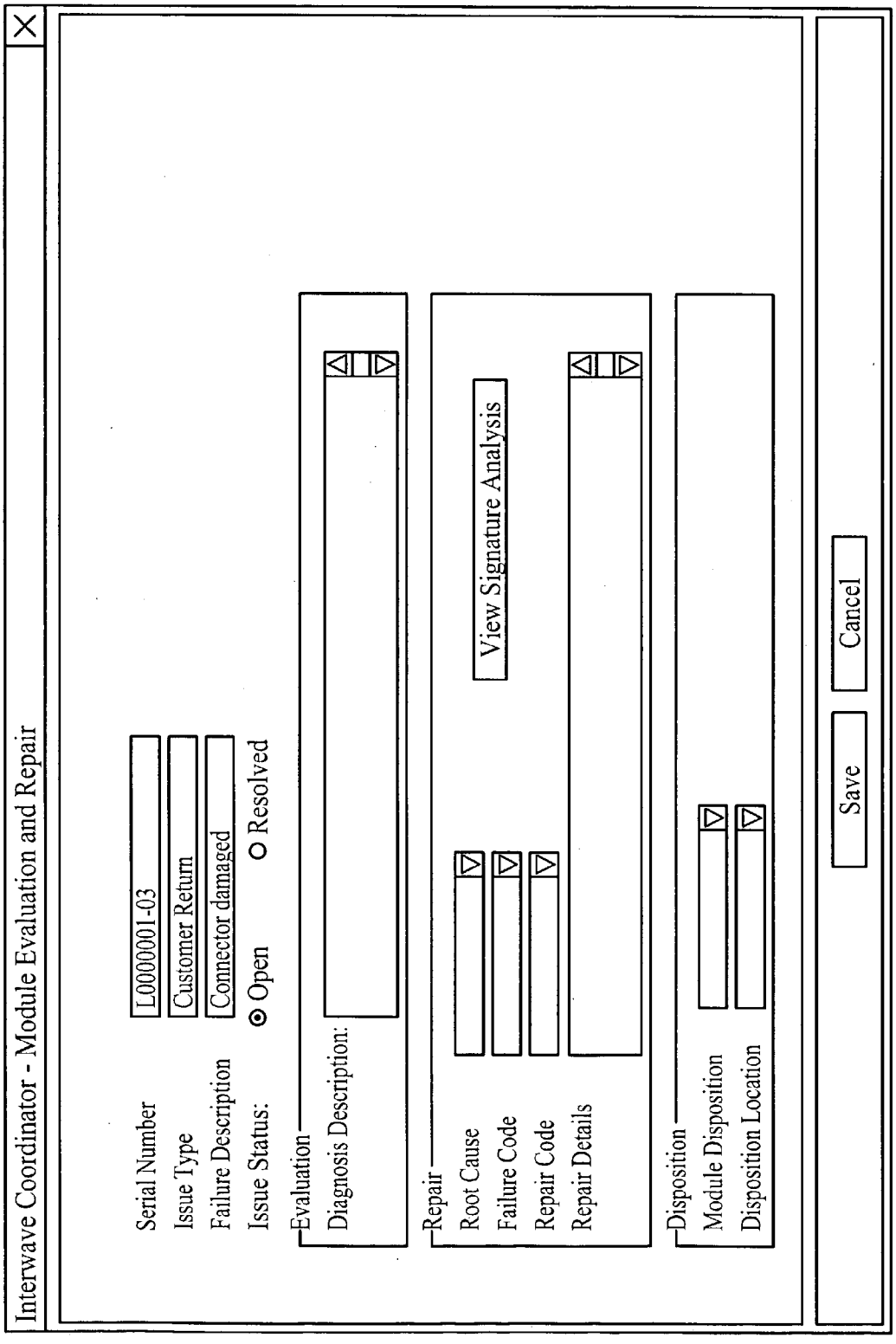

Interwave Coordinator - Module Evaluation and Repair
Serial Number
L0000001-03
Issue Type
Customer Return
Failure Description
Connector damaged
Issue Status:
Open
Resolved
Evaluation
Diagnosis Description:
Repair
Root Cause
Failure Code
Repair Code
Repair Details
View Signature Analysis
Disposition
Module Disposition
Disposition Location
Save
Cancel

Fig. 28B

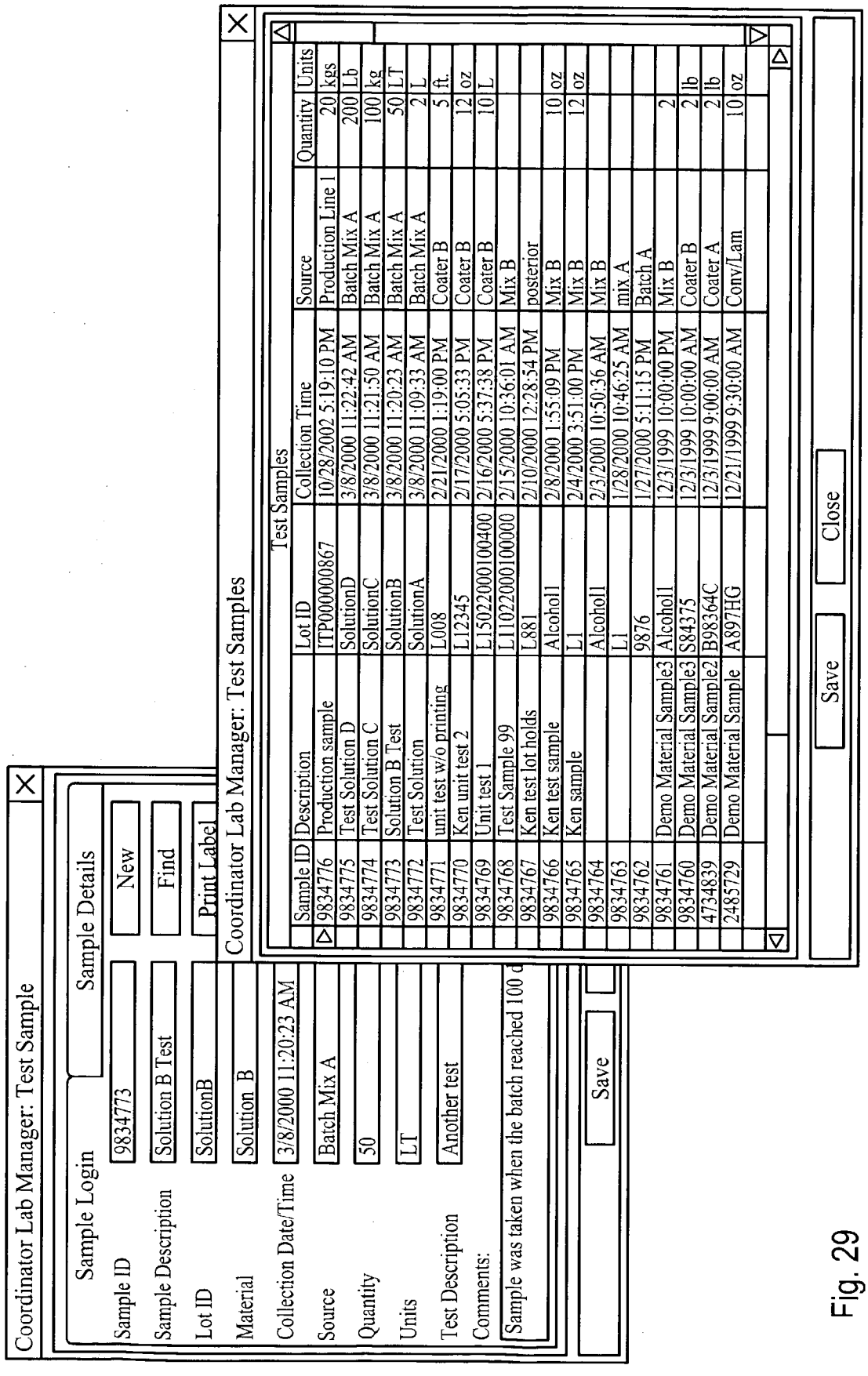

Coordinator Lab Manager: Test Sample
Sample Login
Sample Details
Sample ID
9834773
New
Sample Description
Solution B Test
Find
Lot ID
SolutionB
Print Label
Material
Solution_B
Collection Date/Time
3/8/2000 11:20:23 AM
Source
Batch Mix A
Quantity
50
Units
LT
Test Description
Another test
Comments:
Sample was taken when the batch reached 100 d
Save
Coordinator Lab Manager: Test Samples
Test Samples
Sample ID | Description | Lot ID | Collection Time | Source | Quantity | Units
9834776 | Production sample | ITP000000867 | 10/28/2002 5:19:10 PM | Production Line 1 | 20 | kgs
9834775 | Test Solution D | SolutionD | 3/8/2000 11:22:42 AM | Batch Mix A | 200 | Lb
9834774 | Test Solution C | SolutionC | 3/8/2000 11:21:50 AM | Batch Mix A | 100 | kg
9834773 | Solution B Test | SolutionB | 3/8/2000 11:20:23 AM | Batch Mix A | 50 | LT
9834772 | Test Solution | SolutionA | 3/8/2000 11:09:33 AM | Batch Mix A | 2 | L
9834771 | unit test w/o printing | L008 | 2/21/2000 1:19:00 PM | Coater B | 5 | ft.
9834770 | Ken unit test 2 | L12345 | 2/17/2000 5:05:33 PM | Coater B | 12 | oz
9834769 | Unit test 1 | L150220001004000 | 2/16/2000 5:37:38 PM | Coater B | 10 | L
9834768 | Test Sample 99 | L110220001000000 | 2/15/2000 10:36:01 AM | Mix B
9834767 | Ken test lot holds | L881 | 2/10/2000 12:28:54 PM | posterior
9834766 | Ken test sample | Alcohol1 | 2/8/2000 1:55:09 PM | Mix B | 10 | oz
9834765 | Ken sample | L1 | 2/4/2000 3:51:00 PM | Mix B | 12 | oz
9834764 | | Alcohol1 | 2/3/2000 10:50:36 AM | Mix B
9834763 | | L1 | 1/28/2000 10:46:25 AM | mix A
9834762 | | 9876 | 1/27/2000 5:11:15 PM | Batch A
9834761 | Demo Material Sample3 | Alcohol1 | 12/3/1999 10:00:00 PM | Mix B | 2
9834760 | Demo Material Sample3 | S84375 | 12/3/1999 10:00:00 AM | Coater B | 2 | lb
4734839 | Demo Material Sample2 | B98364C | 12/3/1999 9:00:00 AM | Coater A | 2 | lb
2485729 | Demo Material Sample | A897HG | 12/21/1999 9:30:00 AM | Conv/Lam | 10 | oz
Save
Close

Fig. 29

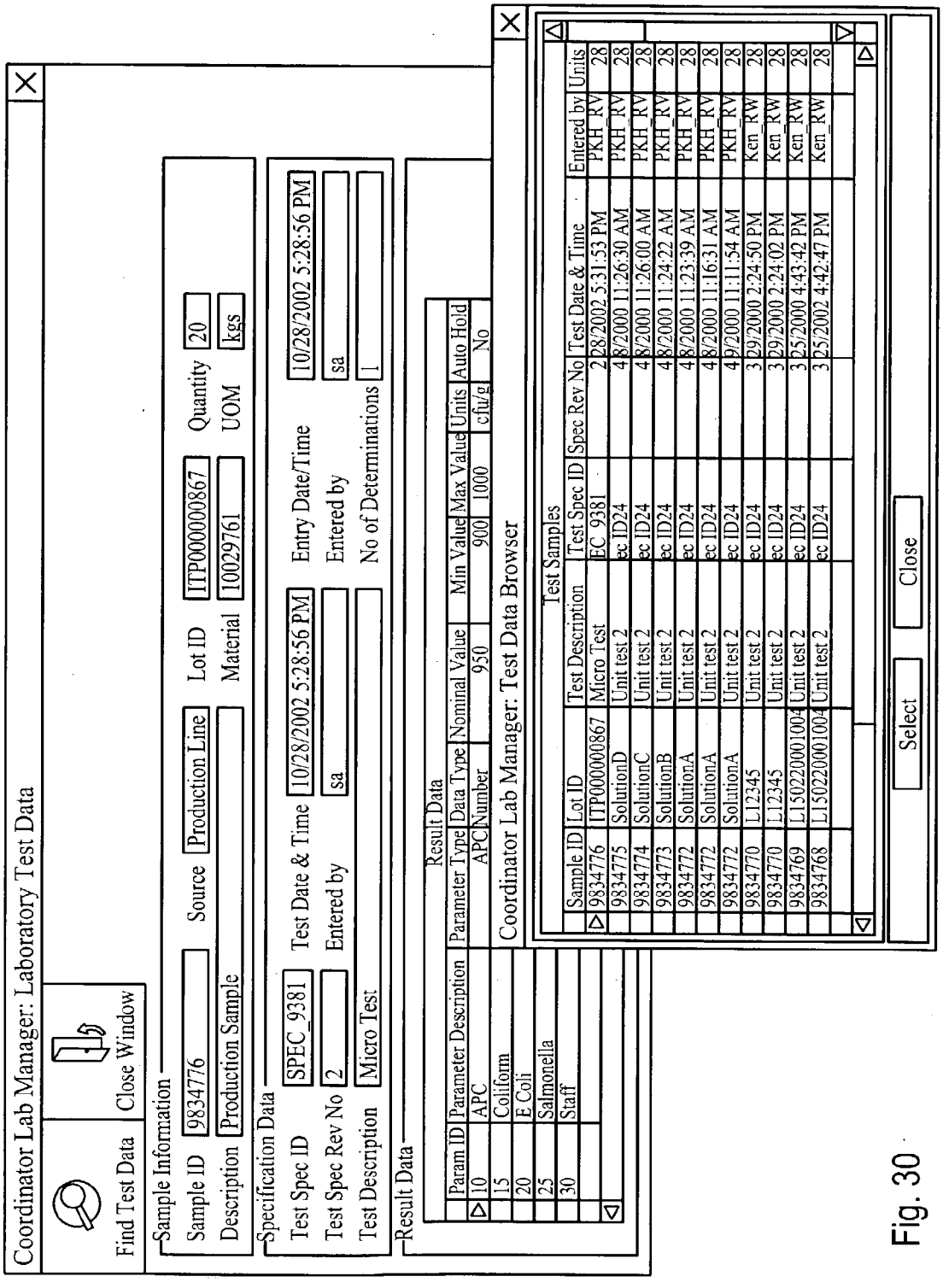

Coordinator Lab Manager: Laboratory Test Data
Find Test Data
Close Window
Sample Information
Sample ID 9834776
Source Production Line
Lot ID ITP000000867
Quantity 20
Description Production Sample
Material 10029761
UOM kgs
Specification Data
Test Spec ID SPEC_9381
Test Date & Time 10/28/2002 5:28:56 PM
Entry Date/Time 10/28/2002 5:28:56 PM
Test Spec Rev No 2
Entered by sa
Entered by sa
Test Description Micro Test
No of Determinations 1
Result Data
Param ID Parameter Description
10 APC
15 Coliform
20 E Coli
25 Salmonella
30 Staff
Result Data
Parameter Type Data Type Nominal Value Min Value Max Value Units Auto Hold
APC Number 950 900 1000 cfu/g No
Coordinator Lab Manager: Test Data Browser
Test Samples
Sample ID Lot ID Test Description Test Spec ID Spec Rev No Test Date & Time Entered by Units
9834776 ITP000000867 Micro Test EC_9381 2 28/2002 5:31:53 PM PKH_RV 28
9834775 SolutionD Unit test 2 ec ID24 4 8/2000 11:26:30 AM PKH_RV 28
9834774 SolutionC Unit test 2 ec ID24 4 8/2000 11:26:00 AM PKH_RV 28
9834773 SolutionB Unit test 2 ec ID24 4 8/2000 11:24:22 AM PKH_RV 28
9834772 SolutionA Unit test 2 ec ID24 4 8/2000 11:23:39 AM PKH_RV 28
9834772 SolutionA Unit test 2 ec ID24 4 8/2000 11:16:31 AM PKH_RV 28
9834772 SolutionA Unit test 2 ec ID24 4 9/2000 11:11:54 AM PKH_RV 28
9834770 L12345 Unit test 2 ec ID24 3 29/2000 2:24:50 PM Ken_RW 28
9834770 L12345 Unit test 2 ec ID24 3 29/2000 2:24:02 PM Ken_RW 28
9834769 L150220001004 Unit test 2 ec ID24 3 25/2000 4:43:42 PM Ken_RW 28
9834768 L150220001004 Unit test 2 ec ID24 3 25/2002 4:42:47 PM Ken_RW 28
Select
Close

Fig. 30

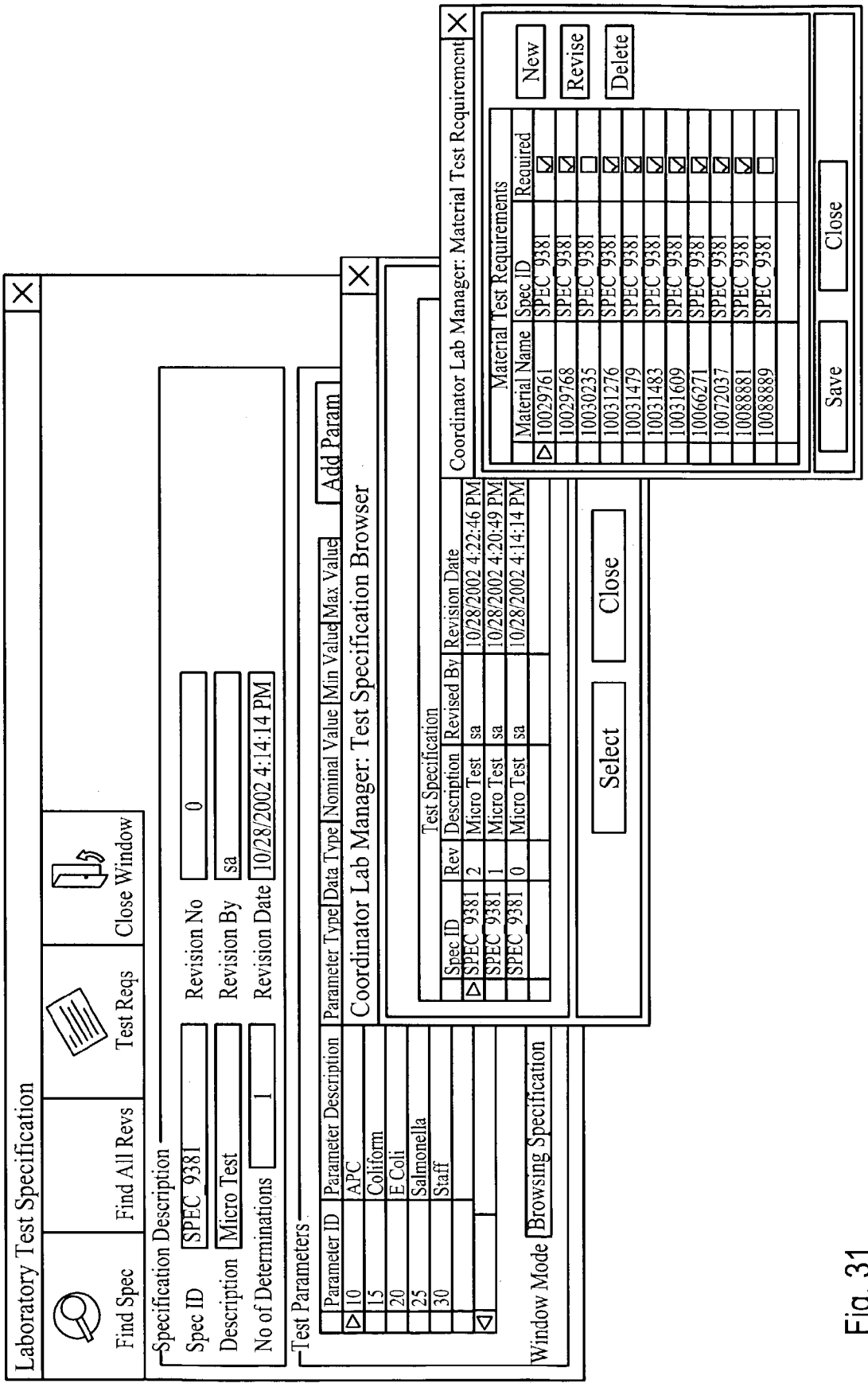

Laboratory Test Specification
Find Spec
Find All Revs
Test Reqs
Close Window
Specification Description
Spec ID
SPEC_9381
Description
Micro Test
No of Determinations
1
Revision No
0
Revision By
sa
Revision Date
10/28/2002 4:14:14 PM
Test Parameters
Parameter ID
Parameter Description
Parameter Type
Data Type
Nominal Value
Min Value
Max Value
Add Param
10 APC
15 Coliform
20 E Coli
25 Salmonella
30 Staff
Window Mode
Browsing Specification
Coordinator Lab Manager: Test Specification Browser
Test Specification
Spec ID
Rev
Description
Revised By
Revision Date
SPEC_9381 2 Micro Test sa 10/28/2002 4:22:46 PM
SPEC_9381 1 Micro Test sa 10/28/2002 4:20:49 PM
SPEC_9381 0 Micro Test sa 10/28/2002 4:14:14 PM
Select
Close
Coordinator Lab Manager: Material Test Requirement
Material Test Requirements
Material Name
Spec ID
Required
10029761 SPEC_9381
10029768 SPEC_9381
10030235 SPEC_9381
10031276 SPEC_9381
10031479 SPEC_9381
10031483 SPEC_9381
10031609 SPEC_9381
10066271 SPEC_9381
10072037 SPEC_9381
10088881 SPEC_9381
10088889 SPEC_9381
New
Revise
Delete
Save
Close

Fig. 31

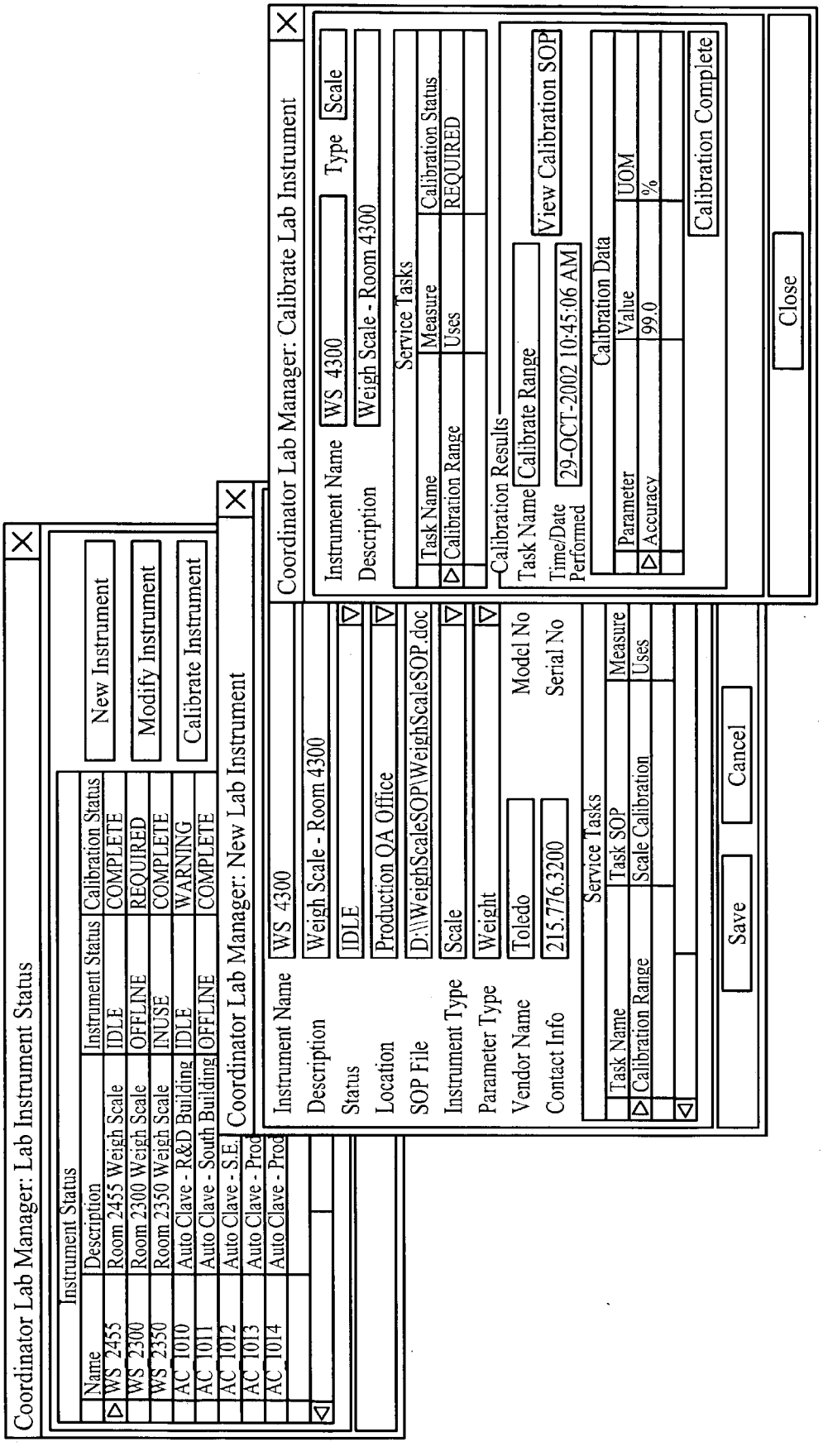

Coordinator Lab Manager: Lab Instrument Status
Instrument Status
Name
Description
Instrument Status
Calibration Status
WS 2455
Room 2455 Weigh Scale
IDLE
COMPLETE
WS 2300
Room 2300 Weigh Scale
OFFLINE
REQUIRED
WS 2350
Room 2350 Weigh Scale
INUSE
COMPLETE
AC 1010
Auto Clave - R&D Building
IDLE
WARNING
AC 1011
Auto Clave - South Building
OFFLINE
COMPLETE
AC 1012
Auto Clave - S.E.
AC 1013
Auto Clave - Prod
AC 1014
Auto Clave - Prod
New Instrument
Modify Instrument
Calibrate Instrument
Coordinator Lab Manager: New Lab Instrument
Instrument Name
WS 4300
Description
Weigh Scale - Room 4300
Status
IDLE
Location
Production QA Office
SOP File
D:\WeighScaleSOP\WeighScaleSOP.doc
Instrument Type
Scale
Parameter Type
Weight
Vendor Name
Toledo
Model No
Contact Info
215.776.3200
Serial No
Service Tasks
Task Name
Task SOP
Measure
Calibration Range
Scale Calibration
Uses
Save
Cancel
Coordinator Lab Manager: Calibrate Lab Instrument
Instrument Name
WS 4300
Type
Scale
Description
Weigh Scale - Room 4300
Service Tasks
Task Name
Measure
Calibration Status
Calibration Range
Uses
REQUIRED
Calibration Results
Task Name
Calibrate Range
View Calibration SOP
Time/Date Performed
29-OCT-2002 10:45:06 AM
Calibration Data
Parameter
Value
UOM
Accuracy
99.0
%
Calibration Complete
Close

Fig. 32

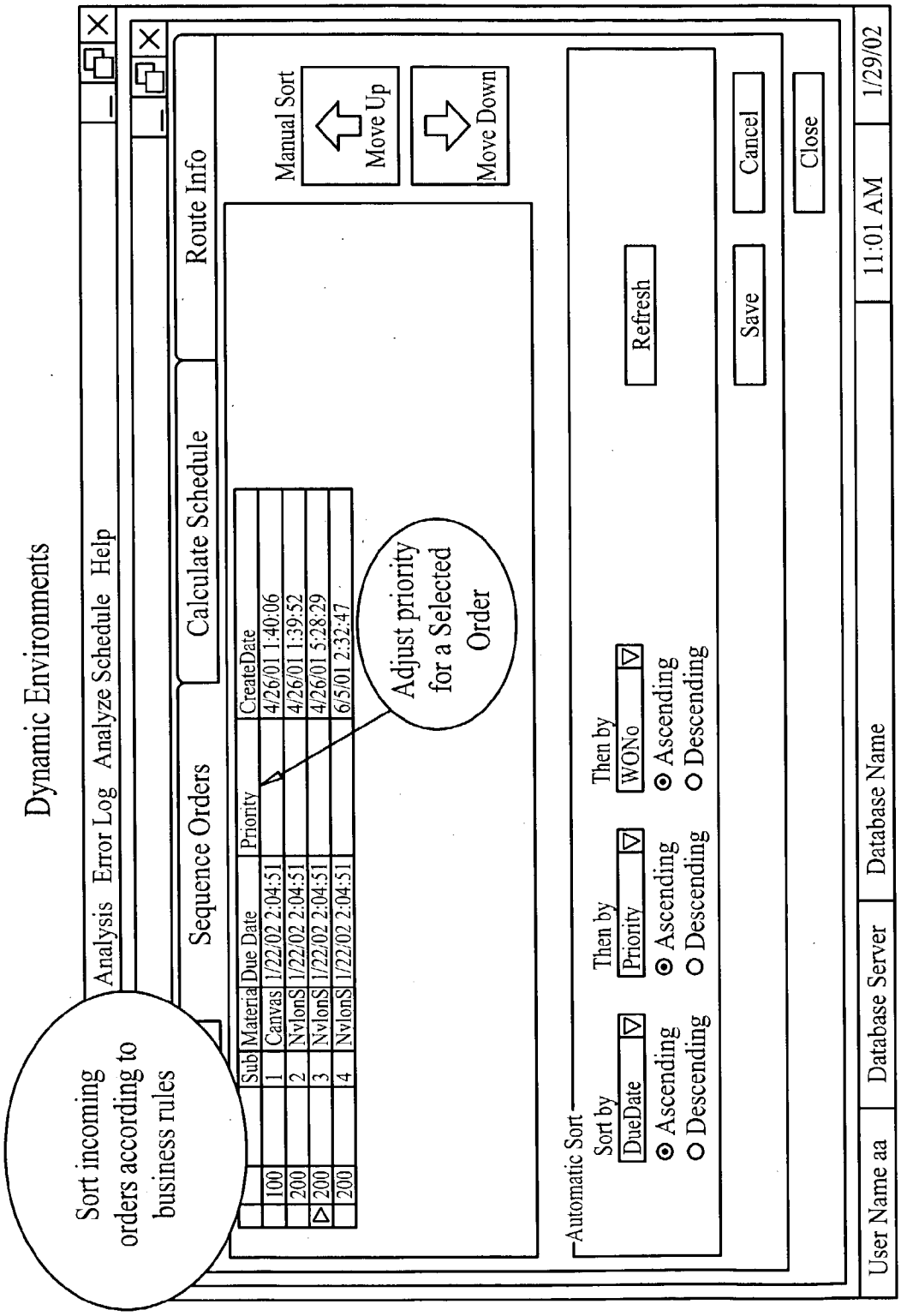

Dynamic Environments
Analysis Error Log Analyze Schedule Help
Sequence Orders
Calculate Schedule
Route Info
Sort incoming orders according to business rules
Adjust priority for a Selected Order
Manual Sort
Move Up
Move Down
Sub Materia Due Date Priority CreateDate
100 1 Canvas 1/22/02 2:04:51 4/26/01 1:40:06
200 2 NylonS 1/22/02 2:04:51 4/26/01 1:39:52
200 3 NylonS 1/22/02 2:04:51 4/26/01 5:28:29
200 4 NylonS 1/22/02 2:04:51 6/5/01 2:32:47
Automatic Sort
Sort by DueDate
Ascending
Descending
Then by Priority
Ascending
Descending
Then by WONo
Ascending
Descending
Refresh
Save
Cancel
Close
User Name aa
Database Server
Database Name
11:01 AM
1/29/02

Fig. 33

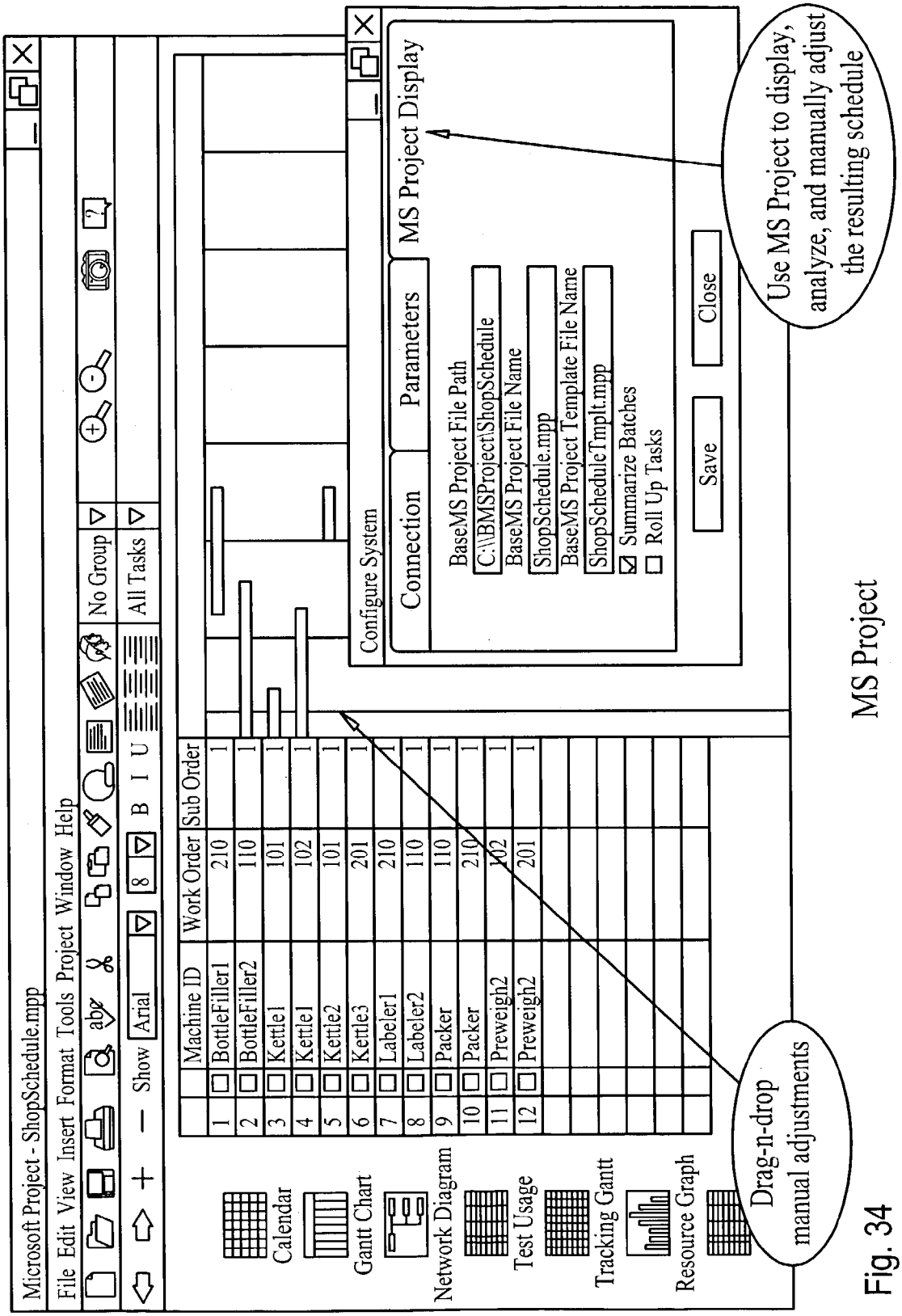

Microsoft Project - ShopSchedule.mpp
File Edit View Insert Format Tools Project Window Help
Show
Arial
8
B I U
No Group
All Tasks
Machine ID
Work Order
Sub Order
1 BottleFiller1 210 1
2 BottleFiller2 110 1
3 Kettle1 101 1
4 Kettle1 102 1
5 Kettle2 101 1
6 Kettle3 201 1
7 Labeler1 210 1
8 Labeler2 110 1
9 Packer 110 1
10 Packer 210 1
11 Preweigh2 102 1
12 Preweigh2 201 1
Calendar
Gantt Chart
Network Diagram
Test Usage
Tracking Gantt
Resource Graph
Configure System
Connection
Parameters
MS Project Display
BaseMS Project File Path
C:\\BMSProject\ShopSchedule
BaseMS Project File Name
ShopSchedule.mpp
BaseMS Project Template File Name
ShopScheduleTmplt.mpp
Summarize Batches
Roll Up Tasks
Save
Close
Use MS Project to display, analyze, and manually adjust the resulting schedule
Drag-n-drop manual adjustments
MS Project

Fig. 34

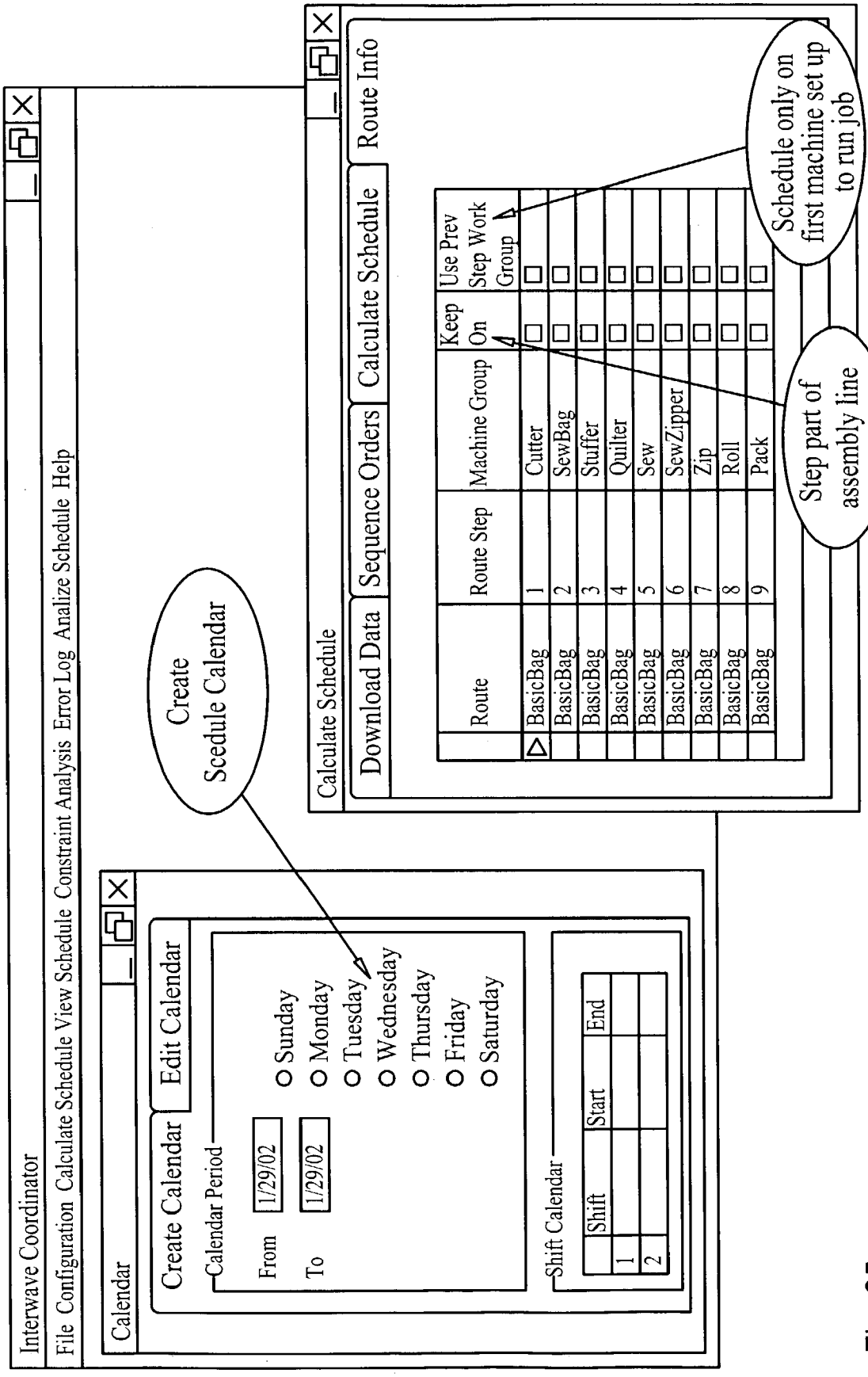

Interwave Coordinator
File Configuration Calculate Schedule View Schedule Constraint Analysis Error Log Analize Schedule Help
Calendar
Create Calendar
Edit Calendar
Calendar Period
From 1/29/02
To 1/29/02
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Shift Calendar
Shift
Start
End
1
2
Create Scedule Calendar
Calculate Schedule
Download Data
Sequence Orders
Calculate Schedule
Route Info
Route
Route Step
Machine Group
Keep On
Use Prev Step Work Group
BasicBag 1 Cutter
BasicBag 2 SewBag
BasicBag 3 Stuffer
BasicBag 4 Quilter
BasicBag 5 Sew
BasicBag 6 SewZipper
BasicBag 7 Zip
BasicBag 8 Roll
BasicBag 9 Pack
Schedule only on first machine set up to run job
Step part of assembly line

Fig. 35

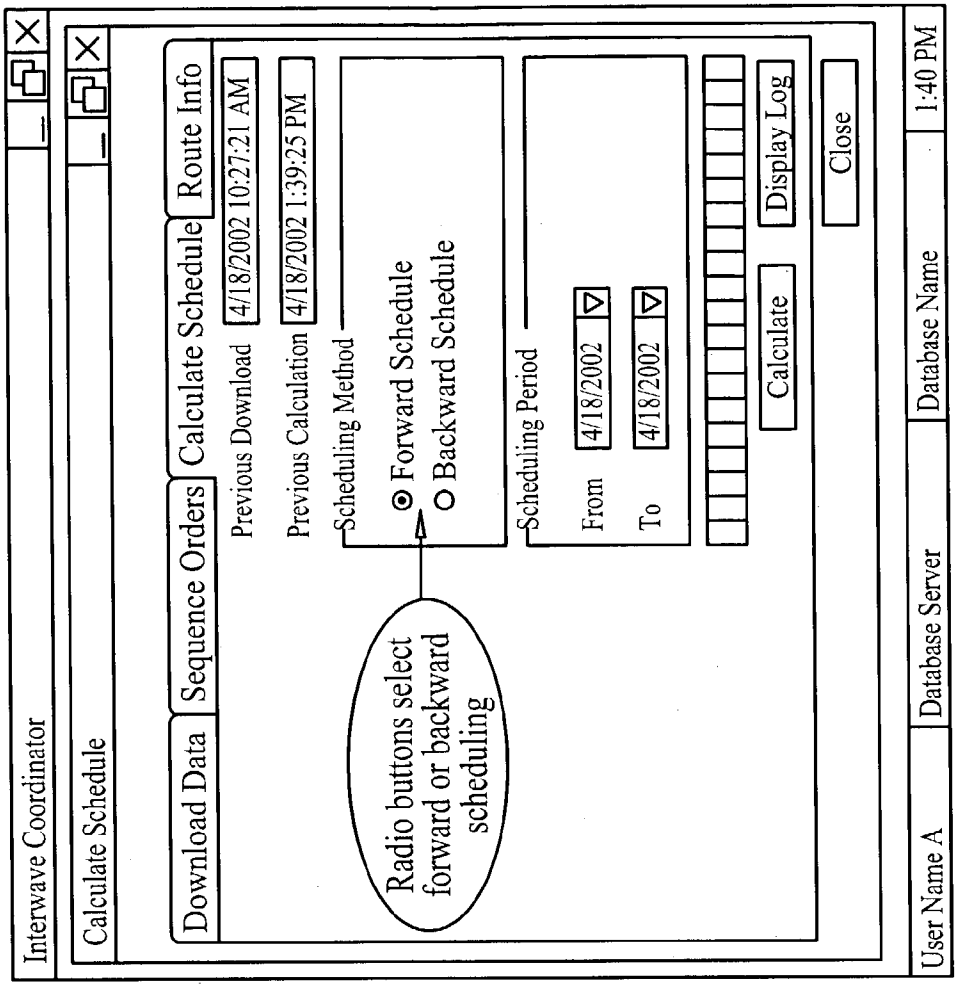

Interwave Coordinator
Calculate Schedule
Download Data
Sequence Orders
Calculate Schedule
Route Info
Previous Download
4/18/2002 10:27:21 AM
Previous Calculation
4/18/2002 1:39:25 PM
Scheduling Method
Forward Schedule
Backward Schedule
Radio buttons select forward or backward scheduling
Scheduling Period
From
4/18/2002
To
4/18/2002
Calculate
Display Log
Close
User Name A
Database Server
Database Name
1:40 PM

Fig. 37

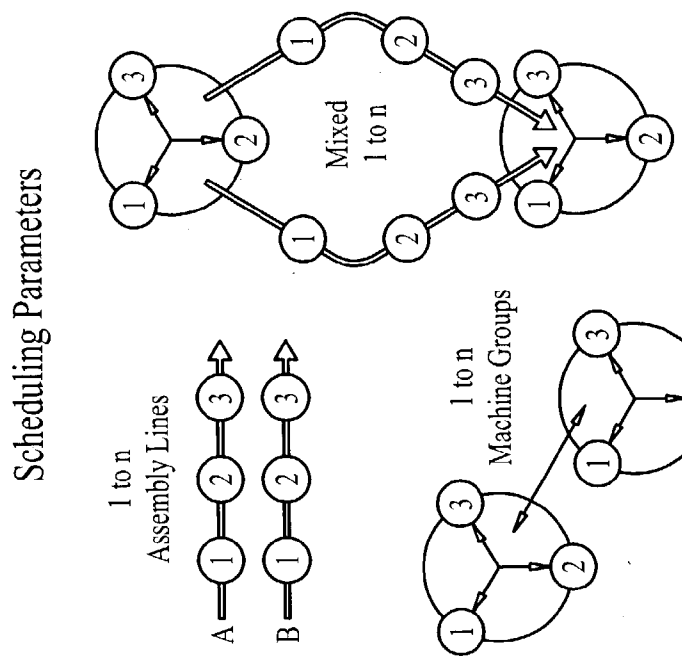

Scheduling Parameters
1 to n
Assembly Lines
A
B
Mixed
1 to n
1 to n
Machine Groups

Fig. 36

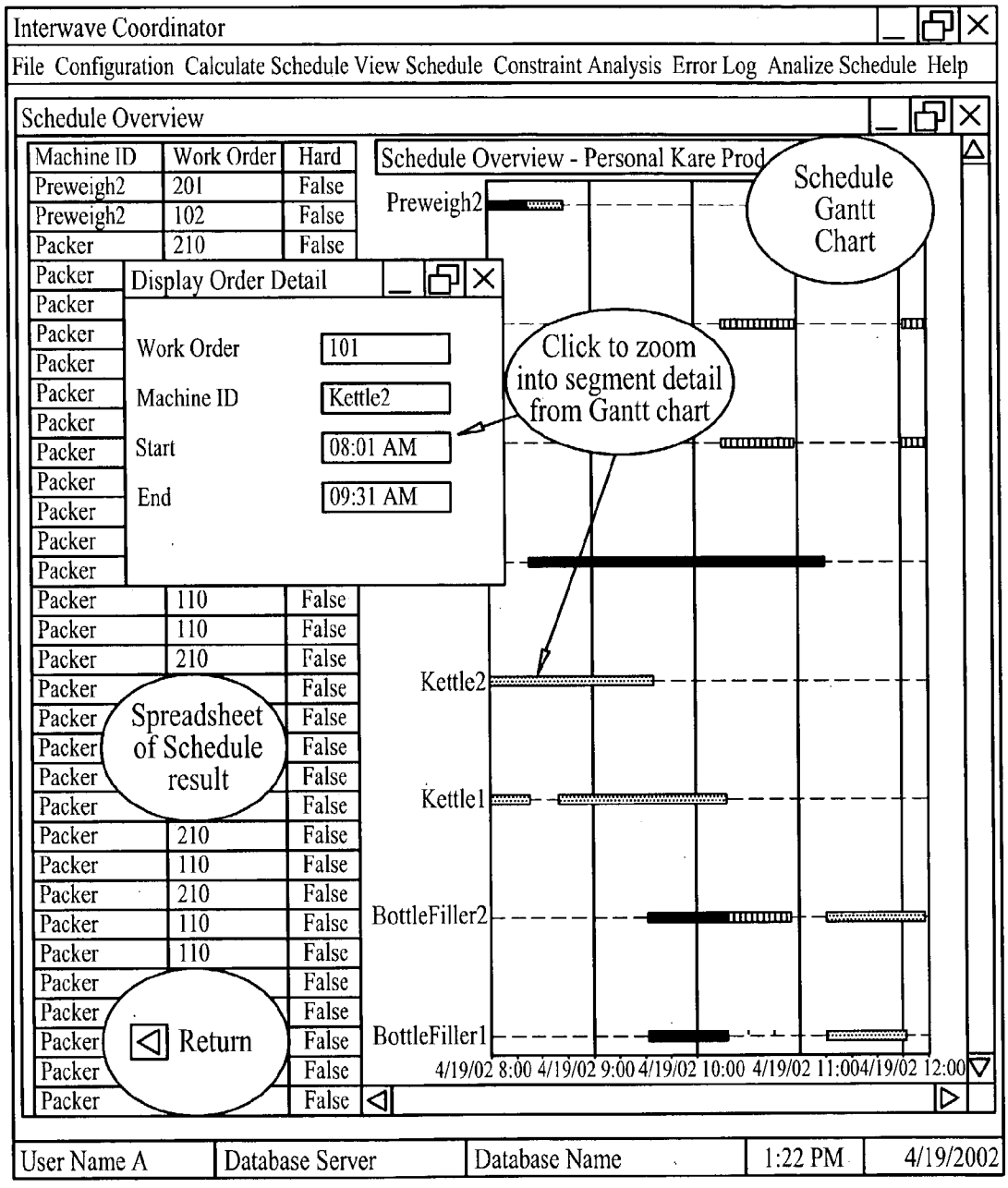

Interwave Coordinator
File Configuration Calculate Schedule View Schedule Constraint Analysis Error Log Analize Schedule Help
Schedule Overview
Machine ID
Work Order
Hard
Schedule Overview - Personal Kare Prod
Schedule Gantt Chart
Display Order Detail
Work Order
101
Machine ID
Kettle2
Start
08:01 AM
End
09:31 AM
Click to zoom into segment detail from Gantt chart
Spreadsheet of Schedule result
Return
Preweigh2
Kettle2
Kettle1
BottleFiller2
BottleFiller1
4/19/02 8:00 4/19/02 9:00 4/19/02 10:00 4/19/02 11:00 4/19/02 12:00
User Name A
Database Server
Database Name
1:22 PM
4/19/2002

Fig. 38

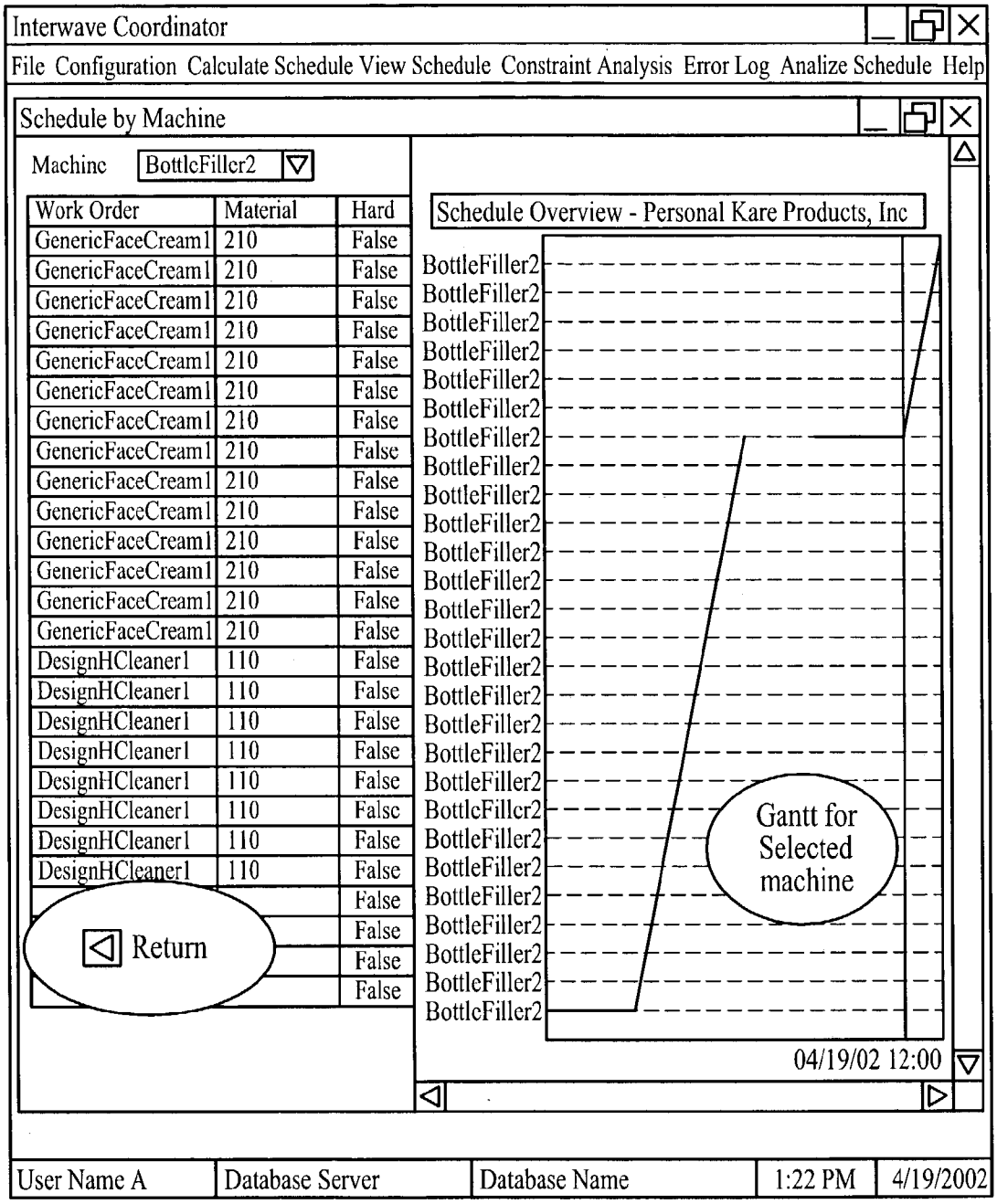

Interwave Coordinator
File Configuration Calculate Schedule View Schedule Constraint Analysis Error Log Analize Schedule Help
Schedule by Machine
Machine BottleFiller2
Work Order Material Hard
GenericFaceCream1 210 False
DesignHCleaner1 110 False
Return
Schedule Overview - Personal Kare Products, Inc
BottleFiller2
Gantt for Selected machine
04/19/02 12:00
User Name A
Database Server
Database Name
1:22 PM
4/19/2002

Fig. 39

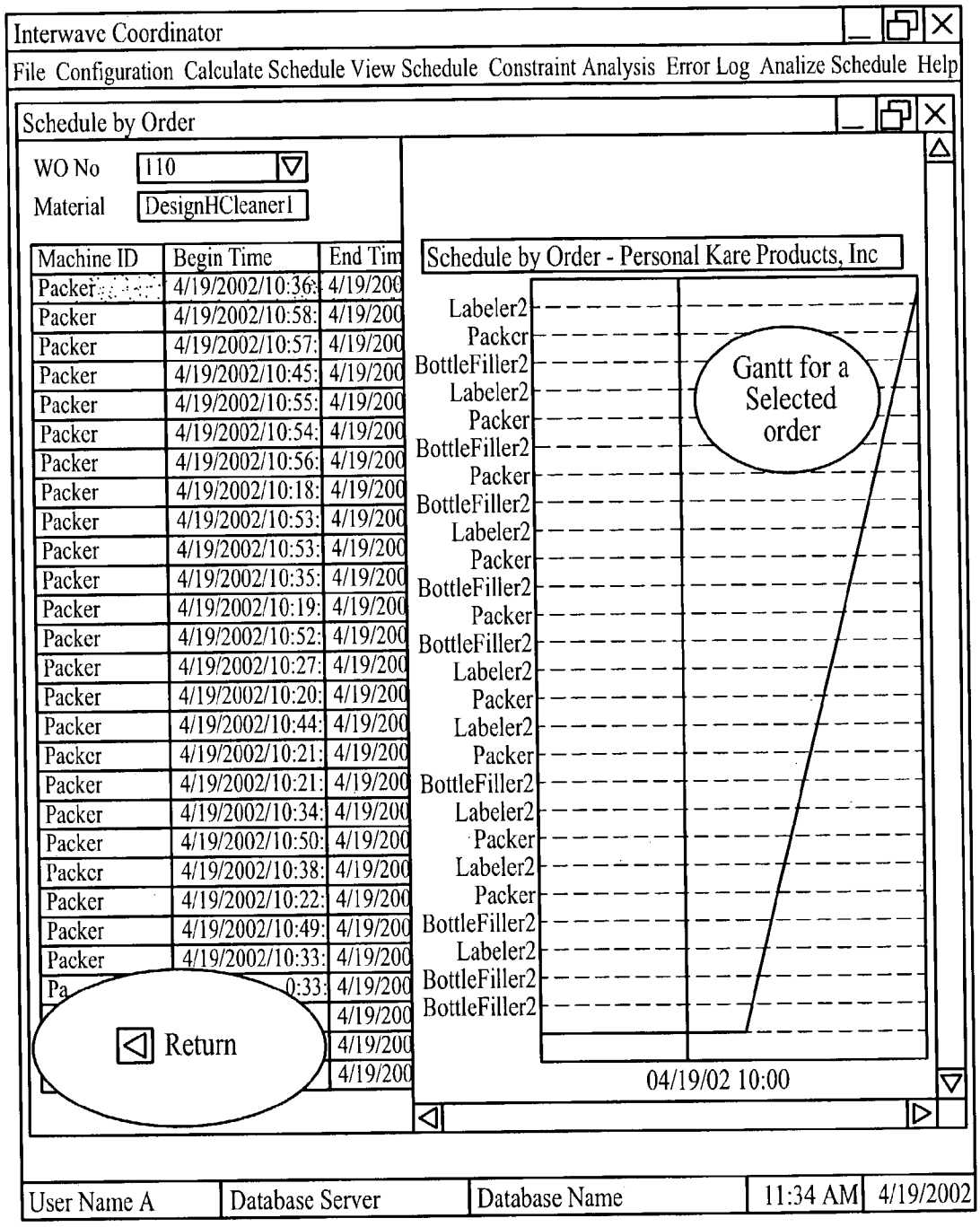

Interwave Coordinator
File Configuration Calculate Schedule View Schedule Constraint Analysis Error Log Analize Schedule Help
Schedule by Order
WO No 110
Material DesignHCleaner1
Machine ID Begin Time End Tim
Packer 4/19/2002/10:36: 4/19/200
Packer 4/19/2002/10:58: 4/19/200
Packer 4/19/2002/10:57: 4/19/200
Packer 4/19/2002/10:45: 4/19/200
Packer 4/19/2002/10:55: 4/19/200
Packer 4/19/2002/10:54: 4/19/200
Packer 4/19/2002/10:56: 4/19/200
Packer 4/19/2002/10:18: 4/19/200
Packer 4/19/2002/10:53: 4/19/200
Packer 4/19/2002/10:53: 4/19/200
Packer 4/19/2002/10:35: 4/19/200
Packer 4/19/2002/10:19: 4/19/200
Packer 4/19/2002/10:52: 4/19/200
Packer 4/19/2002/10:27: 4/19/200
Packer 4/19/2002/10:20: 4/19/200
Packer 4/19/2002/10:44: 4/19/200
Packer 4/19/2002/10:21: 4/19/200
Packer 4/19/2002/10:21: 4/19/200
Packer 4/19/2002/10:34: 4/19/200
Packer 4/19/2002/10:50: 4/19/200
Packer 4/19/2002/10:38: 4/19/200
Packer 4/19/2002/10:22: 4/19/200
Packer 4/19/2002/10:49: 4/19/200
Packer 4/19/2002/10:33: 4/19/200
Return
Schedule by Order - Personal Kare Products, Inc
Labeler2
Packer
BottleFiller2
Labeler2
Packer
BottleFiller2
Packer
BottleFiller2
Labeler2
Packer
BottleFiller2
Packer
BottleFiller2
Labeler2
Packer
Labeler2
Packer
BottleFiller2
Labeler2
Packer
Labeler2
Packer
BottleFiller2
Labeler2
BottleFiller2
BottleFiller2
Gantt for a Selected order
04/19/02 10:00
User Name A
Database Server
Database Name
11:34 AM
4/19/2002

Fig. 40

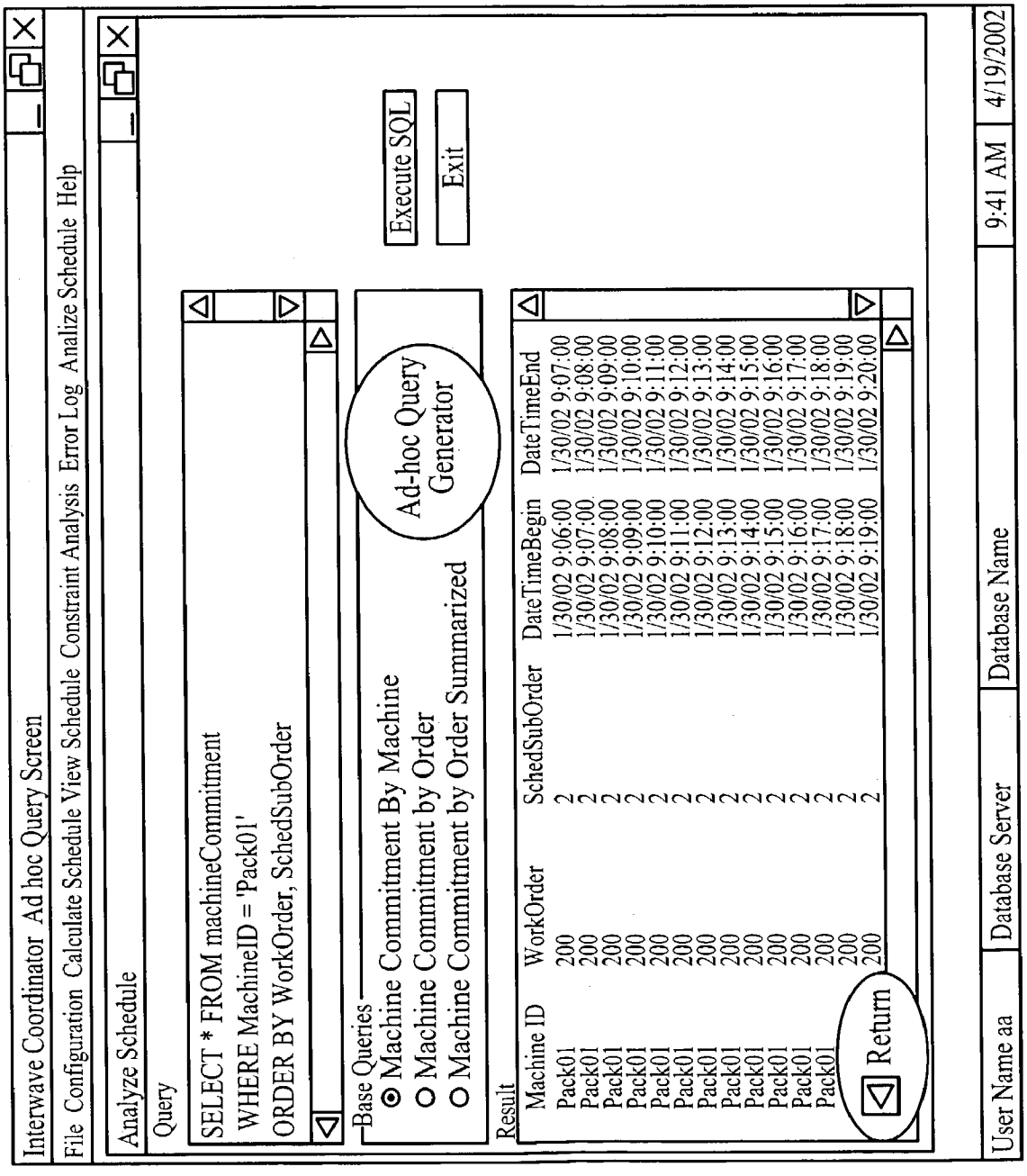

Interwave Coordinator Ad hoc Query Screen
File Configuration Calculate Schedule View Schedule Constraint Analysis Error Log Analize Schedule Help
Analyze Schedule
Query
SELECT * FROM machineCommitment
WHERE MachineID = 'Pack01'
ORDER BY WorkOrder, SchedSubOrder
Base Queries
Machine Commitment By Machine
Machine Commitment by Order
Machine Commitment by Order Summarized
Ad-hoc Query Generator
Execute SQL
Exit
Result
Machine ID WorkOrder SchedSubOrder DateTimeBegin DateTimeEnd
Pack01 200 2 1/30/02 9:06:00 1/30/02 9:07:00
Pack01 200 2 1/30/02 9:07:00 1/30/02 9:08:00
Pack01 200 2 1/30/02 9:08:00 1/30/02 9:09:00
Pack01 200 2 1/30/02 9:09:00 1/30/02 9:10:00
Pack01 200 2 1/30/02 9:10:00 1/30/02 9:11:00
Pack01 200 2 1/30/02 9:11:00 1/30/02 9:12:00
Pack01 200 2 1/30/02 9:12:00 1/30/02 9:13:00
Pack01 200 2 1/30/02 9:13:00 1/30/02 9:14:00
Pack01 200 2 1/30/02 9:14:00 1/30/02 9:15:00
Pack01 200 2 1/30/02 9:15:00 1/30/02 9:16:00
Pack01 200 2 1/30/02 9:16:00 1/30/02 9:17:00
Pack01 200 2 1/30/02 9:17:00 1/30/02 9:18:00
Pack01 200 2 1/30/02 9:18:00 1/30/02 9:19:00
200 2 1/30/02 9:19:00 1/30/02 9:20:00
Return
User Name aa
Database Server
Database Name
9:41 AM
4/19/2002

Fig. 41

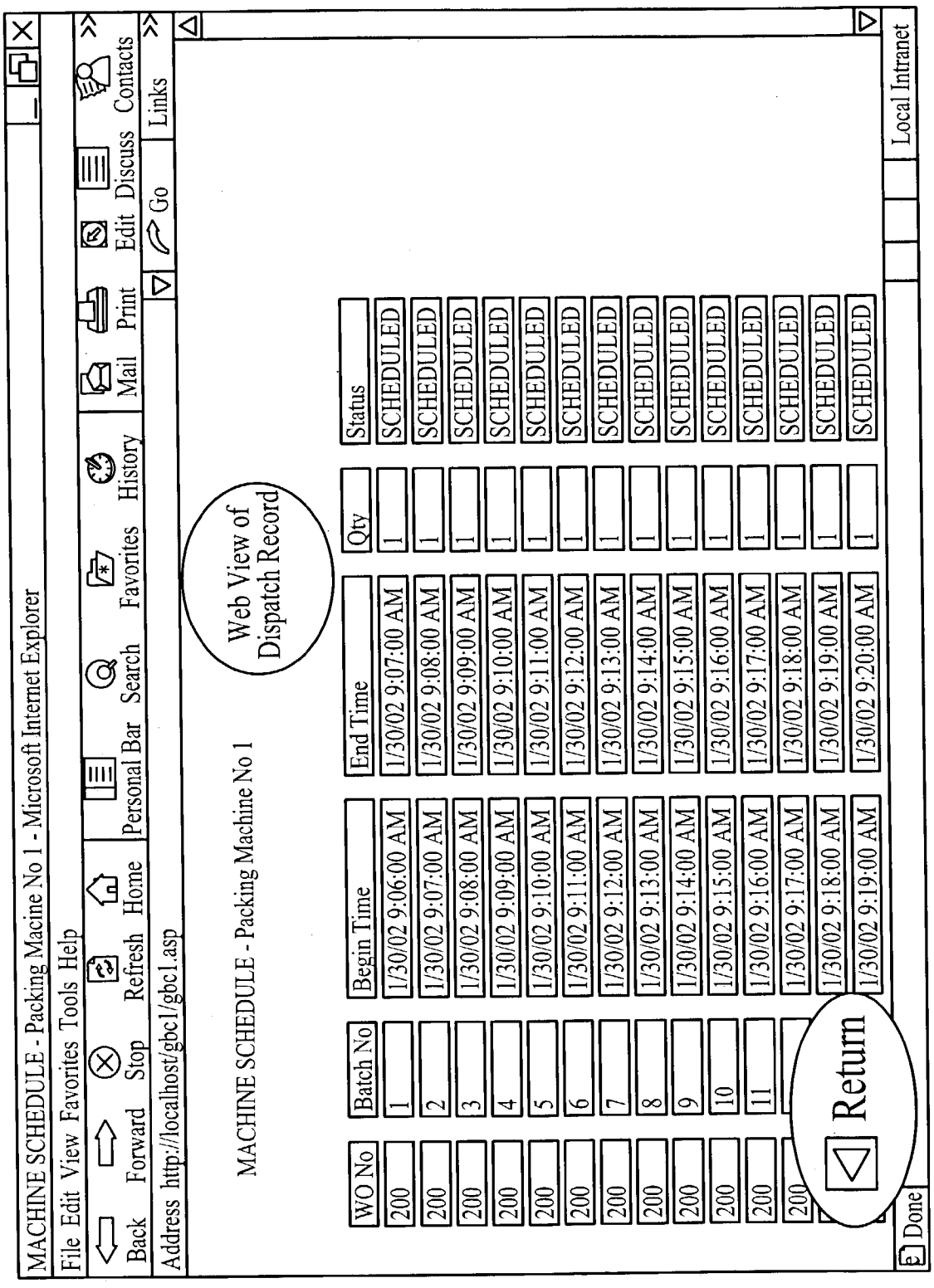

MACHINE SCHEDULE - Packing Macine No 1 - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Personal Bar Search Favorites History Mail Print Edit Discuss Contacts
Address http://localhost/gbc1/gbc1.asp
Go
Links
MACHINE SCHEDULE - Packing Machine No 1
Web View of Dispatch Record
WO No
Batch No
Begin Time
End Time
Qty
Status
200 1 1/30/02 9:06:00 AM 1/30/02 9:07:00 AM 1 SCHEDULED
200 2 1/30/02 9:07:00 AM 1/30/02 9:08:00 AM 1 SCHEDULED
200 3 1/30/02 9:08:00 AM 1/30/02 9:09:00 AM 1 SCHEDULED
200 4 1/30/02 9:09:00 AM 1/30/02 9:10:00 AM 1 SCHEDULED
200 5 1/30/02 9:10:00 AM 1/30/02 9:11:00 AM 1 SCHEDULED
200 6 1/30/02 9:11:00 AM 1/30/02 9:12:00 AM 1 SCHEDULED
200 7 1/30/02 9:12:00 AM 1/30/02 9:13:00 AM 1 SCHEDULED
200 8 1/30/02 9:13:00 AM 1/30/02 9:14:00 AM 1 SCHEDULED
200 9 1/30/02 9:14:00 AM 1/30/02 9:15:00 AM 1 SCHEDULED
200 10 1/30/02 9:15:00 AM 1/30/02 9:16:00 AM 1 SCHEDULED
200 11 1/30/02 9:16:00 AM 1/30/02 9:17:00 AM 1 SCHEDULED
200 1/30/02 9:17:00 AM 1/30/02 9:18:00 AM 1 SCHEDULED
1/30/02 9:18:00 AM 1/30/02 9:19:00 AM 1 SCHEDULED
1/30/02 9:19:00 AM 1/30/02 9:20:00 AM 1 SCHEDULED
Return
Done
Local Intranet

Fig. 42

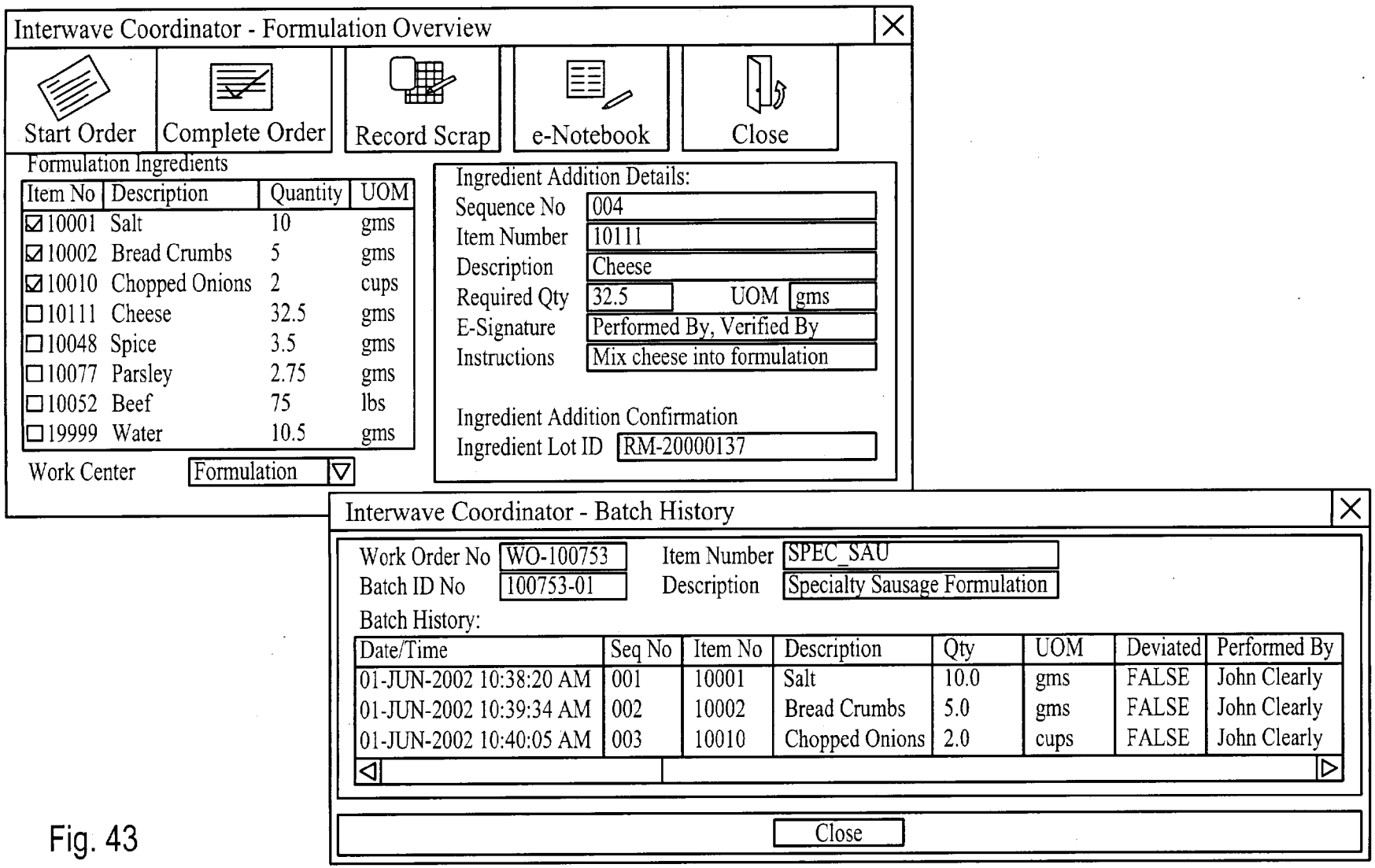

Interwave Coordinator - Formulation Overview
Start Order
Complete Order
Record Scrap
e-Notebook
Close
Formulation Ingredients
Item No | Description | Quantity | UOM
10001 Salt 10 gms
10002 Bread Crumbs 5 gms
10010 Chopped Onions 2 cups
10111 Cheese 32.5 gms
10048 Spice 3.5 gms
10077 Parsley 2.75 gms
10052 Beef 75 lbs
19999 Water 10.5 gms
Work Center Formulation
Ingredient Addition Details:
Sequence No 004
Item Number 10111
Description Cheese
Required Qty 32.5 UOM gms
E-Signature Performed By, Verified By
Instructions Mix cheese into formulation
Ingredient Addition Confirmation
Ingredient Lot ID RM-20000137
Interwave Coordinator - Batch History
Work Order No WO-100753
Batch ID No 100753-01
Item Number SPEC_SAU
Description Specialty Sausage Formulation
Batch History:
Date/Time | Seq No | Item No | Description | Qty | UOM | Deviated | Performed By
01-JUN-2002 10:38:20 AM | 001 | 10001 | Salt | 10.0 | gms | FALSE | John Clearly
01-JUN-2002 10:39:34 AM | 002 | 10002 | Bread Crumbs | 5.0 | gms | FALSE | John Clearly
01-JUN-2002 10:40:05 AM | 003 | 10010 | Chopped Onions | 2.0 | cups | FALSE | John Clearly
Close

Fig. 43

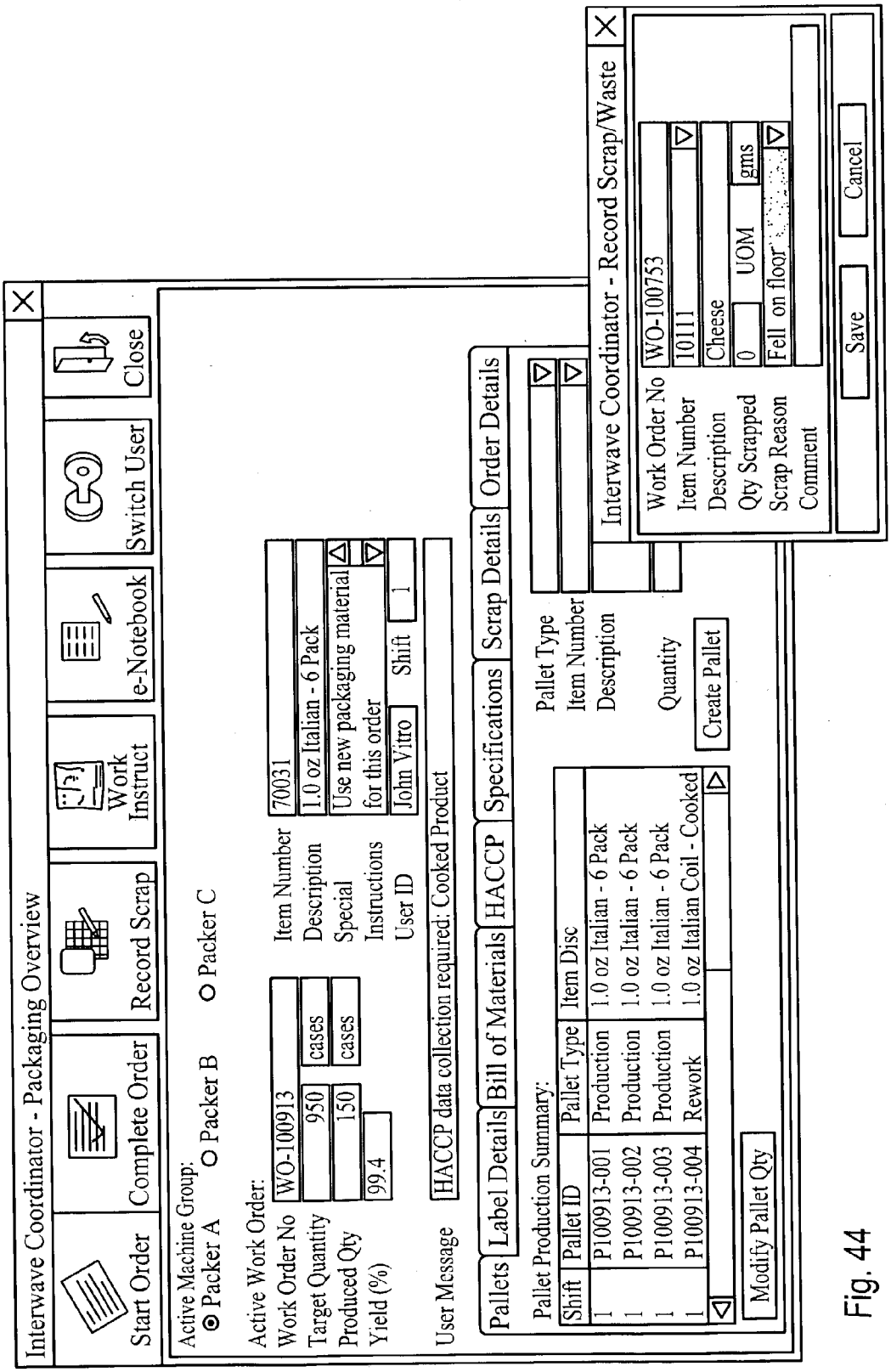

Interwave Coordinator - Packaging Overview
Start Order
Complete Order
Record Scrap
Work Instruct
e-Notebook
Switch User
Close
Active Machine Group:
Packer A
Packer B
Packer C
Active Work Order:
Work Order No
Target Quantity
Produced Qty
Yield (%)
WO-100913
950
cases
150
cases
99.4
Item Number
Description
Special Instructions
User ID
70031
1.0 oz Italian - 6 Pack
Use new packaging material for this order
John Vitro
Shift
1
User Message
HACCP data collection required: Cooked Product
Pallets
Label Details
Bill of Materials
HACCP
Specifications
Scrap Details
Order Details
Pallet Production Summary:
Shift
Pallet ID
Pallet Type
Item Disc
1 P100913-001 Production 1.0 oz Italian - 6 Pack
1 P100913-002 Production 1.0 oz Italian - 6 Pack
1 P100913-003 Production 1.0 oz Italian - 6 Pack
1 P100913-004 Rework 1.0 oz Italian Coil - Cooked
Modify Pallet Qty
Pallet Type
Item Number
Description
Quantity
Create Pallet
Interwave Coordinator - Record Scrap/Waste
Work Order No
Item Number
Description
Qty Scrapped
Scrap Reason
Comment
WO-100753
10111
Cheese
0
UOM
gms
Fell on floor
Save
Cancel

Fig. 44

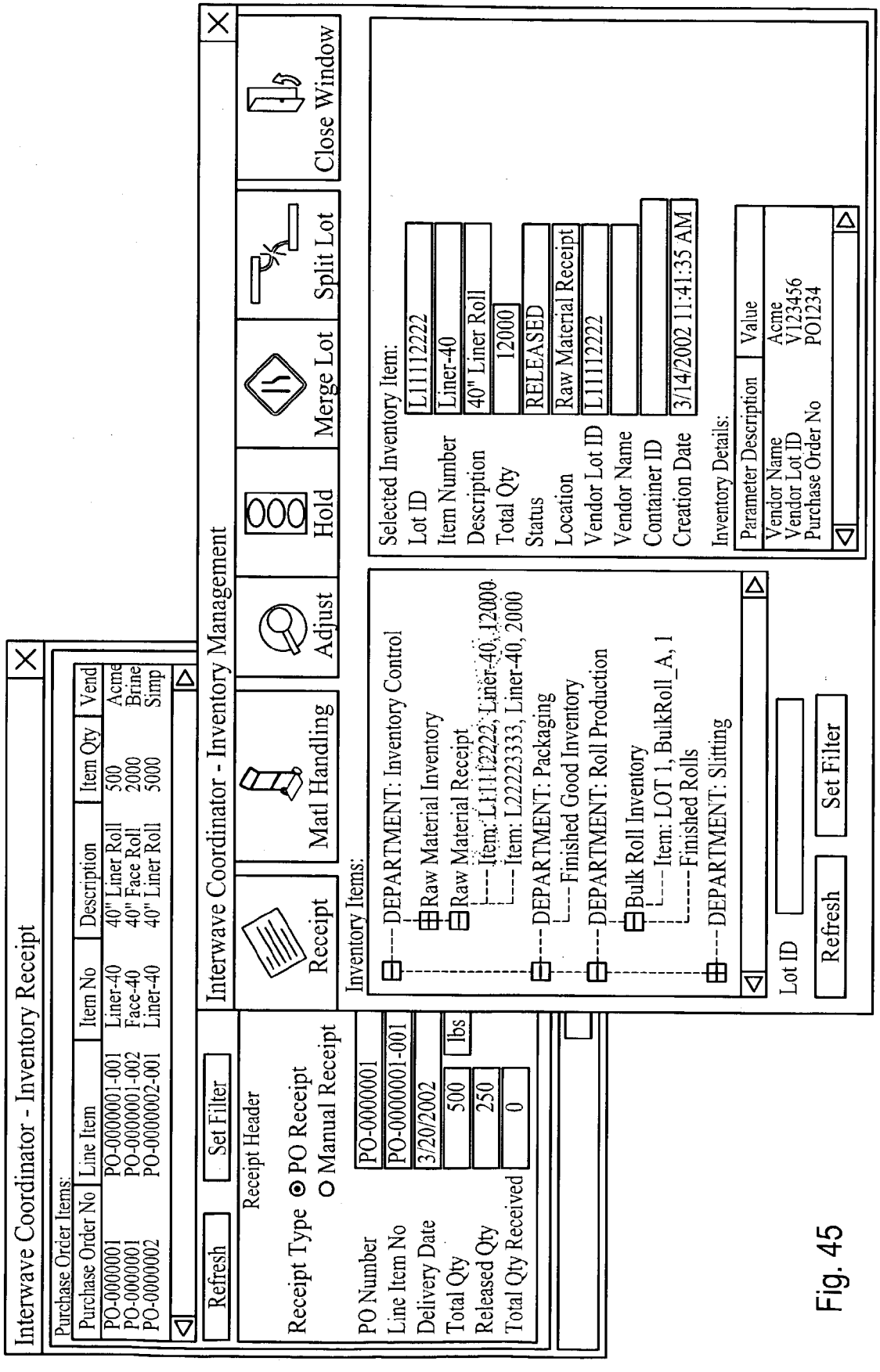

Interwave Coordinator - Inventory Receipt
Purchase Order Items:
Purchase Order No
Line Item
Item No
Description
Item Qty
Vend
PO-0000001
PO-0000001-001
Liner-40
40" Liner Roll
500
Acme
PO-0000001
PO-0000001-002
Face-40
40" Face Roll
2000
Brine
PO-0000002
PO-0000002-001
Liner-40
40" Liner Roll
5000
Simp
Refresh
Set Filter
Receipt Header
Receipt Type
PO Receipt
Manual Receipt
PO Number
PO-0000001
Line Item No
PO-0000001-001
Delivery Date
3/20/2002
Total Qty
500
lbs
Released Qty
250
Total Qty Received
0
Interwave Coordinator - Inventory Management
Receipt
Matl Handling
Adjust
Hold
Merge Lot
Split Lot
Close Window
Inventory Items:
DEPARTMENT: Inventory Control
Raw Material Inventory
Raw Material Receipt
Item: L11112222, Liner-40, 12000
Item: L22223333, Liner-40, 2000
DEPARTMENT: Packaging
Finished Good Inventory
DEPARTMENT: Roll Production
Bulk Roll Inventory
Item: LOT 1, BulkRoll_A, 1
Finished Rolls
DEPARTMENT: Slitting
Lot ID
Refresh
Set Filter
Selected Inventory Item:
Lot ID
L11112222
Item Number
Liner-40
Description
40" Liner Roll
Total Qty
12000
Status
RELEASED
Location
Raw Material Receipt
Vendor Lot ID
L11112222
Vendor Name
Container ID
Creation Date
3/14/2002 11:41:35 AM
Inventory Details:
Parameter Description
Value
Vendor Name
Acme
Vendor Lot ID
V123456
Purchase Order No
PO1234

Fig. 45

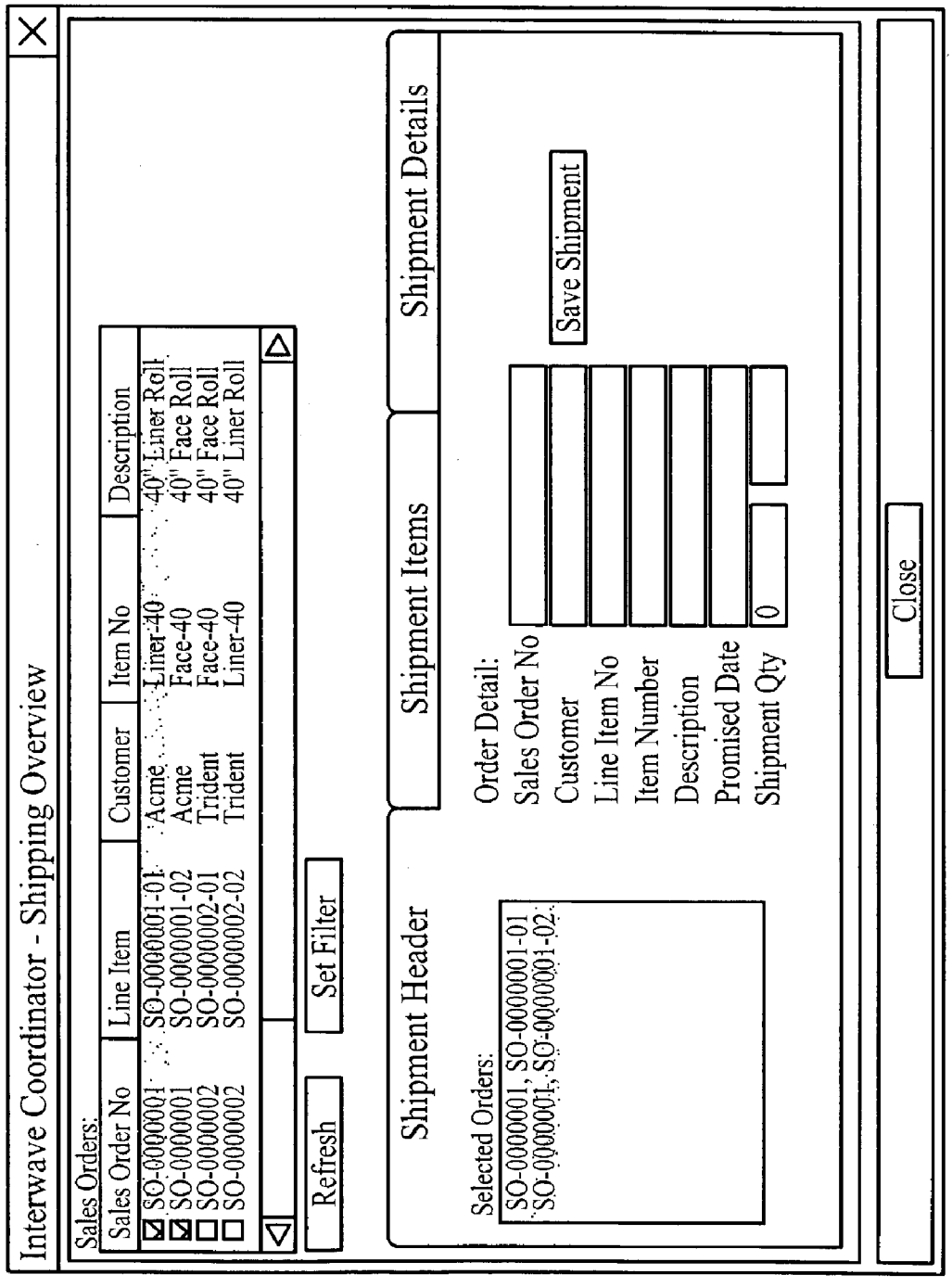

Interwave Coordinator - Shipping Overview
Sales Orders:
Sales Order No
Line Item
Customer
Item No
Description
SO-0000001 SO-0000001-01 Acme Liner-40 40" Liner Roll
SO-0000001 SO-0000001-02 Acme Face-40 40" Face Roll
SO-0000002 SO-0000002-01 Trident Face-40 40" Face Roll
SO-0000002 SO-0000002-02 Trident Liner-40 40" Liner Roll
Refresh
Set Filter
Shipment Header
Shipment Items
Shipment Details
Selected Orders:
SO-0000001, SO-0000001-01
SO-0000001, SO-0000001-02
Order Detail:
Sales Order No
Customer
Line Item No
Item Number
Description
Promised Date
Shipment Qty
0
Save Shipment
Close

Fig. 46

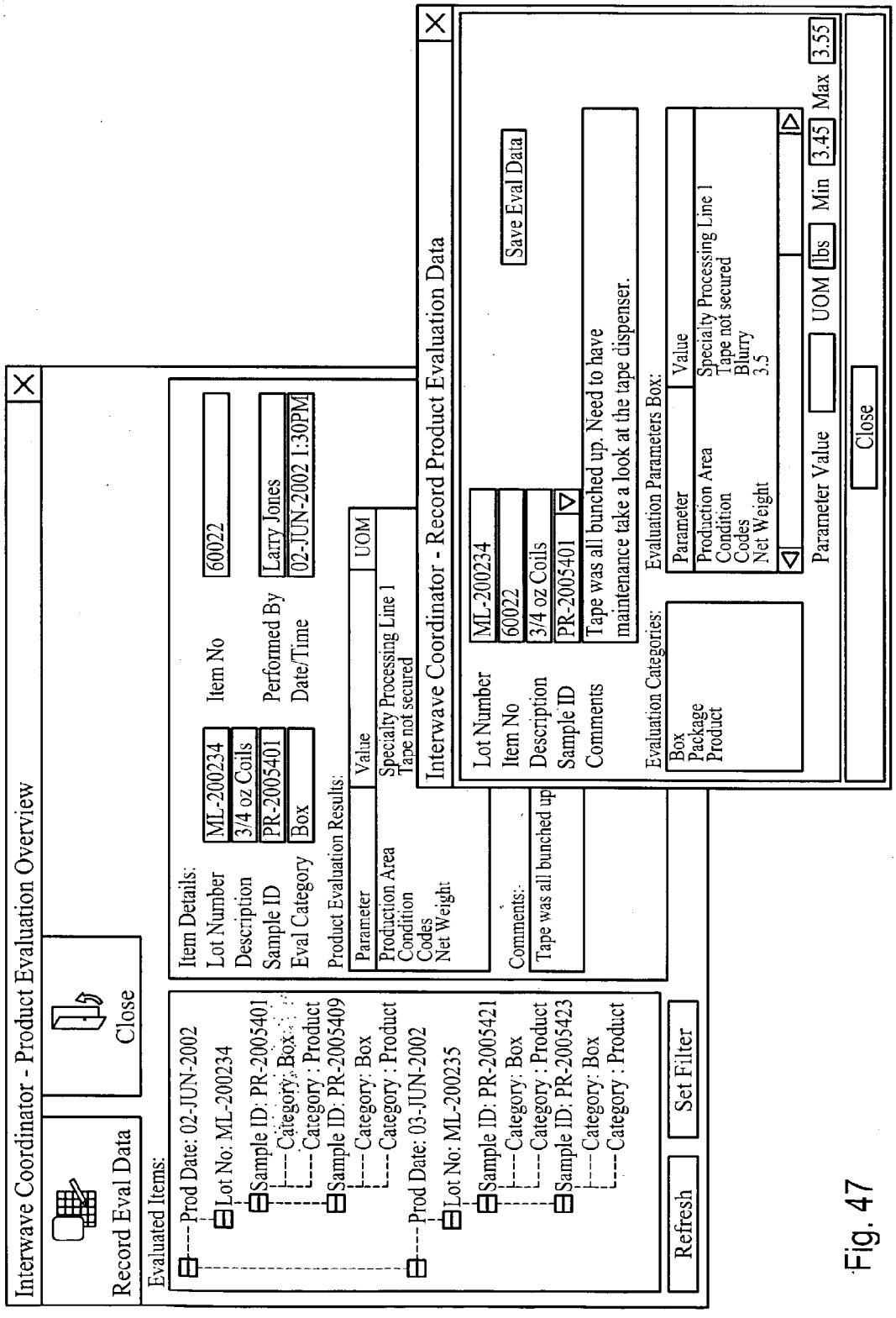

Interwave Coordinator - Product Evaluation Overview
Record Eval Data
Close
Evaluated Items:
Prod Date: 02-JUN-2002
Lot No: ML-200234
Sample ID: PR-2005401
Category: Box
Category : Product
Sample ID: PR-2005409
Category: Box
Category : Product
Prod Date: 03-JUN-2002
Lot No: ML-200235
Sample ID: PR-2005421
Category: Box
Category : Product
Sample ID: PR-2005423
Category: Box
Category : Product
Refresh
Set Filter
Item Details:
Lot Number ML-200234
Description 3/4 oz Coils
Sample ID PR-2005401
Eval Category Box
Item No 60022
Performed By Larry Jones
Date/Time 02-JUN-2002 1:30PM
Product Evaluation Results:
Parameter Value UOM
Production Area Specialty Processing Line 1
Condition Tape not secured
Codes
Net Weight
Comments:
Tape was all bunched up
Interwave Coordinator - Record Product Evaluation Data
Lot Number ML-200234
Item No 60022
Description 3/4 oz Coils
Sample ID PR-2005401
Comments Tape was all bunched up. Need to have maintenance take a look at the tape dispenser.
Save Eval Data
Evaluation Categories:
Box
Package
Product
Evaluation Parameters Box:
Parameter Value
Production Area Specialty Processing Line 1
Condition Tape not secured
Codes Blurry
Net Weight 3.5
Parameter Value
UOM lbs
Min 3.45
Max 3.55
Close

Fig. 47

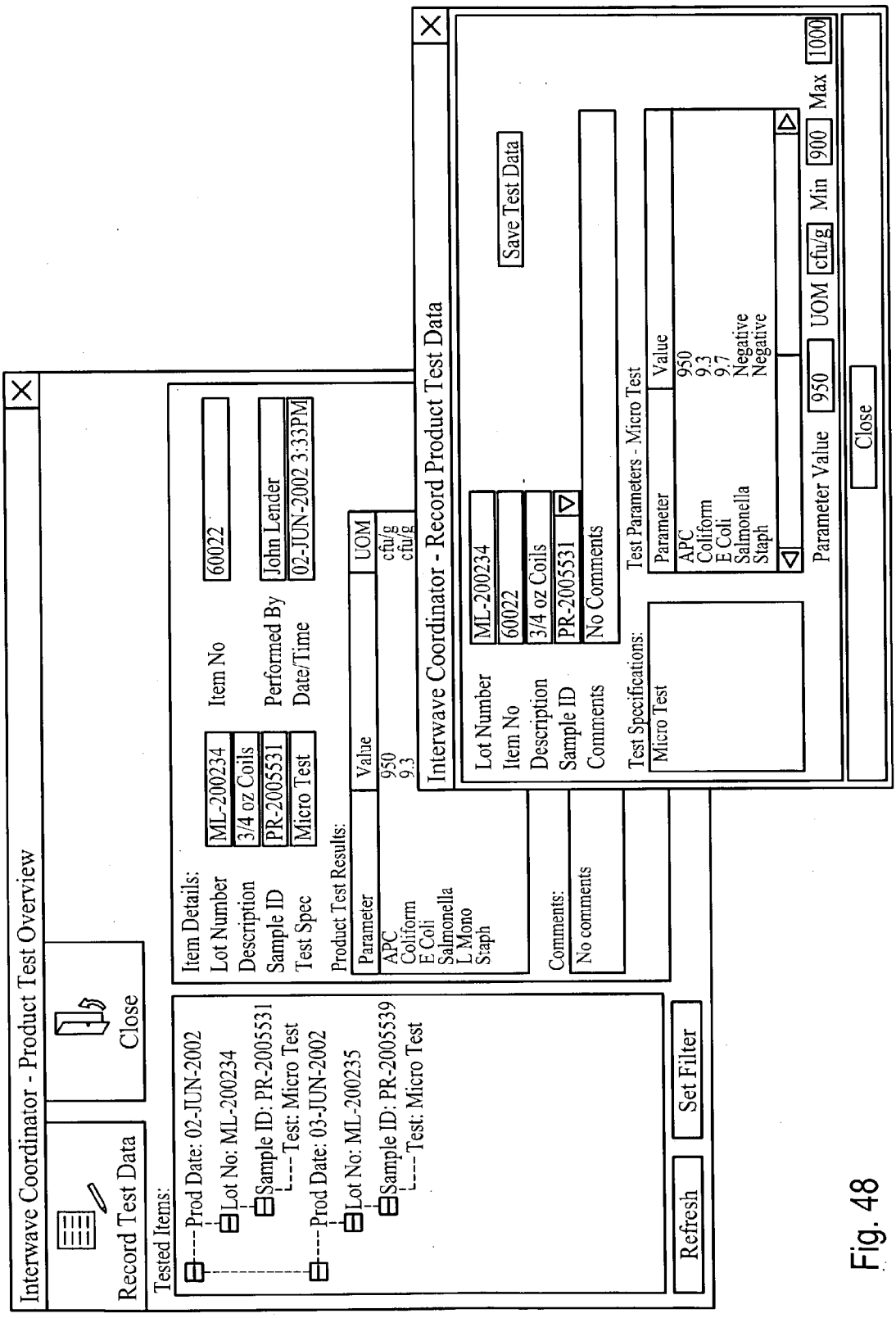

Interwave Coordinator - Product Test Overview
Record Test Data
Close
Tested Items:
Prod Date: 02-JUN-2002
Lot No: ML-200234
Sample ID: PR-2005531
Test: Micro Test
Prod Date: 03-JUN-2002
Lot No: ML-200235
Sample ID: PR-2005539
Test: Micro Test
Refresh
Set Filter
Item Details:
Lot Number
Description
Sample ID
Test Spec
ML-200234
3/4 oz Coils
PR-2005531
Micro Test
Item No
60022
Performed By
John Lender
Date/Time
02-JUN-2002 3:33PM
Product Test Results:
Parameter
Value
UOM
APC
950
cfu/g
Coliform
9.3
cfu/g
E Coli
Salmonella
L Mono
Staph
Comments:
No comments
Interwave Coordinator - Record Product Test Data
Lot Number
Item No
Description
Sample ID
Comments
ML-200234
60022
3/4 oz Coils
PR-2005531
No Comments
Save Test Data
Test Specifications:
Micro Test
Test Parameters - Micro Test
Parameter
Value
APC
950
Coliform
9.3
E Coli
9.7
Salmonella
Negative
Staph
Negative
Parameter Value
950
UOM
cfu/g
Min
900
Max
1000
Close

Fig. 48

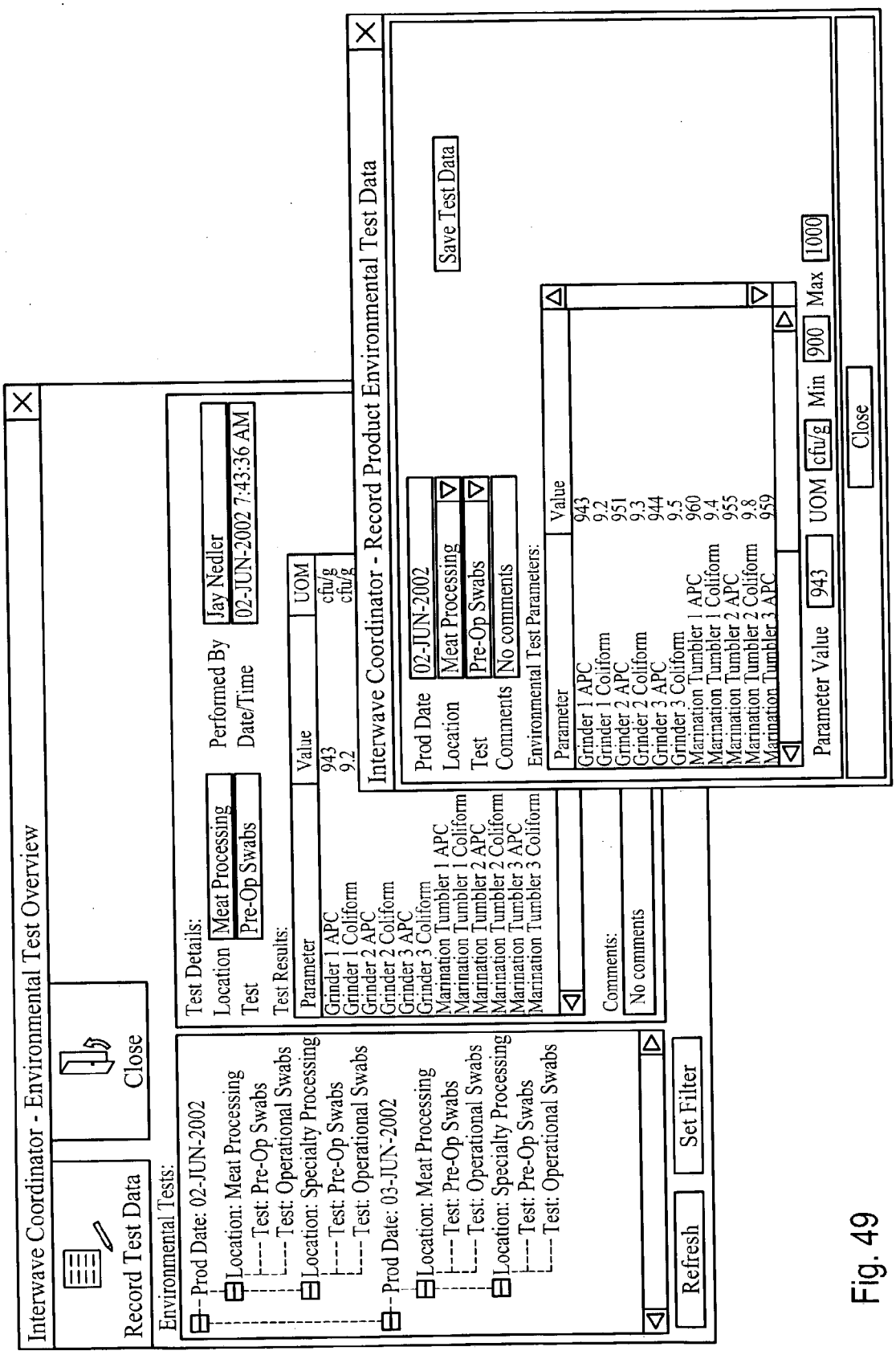

Interwave Coordinator - Environmental Test Overview
Record Test Data
Close
Environmental Tests:
Prod Date: 02-JUN-2002
Location: Meat Processing
Test: Pre-Op Swabs
Test: Operational Swabs
Location: Specialty Processing
Test: Pre-Op Swabs
Test: Operational Swabs
Prod Date: 03-JUN-2002
Location: Meat Processing
Test: Pre-Op Swabs
Test: Operational Swabs
Location: Specialty Processing
Test: Pre-Op Swabs
Test: Operational Swabs
Refresh
Set Filter
Test Details:
Location Meat Processing
Test Pre-Op Swabs
Performed By Jay Nedler
Date/Time 02-JUN-2002 7:43:36 AM
Test Results:
Parameter Value UOM
Grinder 1 APC 943 cfu/g
Grinder 1 Coliform 9.2 cfu/g
Grinder 2 APC
Grinder 2 Coliform
Grinder 3 APC
Grinder 3 Coliform
Marination Tumbler 1 APC
Marination Tumbler 1 Coliform
Marination Tumbler 2 APC
Marination Tumbler 2 Coliform
Marination Tumbler 3 APC
Marination Tumbler 3 Coliform
Comments:
No comments
Interwave Coordinator - Record Product Environmental Test Data
Prod Date 02-JUN-2002
Location Meat Processing
Test Pre-Op Swabs
Comments No comments
Save Test Data
Environmental Test Parameters:
Parameter Value
Grinder 1 APC 943
Grinder 1 Coliform 9.2
Grinder 2 APC 951
Grinder 2 Coliform 9.3
Grinder 3 APC 944
Grinder 3 Coliform 9.5
Marination Tumbler 1 APC 960
Marination Tumbler 1 Coliform 9.4
Marination Tumbler 2 APC 955
Marination Tumbler 2 Coliform 9.8
Marination Tumbler 3 APC 959
Parameter Value 943 UOM cfu/g Min 900 Max 1000
Close

Fig. 49

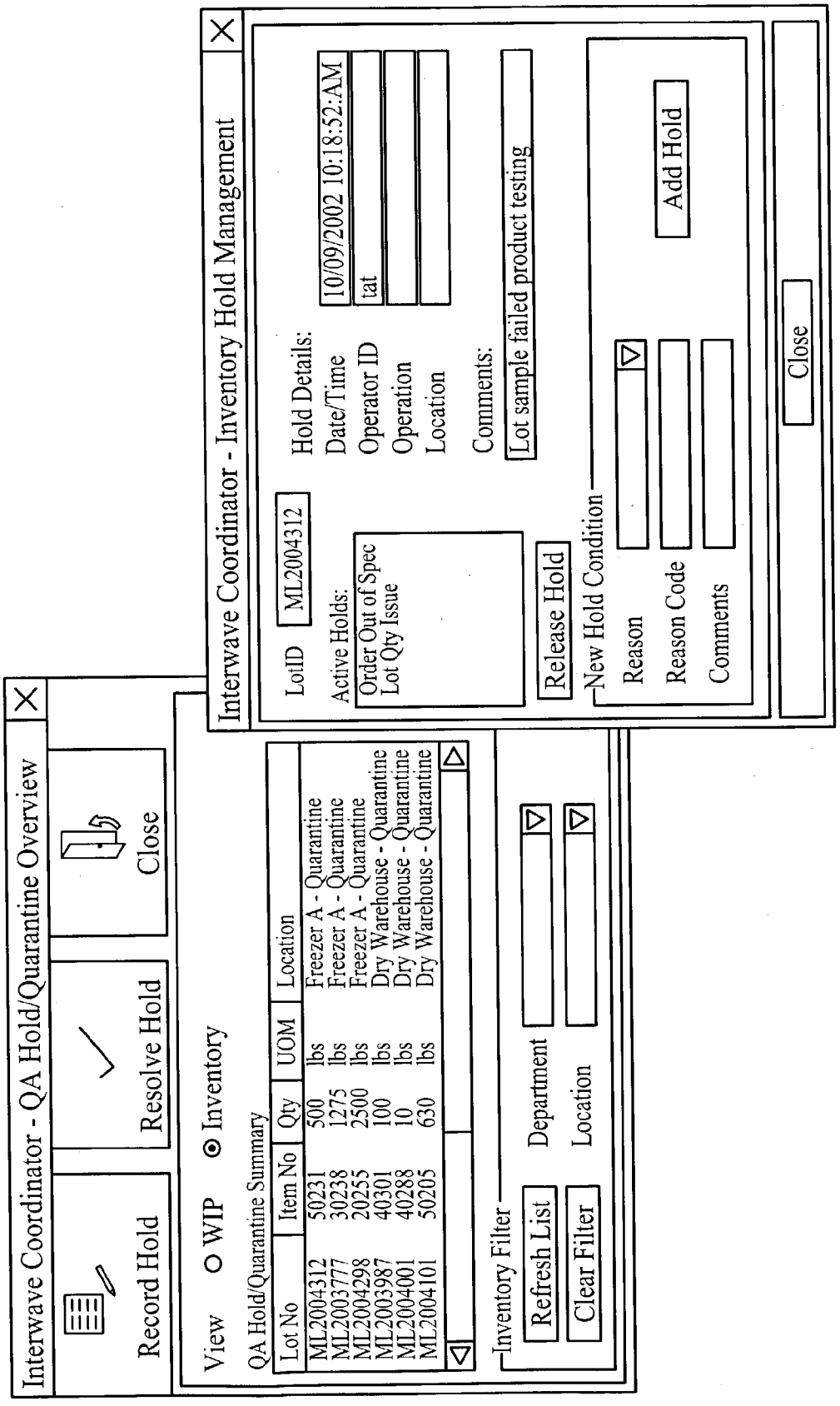

Interwave Coordinator - QA Hold/Quarantine Overview
Record Hold
Resolve Hold
Close
View
WIP
Inventory
QA Hold/Quarantine Summary
Lot No
Item No
Qty
UOM
Location
ML2004312 50231 500 lbs Freezer A - Quarantine
ML2003777 30238 1275 lbs Freezer A - Quarantine
ML2004298 20255 2500 lbs Freezer A - Quarantine
ML2003987 40301 100 lbs Dry Warehouse - Quarantine
ML2004001 40288 10 lbs Dry Warehouse - Quarantine
ML2004101 50205 630 lbs Dry Warehouse - Quarantine
Inventory Filter
Refresh List
Department
Clear Filter
Location
Interwave Coordinator - Inventory Hold Management
LotID
ML2004312
Active Holds:
Order Out of Spec
Lot Qty Issue
Release Hold
Hold Details:
Date/Time
10/09/2002 10:18:52:AM
Operator ID
tat
Operation
Location
Comments:
Lot sample failed product testing
New Hold Condition
Reason
Reason Code
Comments
Add Hold
Close

Fig. 50

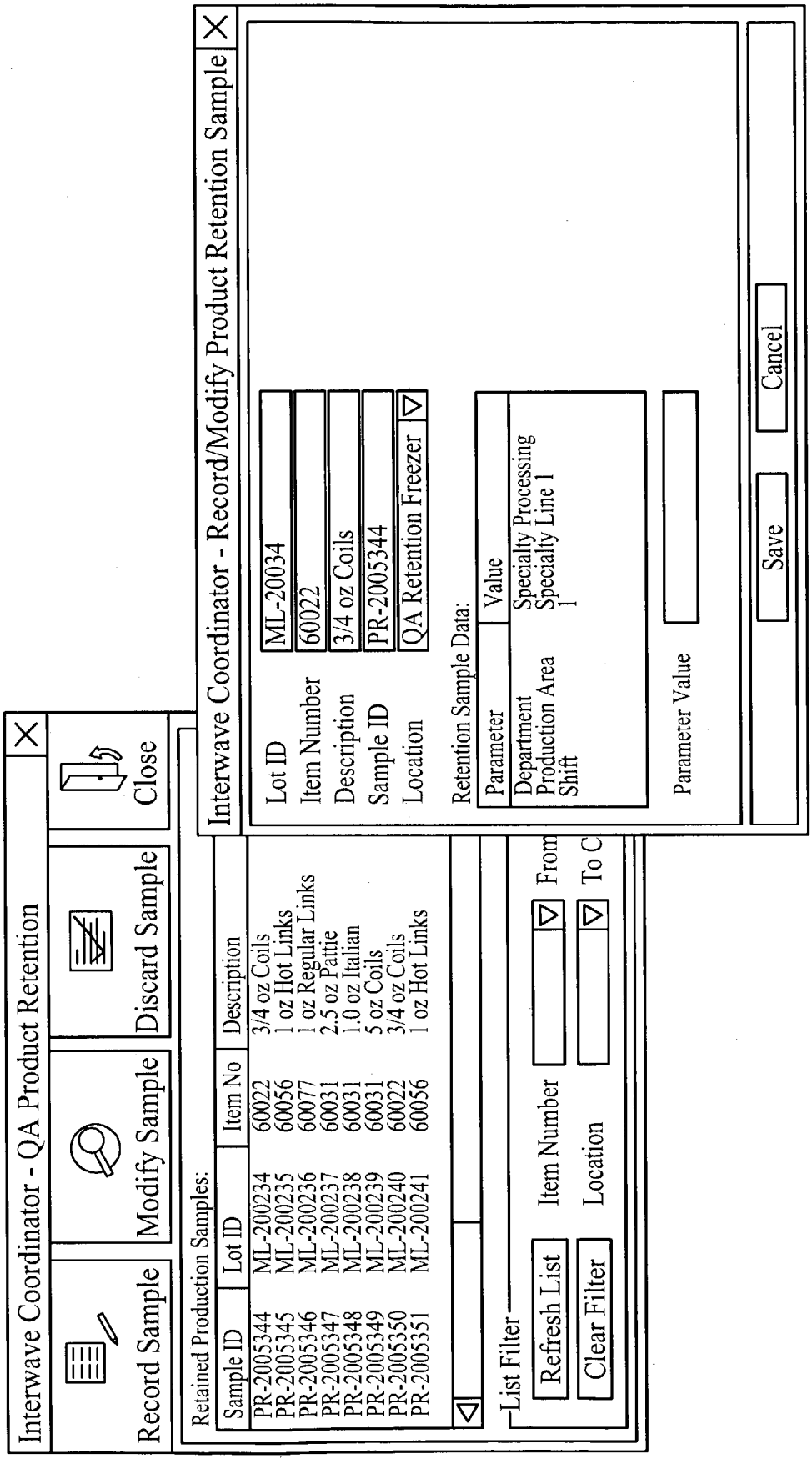

Interwave Coordinator - QA Product Retention
Record Sample
Modify Sample
Discard Sample
Close
Retained Production Samples:
Sample ID
Lot ID
Item No
Description
PR-2005344 ML-200234 60022 3/4 oz Coils
PR-2005345 ML-200235 60056 1 oz Hot Links
PR-2005346 ML-200236 60077 1 oz Regular Links
PR-2005347 ML-200237 60031 2.5 oz Pattie
PR-2005348 ML-200238 60031 1.0 oz Italian
PR-2005349 ML-200239 60031 5 oz Coils
PR-2005350 ML-200240 60022 3/4 oz Coils
PR-2005351 ML-200241 60056 1 oz Hot Links
List Filter
Refresh List
Item Number
From
Clear Filter
Location
To C
Interwave Coordinator - Record/Modify Product Retention Sample
Lot ID
ML-20034
Item Number
60022
Description
3/4 oz Coils
Sample ID
PR-2005344
Location
QA Retention Freezer
Retention Sample Data:
Parameter
Value
Department
Specialty Processing
Production Area
Specialty Line 1
Shift
1
Parameter Value
Save
Cancel

Fig. 51

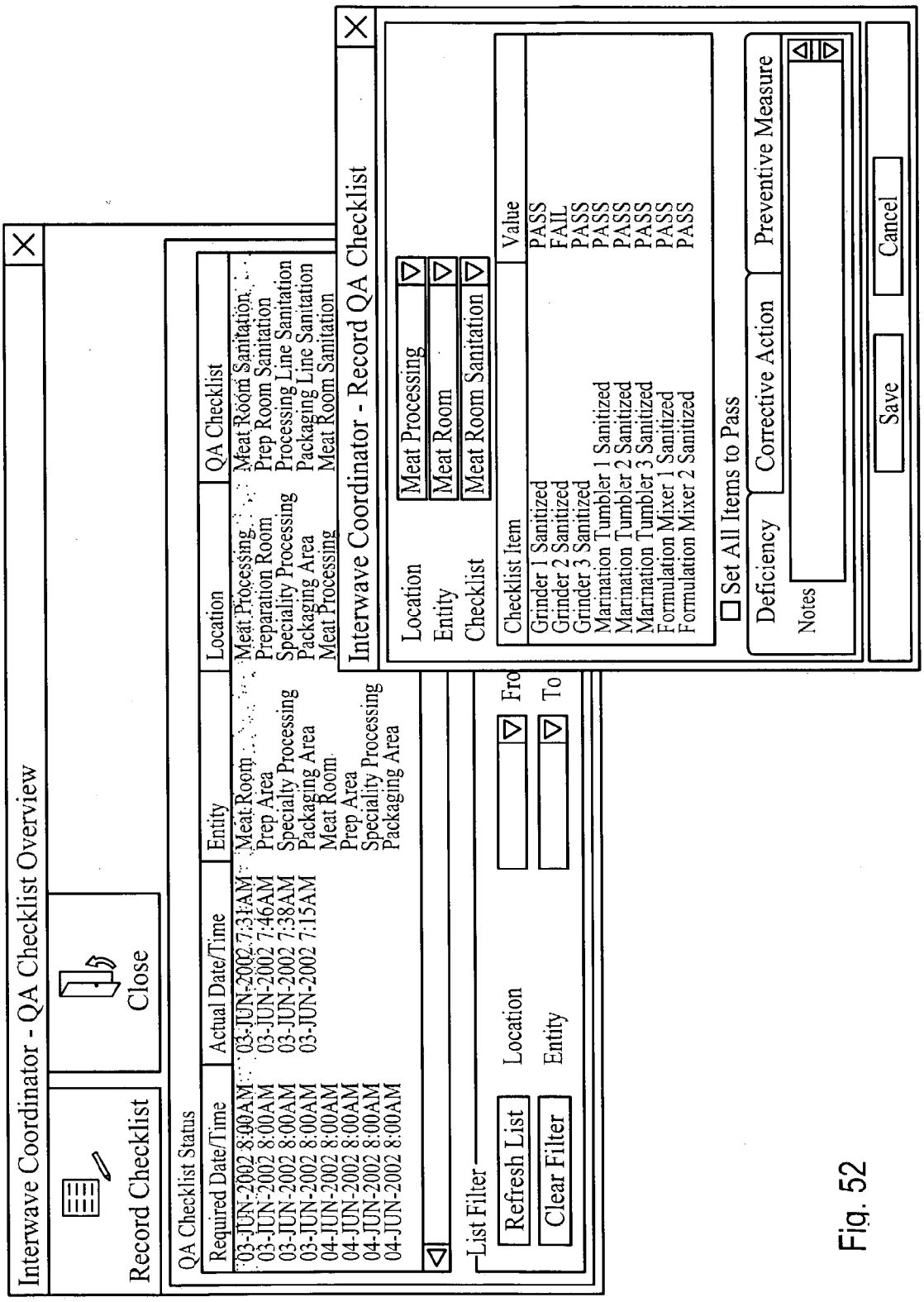
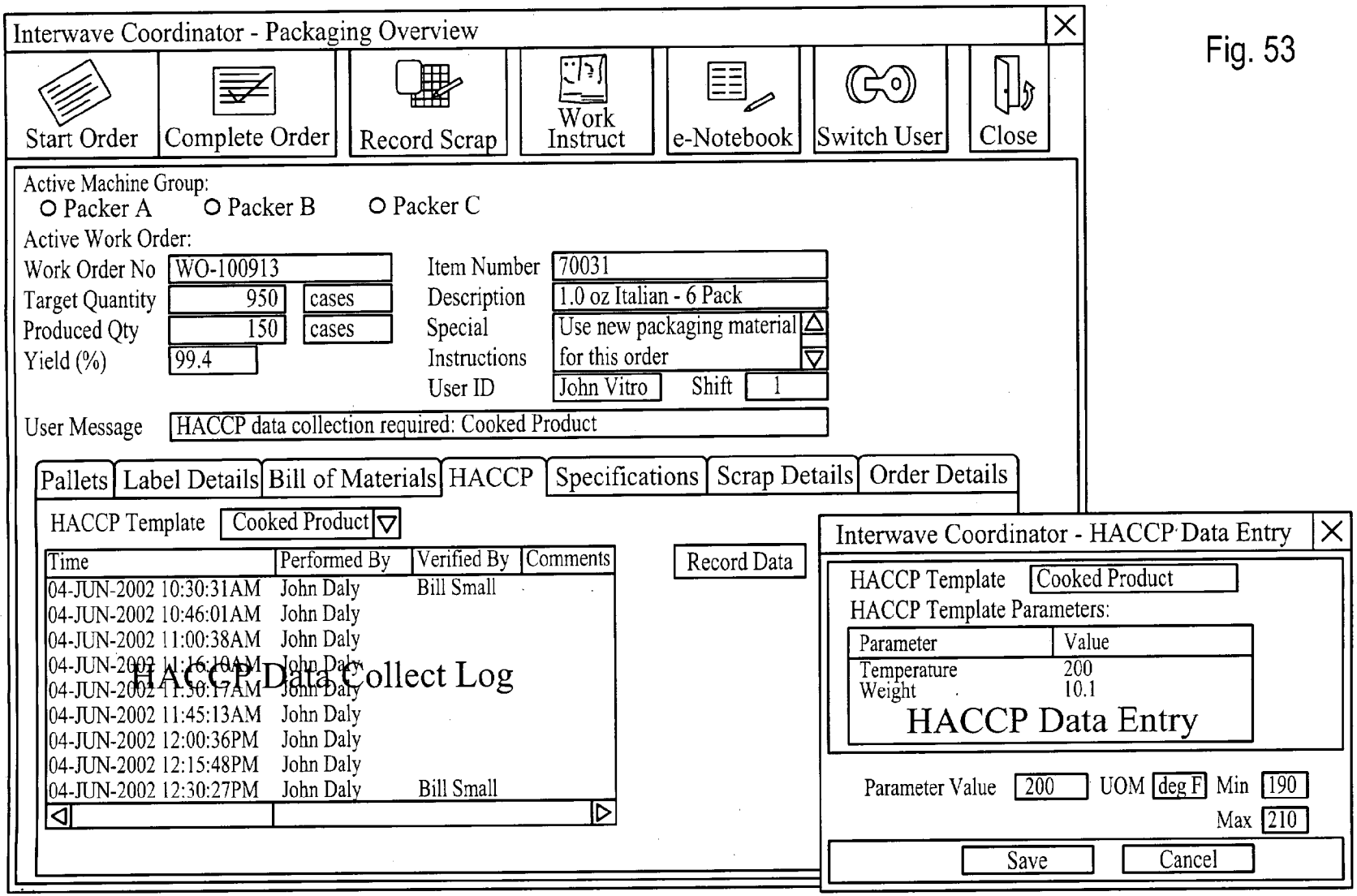

Interwave Coordinator - QA Checklist Overview
Record Checklist
Close
QA Checklist Status
Required Date/Time
Actual Date/Time
Entity
Location
QA Checklist
03-JUN-2002 8:00AM
03-JUN-2002 7:31AM
Meat Room
Meat Processing
Meat Room Sanitation
03-JUN-2002 8:00AM
03-JUN-2002 7:46AM
Prep Area
Preparation Room
Prep Room Sanitation
03-JUN-2002 8:00AM
03-JUN-2002 7:38AM
Specialty Processing
Specialty Processing
Processing Line Sanitation
03-JUN-2002 8:00AM
03-JUN-2002 7:15AM
Packaging Area
Packaging Area
Packaging Line Sanitation
04-JUN-2002 8:00AM
Meat Room
Meat Processing
Meat Room Sanitation
04-JUN-2002 8:00AM
Prep Area
04-JUN-2002 8:00AM
Specialty Processing
04-JUN-2002 8:00AM
Packaging Area
List Filter
Refresh List
Location
Fro
Clear Filter
Entity
To
Interwave Coordinator - Record QA Checklist
Location
Meat Processing
Entity
Meat Room
Checklist
Meat Room Sanitation
Checklist Item
Value
Grinder 1 Sanitized
PASS
Grinder 2 Sanitized
FAIL
Grinder 3 Sanitized
PASS
Marination Tumbler 1 Sanitized
PASS
Marination Tumbler 2 Sanitized
PASS
Marination Tumbler 3 Sanitized
PASS
Formulation Mixer 1 Sanitized
PASS
Formulation Mixer 2 Sanitized
PASS
Set All Items to Pass
Deficiency
Corrective Action
Preventive Measure
Notes
Save
Cancel

Fig. 52

Fig. 53


Interwave Coordinator - Packaging Overview
Start Order
Complete Order
Record Scrap
Work Instruct
e-Notebook
Switch User
Close
Active Machine Group:
Packer A
Packer B
Packer C
Active Work Order:
Work Order No
WO-100913
Target Quantity
950
cases
Produced Qty
150
cases
Yield (%)
99.4
Item Number
70031
Description
1.0 oz Italian - 6 Pack
Special Instructions
Use new packaging material for this order
User ID
John Vitro
Shift
1
User Message
HACCP data collection required: Cooked Product
Pallets
Label Details
Bill of Materials
HACCP
Specifications
Scrap Details
Order Details
HACCP Template
Cooked Product
Time
Performed By
Verified By
Comments
04-JUN-2002 10:30:31AM John Daly Bill Small
04-JUN-2002 10:46:01AM John Daly
04-JUN-2002 11:00:38AM John Daly
04-JUN-2002 11:16:10AM John Daly
04-JUN-2002 11:30:17AM John Daly
04-JUN-2002 11:45:13AM John Daly
04-JUN-2002 12:00:36PM John Daly
04-JUN-2002 12:15:48PM John Daly
04-JUN-2002 12:30:27PM John Daly Bill Small
HACCP Data Collect Log
Record Data
Interwave Coordinator - HACCP Data Entry
HACCP Template
Cooked Product
HACCP Template Parameters:
Parameter
Value
Temperature
200
Weight
10.1
HACCP Data Entry
Parameter Value
200
UOM
deg F
Min
190
Max
210
Save
Cancel

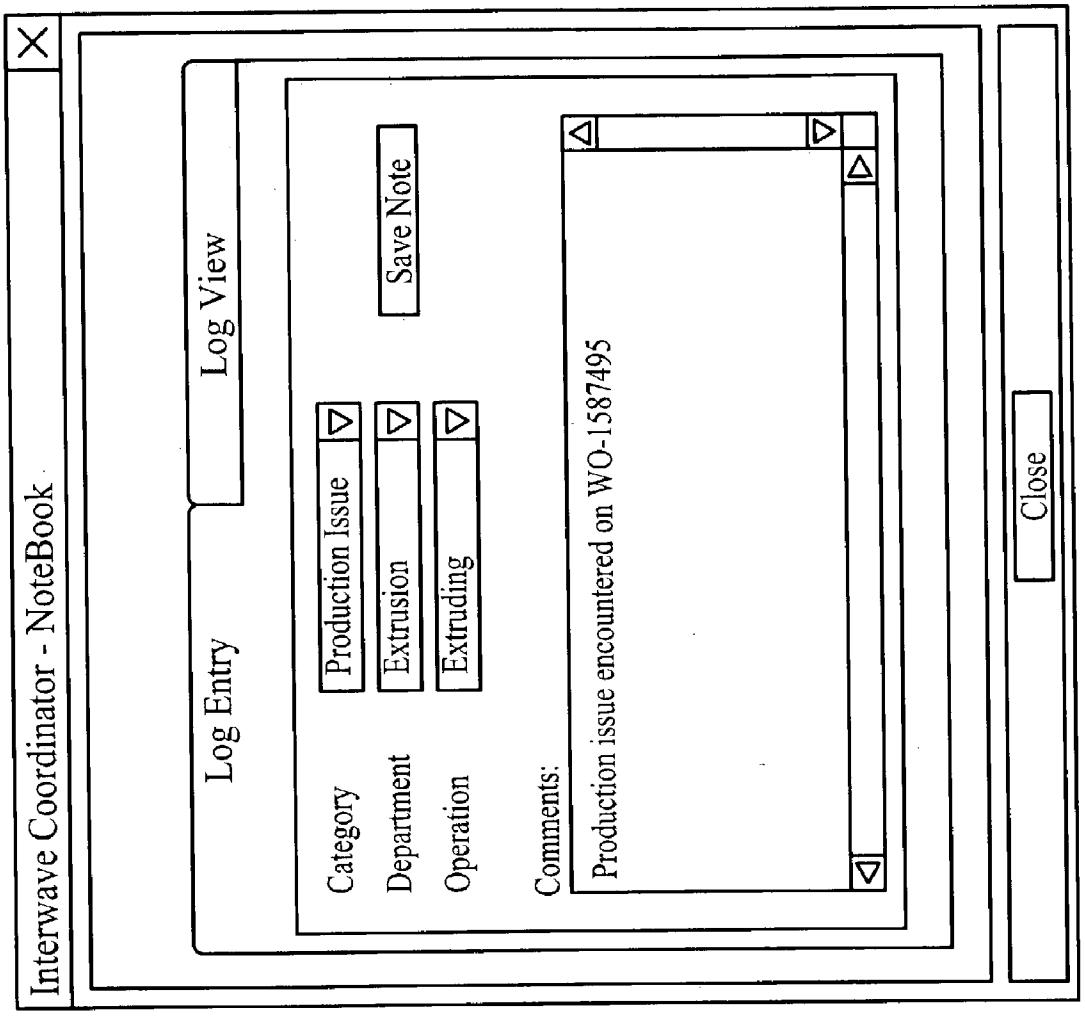

Interwave Coordinator - NoteBook
Log Entry
Log View
Category
Production Issue
Department
Extrusion
Operation
Extruding
Save Note
Comments:
Production issue encountered on WO-1587495
Close

Fig. 54

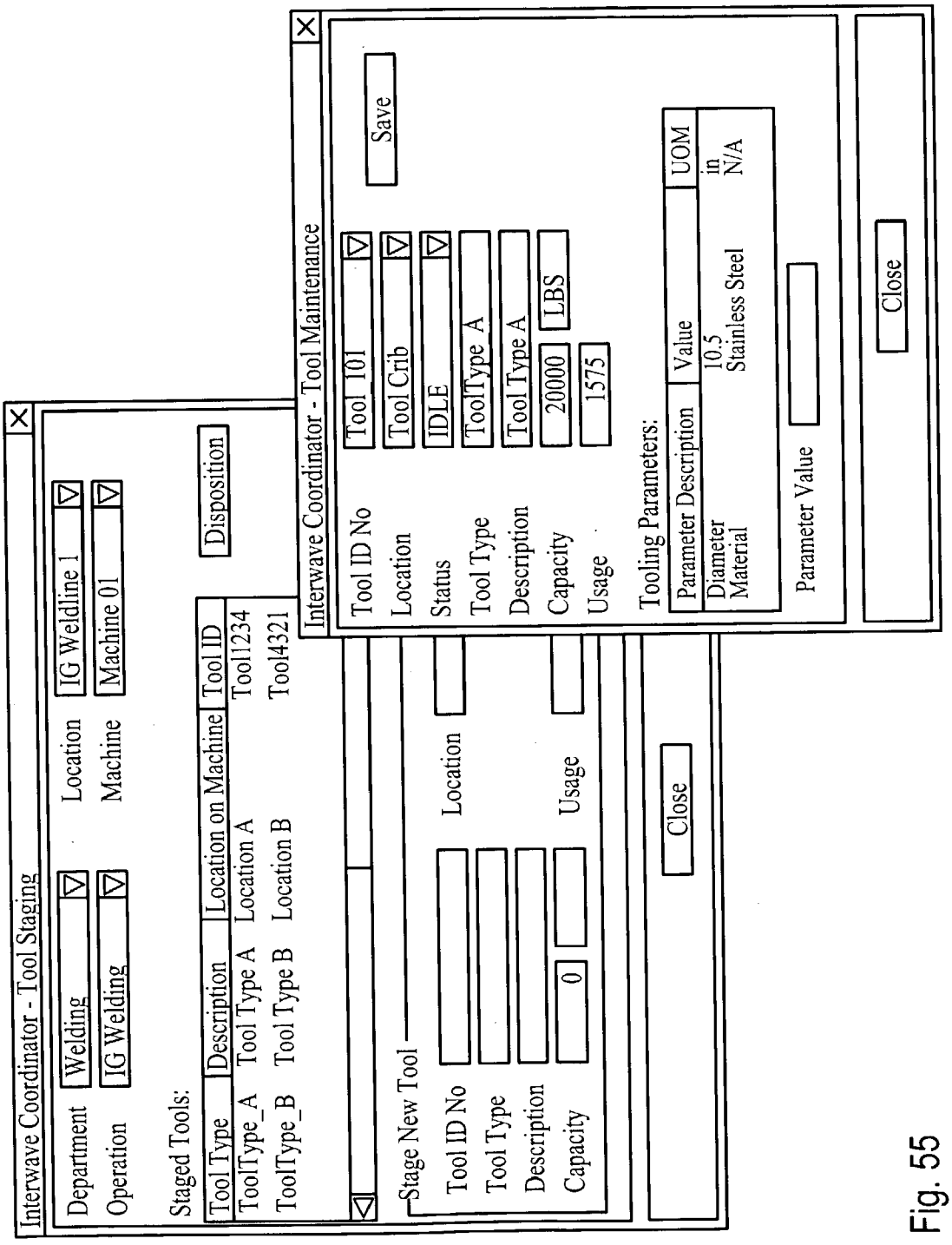
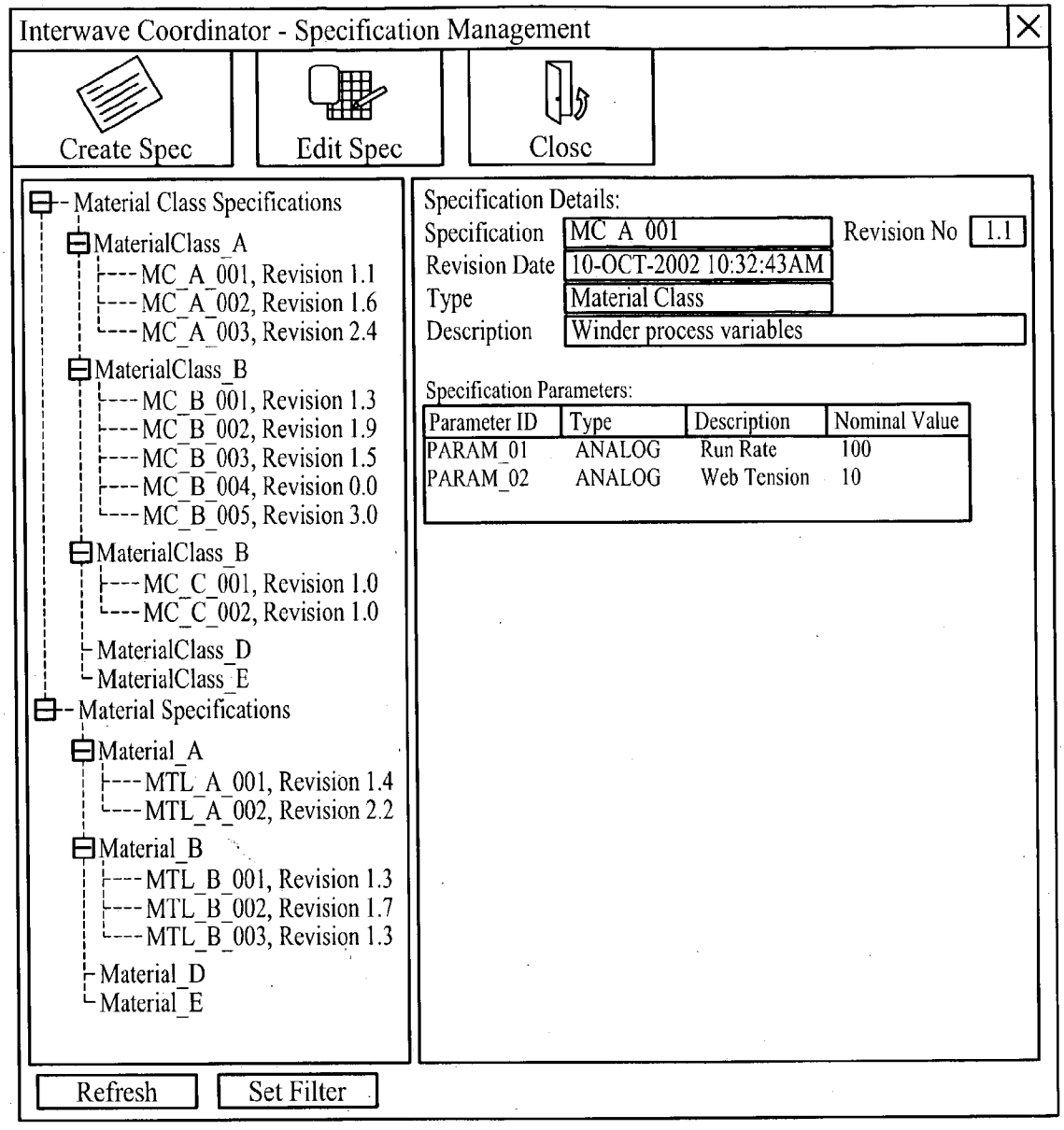

Interwave Coordinator - Tool Staging
Department
Welding
Location
IG Weldline 1
Operation
IG Welding
Machine
Machine 01
Staged Tools:
Tool Type
Description
Location on Machine
Tool ID
Disposition
ToolType_A
Tool Type A
Location A
Tool1234
ToolType_B
Tool Type B
Location B
Tool4321
Stage New Tool
Tool ID No
Location
Tool Type
Description
Capacity
0
Usage
Close
Interwave Coordinator - Tool Maintenance
Tool ID No
Tool 101
Save
Location
Tool Crib
Status
IDLE
Tool Type
ToolType A
Description
Tool Type A
Capacity
20000
LBS
Usage
1575
Tooling Parameters:
Parameter Description
Value
UOM
Diameter
10.5
in
Material
Stainless Steel
N/A
Parameter Value
Close

Fig. 55


Interwave Coordinator - Specification Management
Create Spec
Edit Spec
Close
Material Class Specifications
MaterialClass_A
MC_A_001, Revision 1.1
MC_A_002, Revision 1.6
MC_A_003, Revision 2.4
MaterialClass_B
MC_B_001, Revision 1.3
MC_B_002, Revision 1.9
MC_B_003, Revision 1.5
MC_B_004, Revision 0.0
MC_B_005, Revision 3.0
MaterialClass_B
MC_C_001, Revision 1.0
MC_C_002, Revision 1.0
MaterialClass_D
MaterialClass_E
Material Specifications
Material_A
MTL_A_001, Revision 1.4
MTL_A_002, Revision 2.2
Material_B
MTL_B_001, Revision 1.3
MTL_B_002, Revision 1.7
MTL_B_003, Revision 1.3
Material_D
Material_E
Specification Details:
Specification MC_A_001
Revision No 1.1
Revision Date 10-OCT-2002 10:32:43AM
Type Material Class
Description Winder process variables
Specification Parameters:
Parameter ID | Type | Description | Nominal Value
PARAM_01 | ANALOG | Run Rate | 100
PARAM_02 | ANALOG | Web Tension | 10
Refresh
Set Filter

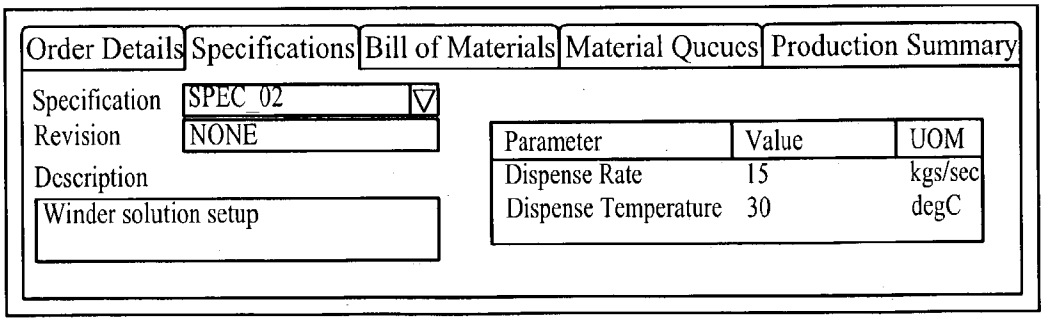

Order Details
Specifications
Bill of Materials
Material Queues
Production Summary
Specification SPEC_02
Revision NONE
Description
Winder solution setup
Parameter | Value | UOM
Dispense Rate | 15 | kgs/sec
Dispense Temperature | 30 | degC

Fig. 56

SUITE OF CONFIGURABLE SUPPLY CHAIN INFRASTRUCTURE MODULES FOR DEPLOYING COLLABORATIVE E-MANUFACTURING SOLUTIONS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 USC 119(e) to U.S. provisional application serial No. 60/354,151, filed Feb. 6, 2002.

BACKGROUND OF THE INVENTION FIELD OF THE INVENTION

[0002] The present invention relates to Manufacturing Executive Systems (MES). Particularly, the present invention relates to Collaborative Manufacturing Executive Systems (CMES), which can be defined as "collaborative manufacturing management infrastructure."

DISCUSSION OF THE BACKGROUND

[0003] U.S. Pat. No. 6,470,227 (hereinafter 227 patent) discloses a method for automating a manufacturing process including configuring application objects embodied in a computer program. The inventors recognized that the '227 patent does not provide any solution to synchronize key supply chain modules (ERP, PLM, and APS etc.) and production support systems (LIMS and FCS etc.) with events and activities that occur on the factory floor, and that the '227 patent fails to disclose the ability to synchronize and coordinate activities across multiple manufacturing sites.

SUMMARY OF THE INVENTION

[0004] A MES system means a software application that provides a real-time view of manufacturing operations. These systems perform the task of integrating corporate or plant business systems information with shop floor data systems. The resulting values provided by MES are data that can be automatically converted into "actionable information" that can then be used for improved decision making at all levels of the manufacturing enterprise. For example, MES provides values derived from data obtained from operations, manufacturing management, engineering, IT, planning, materials management, etc.

[0005] A CMES system is about information, and how to get your data from the plant floor, from production control, from inventory and quality control, from purchasing, from engineering, from marketing and sales, and turn that data into information that can be used by managers at all levels of the enterprise to make mission-critical decisions. To summarize. CMES is about communication, and how to optimize the bi-directional flow of information to and from the operating units in a manufacturing enterprise.

[0006] Therefore, it is the object of the present invention to provide a collaborative manufacturing execution system (CMES) and method. The CMES is designed in the form of a collaborative software system infrastructure that interfaces with business systems, the supply chain modules, such as Enterprise Resource Planning (ERP) and Advanced Planning & Scheduling (APS), production support systems, such as Laboratory Information Management Systems (LIMS), Finite Capacity Scheduling (FCS) Systems, and plant floor systems, such as Supervisory Control and Data Acquisition Systems (SCADA), Distributed Control Systems (DCS), and Programmable Logic Controllers (PLC).

[0007] This collaborative infrastructure, which is a collaborative manufacturing execution system (CMES), supports and enables high velocity e-business initiatives for manufactures in many different market segments, e.g., automotive, consumer products, food and beverage, pharmaceutical, electronic. Furthermore, this collaborative infrastructure is able to coordinate and synchronize business systems, production support systems and plant floor systems across multiple manufacturing sites through an enterprise intranet or the Internet.

[0008] **FIG. 1** illustrates a commercial embodiment of a CMES application of this invention, named Interwave Coordinator. Interwave Coordinator is used to reduce time and expense spent in understanding process and product flow in manufacturing environments and provide real-time integration among them. Interwave Coordinator is also utilized by enterprises to make business objectives decision and determine the requirements for manufacturing and designing products using quantitative information regarding defects, downtime, rework requirements, and resulting quality.

[0009] Furthermore, **FIG. 1** illustrates how Interwave Coordinator provides all of the coordination and synchronization with the external entities (ERP, PLM, PDM, etc.) at a business level that are impacted by the events and activities that occur on the plant floor. This coordination and synchronization is provided via business process modeling modules, such as the Business Process Event Coordinator, along with a supporting communication connector module, such as the XML Business Connector. In addition, Interwave Coordinator provides the internal coordination and synchronization to support typical plant floor production management functions, such as Work Order Management, WIP Management, Inventory Management, etc. This coordination and synchronization is provided via another supporting communication connector module, such as the OPC Shop Floor Connector. These two types of coordination and synchronization provide a completely synchronized information system to support the tremendous information demands of a CMES model. As a result, there will be no overlapping and disconnected segments in various levels of manufacturing work flow and among remote manufacturing sites. The CMES of this invention includes a suite of universal application templates, utilities and pre-configured solutions that leverage Microsoft technology such as Visual Basic, COM+ and SQL Server.

[0010] The universal application templates are configurable, scalable, and maintainable application templates that can be deployed in a stand-alone mode, or can be assembled into a fully functional solution, that is a custom application, based on specific business needs. Specifically, the universal application templates are configurable because they are configurable through a user friendly Graphical User Interface panel or panels to designate a particular business specification by way of selecting parameters in various entries. Further, the universal application templates are scalable because each and every one of them can function independently or in combination with other application template or templates. Enterprises can design a custom application to fit special business needs in manufacturing

simply by selecting at least one appropriate application template. This is the reason why the present invention is capable of operating in a stand-alone mode or being packaged into a fully functional business solution. Finally, the universal application templates are maintainable because it is easy to maintain these templates. Due to the independence nature of each application template, it is less costly, less time-consuming and easy-access to fulfill maintenance needs, such as debugging and updating.

[0011] These application templates provide capabilities, such as Work Order Management, WIP Management, Inventory Management, Material Management, Tool Management, Quality Management, Quality Data Collection, Defect Tracking, Downtime Tracking, Specification Management, Receiving and Inspection, Shipping, Return Merchandise Authorization, Engineering Change Order, Work Instructions and Electronic Notebook.

[0012] Pre-configured solutions are also provided to address specific vertical industries. These market available pre-configured solutions utilize and extend the basic functionality in the universal application templates to address the unique information requirements of a particular manufacturing industry. These solutions include Roll Tracker, which provides basic roll tracking functions for manufacturers in the roll goods industry; Discrete Assembler, which provides discrete assembling and tracking functions for customers in the discrete manufacturing sector; Pharma Manager, which provides specification management, batch execution, on-line data collection, and genealogy for preweigh and dispensing operations under FDA control; MedDevice Tracker, which provides basic tracking, genealogy, quality management, and data collection functions for manufacturers in the medical device industry under FDA control; and Food Processor, which provides basic tracking, genealogy and quality control of inventory and product in the regulated food industry.

[0013] This new CMES application, Intewave Coordinator, also includes a plurality of support applications, such as Shop Scheduler and Lab Manager, providing basic functionality for scheduling and laboratory management. Utility modules are also included in the invention to address common functions such as label printing, event messaging, data archiving, auto tracking, auto data collection and work traveler printing. Furthermore, the invention provides modules to interface to the business systems and shop floor systems, such as the Extensible Markup Language (XML) and Ole for Process Control (OPC) technologies to provide open and standardized interfaces.

[0014] The Interwave Coordinator embodiment also provides a visualization module that provides standard or ad-hoc reporting capability through Microsoft Excel. This module provides visibility into the performance of the manufacturing enterprise by analyzing and reporting Key Performance Indicators (KPIs) and Overall Equipment Efficiency (OEE), such as performance to schedule, downtime, scrap, utilization and efficiency. Because of the visibility of manufacturing performance, enterprises are able to adjust and make better business objectives and, therefore, increase overall enterprise achievements based on the received analysis and report. Moreover, some of the business rules are automatically adjusted based on the visibility feedback.

[0015] There are many advantages of this inventive CMES application. First, the invention decreases time-to-deployment, which accelerates payback and Return On Investment (ROI). Secondly, this invention enables easy, rapid, and cost effective pilots or proof-of-concept. This CMES application is cost-effective and provides affordable industry-based solutions that reduce total cost of ownership (TCO) and increase return on investment. Furthermore, this CMES application reduces project risk and utilizes modular approach that accommodates phased implementations and scalable point solutions. Based on extensive domain expertise, this CMES application contains proven knowledge of market best practices, operational and business processes and enhances lean manufacturing initiatives.

[0016] In one aspect, the invention provides a system and method for providing a work flow from a business decision making layer to a production line and decision making layer; and implementing a real-time integration of said work flow. In additional aspects, the invention provides systems and methods for determining business objectives at said business decision making layer; performing said business objectives at said production line and decision making layer; and carrying out said real-time integration of said business decision making layer, said production line and decision making layer by a collaborative infrastructure, analyzing a result from said production line and decision making layer; and reporting said analyzed result to said business decision making layer; receiving a report containing analyzed result from said reporting process; and adjusting said business objectives according to said report; wherein said report comprises a plurality of formats, including Spreadsheet and GANTT Chart; wherein said collaborative infrastructure further comprises a first coordinator connector providing interface for said collaborative infrastructure and said business decision making layer; wherein said first coordinator connector is a web-based open technology for electronic data interchange; wherein said first coordinator connector is the Extensible Markup language (XML) Business Connector; wherein said collaborative infrastructure further comprises a second coordinator connector providing interface for said collaborative infrastructure and said production line and decision making layer; wherein said second coordinator connector is an Application Programming Interface (API); wherein said second coordinator is the Ole Process Control (OPC) Shop Floor Connector; integrating said business decision making layer, production line and decision making layer by said collaborative infrastructure through an Intranet or the Internet; wherein said production line and decision making layer further comprises a plurality of business rules; analyzing a result from said production line and decision making layer; reporting said analyzed result to said business decision making layer; receiving a report containing analyzed result from said reporting process; and automatically adjusting said business rules based on said report; wherein said collaborative infrastructure further comprises a plurality of configurable module templates; wherein said collaborative infrastructure further comprises a graphical user interface capable of configuring and modifying said plurality of business rules; wherein said configurable application templates are capable of synchronizing and optimizing execution activities at said production line and decision layer; wherein said infrastructure is a Manufacturing Executive System (MES); wherein said infrastructure is a Collaborative Manufacturing Executive System (CMES); wherein said collaborative infrastructure further comprises a plurality of scalable application templates; wherein said collabo-

rative infrastructure comprises at least one custom application constructed with at least one scalable application template; wherein said collaborative infrastructure further comprises a plurality of maintainable application templates; wherein said maintainable application templates increase the updating and debugging abilities of said collaborative infrastructure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The foregoing and other objects of the invention are described with reference to the following figures in which like elements are referred to by the same or similar reference numerals.

[0018] **FIG. 1** is a diagram demonstrating how Interwave Coordinator supports a CMES model.

[0019] **FIG. 2** is a diagram showing the Internal Supply Chain Integration of one of the preferred embodiment of the present invention.

[0020] **FIG. 3** is an illustration of a preferred embodiment of the system architecture of the present invention.

[0021] **FIG. 4** is an illustration of an embodiment of the manufacturing information system architecture of the present invention shown in **FIG. 1**.

[0022] **FIG. 5** is an illustration of a collaborative e-manufacturing solution model of the present invention.

[0023] **FIG. 6** is an illustration of a method of use of the invention to achieve better planning, better processing and better sequencing.

[0024] **FIG. 7** is a flow chart of a process of module installation of the invention.

[0025] **FIG. 8** is continuation of the process shown in **FIG. 7**.

[0026] **FIG. 9** is an illustration of a product overview of the present invention, depicting the relationship among business decisions, manufacturing decisions, and production line and process decisions.

[0027] **FIG. 10** is an illustration of a typical plant operations model which is supported by embodiments of the invention.

[0028] **FIGS. 11 and 12** are illustrations of the GUI for the Work Order Management application template.

[0029] **FIG. 13** is an illustration of the GUI for the WIP, Management application template.

[0030] **FIG. 14** is an illustration of the GUI for the Business Process Modeler module.

[0031] FIGS. **15-21** are displays of reports generated by the Digital Dashboard/Visualization module.

[0032] **FIG. 22** is an illustration of the GUIs for the Material Management application template.

[0033] **FIG. 23** is an illustration of the GUIs for the ECO application template.

[0034] **FIG. 24** is an illustration of the GUI for the Quality Data Collection application template.

[0035] **FIG. 25** is an illustration of the GUI for the Work Instructions application template.

[0036] **FIG. 26** is an illustration of the GUI for the Defect application template.

[0037] **FIG. 27** is an illustration of the GUI for the Downtime Tracker application template.

[0038] **FIG. 28** is an illustration of the GUI for the RMA application template.

[0039] **FIG. 29** is an illustration of the GUI to support sample management within the Lab Manager support application.

[0040] **FIG. 30** is an illustration of the GUI to support test data collection within the Lab Manager support application.

[0041] **FIG. 31** is an illustration of the GUI to support test template maintenance within the Lab Manager support application.

[0042] **FIG. 32** is an illustration of the GUI to support instrumentation management within the Lab Manager support application.

[0043] **FIG. 33** is an illustration of the Dynamic Environments framework under which the Shop Scheduler support application is utilized.

[0044] **FIG. 34** is an illustration of MS Project that enables adjustment of result schedule under the Shop Scheduler application template.

[0045] **FIG. 35** is an illustration of a GUI for the Shop Scheduler support application.

[0046] **FIG. 36** is a diagram showing the assembly lines parameters and machine groups parameters for scheduling.

[0047] **FIG. 37** is an illustration of a Scheduling Engine of Shop Scheduler support application.

[0048] **FIG. 38** is an illustration of a Schedule GANTT Chart report.

[0049] **FIG. 39** is an illustration of a GANTT report for a selected machine.

[0050] **FIG. 40** is an illustration of a GANTT report for a selected work order.

[0051] **FIG. 41** is an illustration of an ad-hoc Query Generator.

[0052] **FIG. 42** is an illustration of a Web View of a Dispatch Report.

[0053] **FIG. 43** is an illustration of the GUIs that support formulation functions within the Food Processor industry application.

[0054] **FIG. 44** is an illustration of the GUIs that support production and packaging functions within the Food Processor industry application.

[0055] **FIG. 45** is an illustration of the GUIs that support receiving and inventory control functions within the Inventory Management application template.

[0056] **FIG. 46** is an illustration of the GUI for the Shipping application template.

[0057] **FIG. 47** is an illustration of the GUIs that support QA lab product evaluation functions within the Food Processor industry application.

[0058] **FIG. 48** is an illustration of the GUIs that support QA lab product test functions within the Food Processor industry application.

[0059] **FIG. 49** is an illustration of the GUIs that support QA lab environmental test functions within the Food Processor industry application.

[0060] **FIG. 50** is an illustration of the GUIs for the Quality Management application template.

[0061] **FIG. 51** is an illustration of the GUIs that support QA product retention functions within the Food Processor industry application.

[0062] **FIG. 52** is an illustration of the GUIs that support QA production checklist functions within the Food Processor industry application.

[0063] **FIG. 53** is an illustration of the GUIs that support HACCP enforcement functions within the Food Processor industry application.

[0064] **FIG. 54** is an illustration of the GUI that supports Electronic Notebook application template.

[0065] **FIG. 55** is an illustration of the GUIs that support Tool Management application template.

[0066] **FIG. 56** is an illustration of the GUIs that support Specification Management application template.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0067] **FIG. 1** illustrates all of the coordination and synchronization provided by this invention with respect to the decision support systems (ERP, APS, CRM, etc.) and production control systems (i.e. automation/plant floor production systems) employed by a typical manufacturing enterprise. The coordination and synchronization provided by this invention is key in supporting a collaborative execution model.

[0068] Collaborative Manufacturing Executive Systems (CMES) are the key to extending the principles of e-business throughout the enterprise. The extended enterprise is the core business, and the web of suppliers, partners, alliances, and customers in which the business participates. At the heart of this extended enterprise is the value chain from raw material to user. The business will have to optimize this value chain in order to be competitive in the future. An example of optimization is using the least raw material and going through most efficient process to produce the best possible products. Hence, open, maintainable, and scalable manufacturing solutions are required to be able to optimize the value chain in the extended enterprise. Collaborative MES pertains to information and how to get data from the plant floor, production control, inventory and quality control, purchasing, engineering, marketing, and sales, and turning that data into information that can be used by management at all levels in the extended enterprise to make mission-critical decision.

[0069] Further, CMES deals with communication, and how to optimize the bi-directional flow of that information to and from the operating units of an enterprise. Collaborative MES opens that bi-directional flow of information to the entire strategic value chain of the extended enterprise. Because CMES enables most of the value-add in of an enterprise derived from the factory floor, CMES becomes the vital link that makes enterprise-wide integration possible. As shown in **FIG. 9**, in an extended enterprise, real-time integration with the business decision making sector and the production line and process decision sector is made possible utilizing a CMES application. Thus, CMES greatly improves the return on applied assets for any given enterprise by increasing on-time delivery, shortening inventory turn time, increasing gross margin and, most of all, improves the cash flow performance. A CMES application synchronizes key supply chain modules (ERP, PLM, PDM, APS, CRM, SCM) in a manufacturing enterprise with events and activities that occur on the factory floor.

[0070] **FIG. 2** shows an overview of an example of internal supply chain integration using a CMES system of the invention including steps 1-8.

[0071] In step 1, an order is entered via the Web and then downloaded into the MES.

[0072] In step 2, once the download is finished, BOM (Bill of Materials) and order specifications are transmitted to the e-Manufacturing System. Step 2 also includes transmitting order information to devices performing step 3 and step 4.

[0073] In step 3, the order is sent to FCS for real time scheduling and optimal sequencing, and the result is then feed back to step 2.

[0074] In step 4, an automatic process is set up which performs the manufacturing and quality testing and transmits information to the structure performing step 5.

[0075] In step 5, the system generates total product genealogy and automatic device history record, and then sends the generated information to step 6.

[0076] In step 6, shipping labels are generated when the order is completed.

[0077] Step 7 is responsible for ERP updates and invoicing.

[0078] In step 8, advanced customer notification of shipment is generated along with shipping instructions. As a result, product is shipped via overnight from the plant.

[0079] **FIG. 3** shows a preferred embodiment of a system architecture of the CMES disclosed by the present invention. The business server **10** provides the decision support functions for the manufacturing enterprise, the Interwave Coordinator Database Server **20** provides the RDBMS for the Interwave Coordinator suite of modules, the Interwave Coordinator Application Server **30** serves up the Interwave Coordinator application templates and support applications, the Interwave Coordinator Production Server **40** provides the business process modeling and event coordination. The Interwave Coordinator Web Sever **50** provides web services for report printing, the Report Printer **60** is used for printing system reports and labels, the Interwave Coordinator Client Work Station **70** provides the GUI interface for the system user. All system components are connected via an local area and/or wide area network.

[0080] **FIG. 4** illustrates a manufacturing information system architecture in which there are deployed a plurality of information packages, and is based upon the system architecture illustrated by **FIG. 3**. More specifically, **FIG. 4** illustrates the flow of information between the three tiers of

systems that support a manufacturing enterprise, along with the material flow that is typical for a manufacturing entity.

[0081] At the business level, the business system **110** is equipped with a business system database **220**. Various pieces of information are passed between the business system **110** and the production management system (CMES). The business system **110** requires key information from the production management system (CMES) **120** in order to fulfill the informational needs (i.e. raw material consumption, production order status, finished good quantities) of the decision support systems that execute within the business system **110**. Furthermore, the production management system requires information from the business system **110** to execute manufacturing orders on the plant floor. This invention provides a XML business system connector module **140** to fulfill the interface needs between the business system **110** and the production management system (CMES) **120**.

[0082] At the production management system (CMES) level, a production management (CMES) database **230** is employed to provide a common data repository for all plant execution functions. Various pieces of information are passed between the production management system (CMES) **120** and the SCADA & Process Control System **130**. The SCADA & Process Control System **130** requires information, such as machine setup parameters, from the production management system (CMES) **120** to manufacturer the product to the proper specification. Furthermore, the production management system (CMES) **120** requires information, such as process alarms and production events, from the SCADA & Process Control System **130** in an effort to manage the production process. This invention provides an OPC shop floor connector module **150** to fulfill the interface needs between the production management system (CMES) **120** and the SCADA & Process Control System **130**.

[0083] The basic manufacturing work flow demonstrated in **FIG. 4** is that raw materials **170** are received from a plurality of raw material vendors **160**. These raw materials **170** are processed through a sequence of production work centers **180**/**190** until a semi-finished or finished product **100** is produced. Upon completing the manufacturing process, the finished product **100** is shipped to the customer **210**. At each production work center **180**/**190**, vertical databases and dedicated process control systems are employed to control and manage the manufacturing process.

[0084] **FIG. 5** shows an embodiment of a system of deployed modules of the invention. At the core of the Collaborative e-Manufacturing Solution Model is the Business Process Event Coordinator. This module synchronizes and coordinates activities at the supply chain/business system level, at the automation/plant floor level, and with the production support systems such as Laboratory Information Management Systems (LIMS), Computerized Maintenance Management Systems (CMMS), Finite Capacity Scheduling Systems (FCS), Time and Attendance Systems, etc. An XML Business System Connector and Ole Process Control (OPC) Shop Floor Connector are leveraged to provide standardized interfaces to the respective systems, wherein the industry standard API called OPC (OLE for Process Control) is used to communicate with hardware PLC devices, OPC can be directly accessed using the simple Data Socket component accesses, and the Extensible Markup Language (XML) is a new format designed to bring structured information to the Web. It is a Web-based language for electronic data interchange. XML is an open technology standard of the World Wide Web Consortium (W3C), which is the standards group responsible for maintaining and advancing HTML and other Web-related standards.

[0085] Application templates are leveraged to build industry specific solutions, or custom solutions that provide typical production management functions such as work order management, WIP management, inventory management, material management, tool management, quality management, etc. These templates operate together in a seamless fashion to provide a cohesive and integrated solution. Some of the benefits realized as a result of the execution of this model are waste reduction, higher process excellence, greater throughput, accurate capability, accurate inventory levels. This feature can be better illustrated by **FIG. 6**.

[0086] **FIG. 6** illustrates the basic sequence of operations that occur with respect to manufacturing a product. These sequences are Plan **300**, Schedule **301**, Execute **302** and Analyze/Report **303**. A business master plan of forecast orders is produced at the Plan **300** stage and then communicated to the Schedule **301** stage. At the Schedule **301** stage, a plant schedule is produced either manually or by a FCS system. Many variables need to be considered within this stage to produce a schedule that utilizes machines, materials, and manpower in an efficient manner.

[0087] Subsequently, the plant schedule is executed at the Execute **302** stage. The Execute **302** stage facilitates machine setup, processing and tear down by product code. Upon completion of the Execute **302** stage, the execution process is analyzed to surface issues that cause waste to be generated, excessive cycle times, etc. This feedback ultimately triggers an effect that produces better sequencing at the Schedule **301** stage, and better planning at the Plan **300** stage. The net effect that is achieved by this invention is that through coordination and synchronization, continuous improvement is realized at all stages of the process.

[0088] **FIGS. 7 and 8** illustrate the Coordinator Module installation of Interwave Coordinator business process modeling components, application templates, industry applications, support applications, connectors and utilities. In the beginning, as shown in **FIG. 7**, at step **410**, Rational Database Management System (RDBMS) on the Coordinator Database Server is installed. Then, the Web Services on the Coordinator Web Server module is installed at step **420**. At step **430**, the Coordinator Business Process Modeler on the Coordinator Production Server is installed. Thereafter, the Coordinator Business Process Event Coordinator is installed on the Coordinator Production Server (authoring and runtime components) at step **440**. Subsequently, desired Coordinator Application Templates are installed on the Coordinator Application Server at step **450**. There are many available application templates that can be installed at this step to suit each individual business special needs. Those available application templates include Work Order Management, WIP Management, Inventory Management, Material Management, Tool Management, Quality Management, Quality Data Collection, Defect Tracker, Downtime Tracker, Specification Management, Receiving & Inspection module, Shipping, Return Merchandise Authorization (RMA), Engi-

neering Change Order (ECO), Material Review Board (MRB), Work Instructions, and Electronic Notebook.

[0089] After installation of desired application templates at step **450**, desired Coordinator Industry Applications are installed on the Coordinator Application Server at step **460**, and desired Coordinator Support Applications are installed on the Coordinator Application Server at step **470**. The available Industry Applications include Roll Tracker, Discrete assembler, Food Processor, Pharma Manager module, and Med Device Tracker module. The available Coordinator Support Applications for installation are Lab Manager, and Shop Scheduler.

[0090] Referring to **FIG. 8**, after installation of all the desired Application Templates, Industry Applications, Support Applications, desired Coordinator Connectors are installed on the Coordinator Application Server at step **480**. Those available Coordinator Connectors are XML Business Connector and OPC Shop Floor Connector. The installation process continues to step **490**. At step **490**, desired Coordinator Utilities are installed on the Coordinator Application Server. The available Coordinator Uitilites include Auto Tracker, Auto Collector, Event Messenger, Work Traveler, Label Manager, and Data Archiver. Finally, desired Coordinator Visualization Tools are installed on the Coordinator Application Server at step **500**, such as Digital Dashboard. The present invention is better described with further detailed information regarding the configurable modules. The modules have classified as Business Process Modeling, Application Template, Industry Application, Support Application, Connector, Visualization or Utility modules.

[0091] Business Process Modeling

[0092] The Business Process Modeling modules address event transaction modeling and execution, along with static process modeling. It includes two modules, the business process event coordinator and business process modeler.

[0093] Business Process Event Coordinator

[0094] The Business Process Event Coordinator (BPEC) provides the end users with the ability to graphically model and configure the manufacturing business rules required by a particular manufacturing entity. The business rules essentially describe the interaction and synchronization required between supply chain modules (ERP, APS, etc.), production support systems (LIMS, FCS, etc.), other manufacturing plants, and the factory floor. For example, how to record the machine downtime and dispose defect product. Once business rule models have been established, a runtime component of (BPEC) enforces or executes the models and rules through the runtime component/module.

[0095] Examples of business rules that would be enforced or executed by BPEC are: when a machine downtime event is detected, send a message to the Computerized Maintenance Management System to create an emergency work order to repair the machine and send a message to the Finite Capacity Scheduling System to re-schedule the others currently assigned to the machine. When a production test sample is created, send a message to the Laboratory Information management System to create a new lab sample. When a new product is being introduced to manufacturing (even if received from external system), retrieve all necessary product specifications (i.e., routes, bills of materials, etc.) from the Product Data Management System. When a work order has been put on hold by Quality, send a message to the ERP to update the status of the order to "Hold."

[0096] Business Process Modeler

[0097] The Business Process Modeler (BPM) provides the ability to model static manufacturing entities such as: departments, work centers, routes, materials, tooling, machines, locations, users, security profiles, user certifications, data collection templates, recipes, and work instructions.

[0098] Application Templates

[0099] In order to further support the collaborative scheme, a suite of highly configurable application templates have been engineered to provide basic production management functions such as work order management, WIP management, inventory management, material management, etc. The application templates are designed to be used as standalone components, or can be either assembled or configured or both into a cohesive solution to provide a basic foundation layer for a Collaborative Manufacturing Execution System (CMES). Once configured, these application templates provide a highly integrated factory floor information system that is essential to operating a highly efficient manufacturing operation. The application templates leverage ActiveX OCX technology to promote rapid solution configuration and deployment.

[0100] The Intewave Coordinator application templates provide the essential production management functions of the Execution layer illustrated in **FIG. 9**. In particular, the templates provide production dispatching, schedule execution, WIP and resource tracking, document control, data collection, resource management, quality management and process management. These functions are essential with respect to supporting a truly collaborative manufacturing model.

[0101] **FIG. 10** illustrates a typical plant operations model. The model breaks down into Schedule and Execution phases. Within each phase, multiple steps are required to be executed in a sequential manner. The application templates have been engineered to specifically address the functionality illustrated in each of these steps. The integrated manner in which the templates have been designed promote the coordination illustrated in the **FIG. 10**.

[0102] Work Order Management Application Template

[0103] **FIGS. 11 and 12** demonstrate the Work Order Management application template Graphical User Interface (GUI), The Work Order Management application template supports Work Order Creation, Machine Assignment, Picklist Assignment, Work Order Update, Work Order Release, and Work Order Deletion. In addition, the Work Order Management application template provides visibility with respect to the status of orders, quantity produced, required bill of material, required process routing.

[0104] Work Order Creation supports automatic creation of work orders based on the latest schedule received from the ERP/APS. It includes Bill of Materials (BOM) and routing, and also provides the ability to manually create work orders to support WAN/LAN failure, or R&D production scenarios.

[0105] Machine Assignment provides the ability to manually assign/schedule machines to work orders at specific work centers.

[0106] Picklist Assignment provides the ability to create material picklists for production work orders. It provides the ability to reserve inventory items against specific BOM items within a production work order.

[0107] Work Order Update provides the ability to modify the quantity, priority, BOM, or routing assignment associated with existing work orders, as shown in **FIG. 12**. It also provides the ability to assign special instructions to work orders to support custom orders. Work Order Release provides the ability to dispatch work orders for production execution. It also provides the ability to suspend/hold in-process work orders. Work Order Deletion supports the automatic deletion of work orders based on the revised work order schedule received from ERP/APS. It also provides the ability to manually delete existing work orders.

[0108] WIP Management Application Template

[0109] **FIG. 13** demonstrates the WIP Management application template Graphical User Interface (GUI). The WIP Management application template supports Lot Create, Lot Start/Complete, and Containerization. In addition, the WIP Management application template provides visibility with respect to WIP items currently queued or in-process at a particular work center.

[0110] **FIG. 14** shows the Resource Modeler functions of the ProcessStudio under Work In Progress (WIP) manager application template. The Resource Modeler models and maintains static manufacturing resources, including departments, work centers, routes, and materials. It also models and maintains resources at the plant floor and the end user parts, such as tooling, machines, locations, user security profiles, user certifications, and data collection templates and recipes, and work instruction.

[0111] **FIGS. 15 through 21** show the various reports generated by the Report Manager under Work In Progress (WIP) manager application template. This Report Manager can be utilized for various reports, including WIP Status Report, as shown in **FIG. 15**, Material Genealogy Report, as shown in **FIG. 16**, Route Genealogy Report, as shown in **FIG. 17**, Inventory Summary Report, as shown in **FIG. 18**, Work Order Status Report, as shown in **FIG. 19**, Defect Data Report, as shown in **FIG. 20**, and Downtime Report, as shown in **FIG. 21**. As discussed in previous **FIGS. 9 and 10**, a better work instruction will be generated based on previous performance analysis and reports when the Schedule module operates to generate instructions next time. The business decision making process is especially depending on the analysis and reports feedback to amend its master plan in the future.

[0112] If required, the Lot Create automatically creates WIP lots when production is reported at a particular work center. Lot Start/Complete provides the ability to Start and/or Complete a WIP entity at a given work center or a specific work operation. It also supports the ability to disposition WIP to scrap, rework, inventory, or next work center on route. The Lot Start/Complete further enforces data collection, material issue, and disposition requirements established for each work order. Containerization is used to provide the ability to assign WIP or Inventory items to a container in order to support bulk transaction processing.

[0113] Inventory Management Application Template

[0114] **FIG. 45** demonstrates the Inventory Management application template Graphical User Interface (GUI). The Inventory Management application template supports Receiving and Inspection, Picklist Delivery, Lot Disposition/Move, Lot Split, Lot Merge, Material Re-grade, Quantity Adjustment, Tiered Storage, Containerization. In addition, the Inventory Management application template provides visibility to all items in inventory.

[0115] Receiving and Inspection provides the ability to receive and inspect incoming raw materials. Receiving and Inspection supports manual receipt or receipt against purchase orders. Picklist Delivery provides the ability to view picklists for a particular work order/work center and confirm delivery. Lot Disposition/Move provides the ability disposition/move inventory entities to different locations within the system. Lot Split provides the ability to split an inventory entity into multiple entities. The Lot Split further supports the ability to re-grade the split entity.

[0116] Lot Merge provides the ability to merge multiple inventory entities into a single entity. Material Re-grade provides the ability to re-grade an existing inventory entity to support material re-classification. Quantity Adjustment provides the ability to modify the quantity of an inventory entity to support cycle counting. Tiered Storage provides the ability to create a hierarchical inventory storage location scheme to support parent/child storage relationships. Containerization provides the ability to assign inventory items to a container to support bulk transaction processing.

[0117] Material Management Application Template

[0118] **FIG. 22** demonstrates the Material Management application template Graphical User Interface (GUI). The Material Management application template supports Genealogy, BOM Enforcement, BOM Substitution, Material Staging, Automatic Consumption and Manual Consumption.

[0119] Genealogy provides full component genealogy and tracking by work center for each work order.

[0120] BOM Enforcement displays BOM requirements for a designated work center and work order. BOM Enforcement also provides validation to ensure that proper components are consumed to produce the finished good.

[0121] BOM Substitution provides the ability to define substitutes for standard items in the BOM. BOM Substitution also enforces substitute definition within the BOM Enforcement function.

[0122] Material Staging provides the ability to stage material at a given work center for automatic consumption.

[0123] Automatic Consumption provides the ability to automatically consume staged materials based upon the BOM established for a particular work order.

[0124] Manual Consumption provides the ability to manual consume material against BOM items established for a particular work order.

[0125] Tool Management Application Template

[0126] **FIG. 55** demonstrates the Tool Management application template Graphical User Interface (GUI). The Tool Management application template supports Genealogy, Tool Enforcement, Tool Substitution, and Tool Maintenance.

[0127] Genealogy provides full tool genealogy and tracking by work center for each work order.

[0128] Tool Enforcement displays tooling requirements for a designated work center and work order. Tool Enforcement also provides validation to ensure that proper tools are utilized to produce the finished good.

[0129] Tool Substitution provides the ability to define substitutes for standard tooling. Tool Substitution enforces substitute definition within the Tool Enforcement function.

[0130] Tool Maintenance provides the ability to add new tools to the system, or modify the attributes of existing tools. Tool Maintenance also provides full inventory management and tracking capabilities.

[0131] Quality Management Application Template

[0132] **FIG. 50** demonstrates the Quality Management application template Graphical User Interface (GUI). The Quality Management application template supports Quality Hold, Hold Resolution, Quality Quarantine, and Quarantine Resolution.

[0133] Quality Hold provides the ability to issue one or more quality holds against a single WIP or Inventory entity and further implements quality holds by restricting transactional access to held entities. Hold Resolution provides the ability to resolve and release quality holds against a single WIP or Inventory entity. However, it requires selection of a resolution code from a configurable list.

[0134] Quality Quarantine provides the ability to issue one or more quarantines against a single WIP or Inventory entity, and further implements quarantines by restricting the ability to release a finished good to inventory. Quarantine Resolution provides the ability to resolve and release quarantine holds against a single WIP or Inventory entity. It also requires selection of resolution code from a configurable list.

[0135] **FIG. 23** demonstrates the GUIs that support Process Deviation function under Quality Manager application template. The Process Deviation module requests quality management and submits change requests for new or changed materials, products, procedures, processes, or methods to management. The Process Deviation module, once it has received instruction from the quality management, also initiates and manages the authorization process.

[0136] Quality Data Collection Application Template

[0137] **FIG. 24** demonstrates the Quality Data Collection application template Graphical User Interface (GUI). The Quality Data Collection application template under Quality Manager implements data collection requirements defined for a particular work center, operation, and material. **FIG. 24** shows the GUI access window of the Quality Data Collection Module user access window. This application template provides the ability to pre-populate data collection templates from OPC or XML source. Quality Data Collection application template also performs limits checks and applies quality holds when out-of-limits conditions are experienced. Furthermore, this application template allows data to be applied against a single entity (e.g., WIP or Inventory) or multiple entities (e.g., container with multiple WIP or Inventory entities).

[0138] Work Instructions and Electronic Notebook Application Template

[0139] **FIG. 25** demonstrates the Work Instruction application template Graphical User Interface (GUI). The Work Instruction application template provides the ability to manually assign work instructions to work orders and/or work centers and operations. The Work Instruction Viewer provides a drop-down selection of work instruction for user to pick a particular instruction to review. Furthermore, it supports receipt of work instructions from ERP, and a means to access and display documents contained within 3rd party Enterprise Document Management System (EDMS) systems.

[0140] Electronic Notebook Application Template

[0141] **FIG. 54** demonstrates the Electronic Notebook application template Graphical User Interface (GUI). The Electronic Notebook application template provides the ability to capture and display log notes electronically. Particularly, data can be captured against pre-configured categories such as machines issues, material issues, productions issues, and shift changes, etc.

[0142] Material Review Board Application Template

[0143] The Material Review Board (MRB) application template under Quality Manager supports the features of MRB Submission and MRB Management. MRB Submission provides the ability to submit and subject semi-finished or finished goods to an evaluation prior to being processed or shipped to customers. The MRB Management provides the ability to manage the evaluation, disposition, and documentation processes associated with non-conforming or discrepant materials.

[0144] Defect or Waste Tracker Application Template

[0145] **FIG. 26** demonstrates the Defect Tracker application template Graphical User Interface (GUI). The Defect Tracker application template or the Waste Tracker application template supports the defect tracker features of Defect Recording and Defect Resolution. Defect Recording provides the ability to manually capture defects against a WIP or Inventory entity. It supports automatic recording of defects from automated test equipment while Defect Resolution provides the ability to resolve defects against a single WIP or Inventory entity. The resolution transaction requires selection of resolution code from a configurable list, as shown in **FIG. 26, a** two-tier window used as an access of Defect or Waste Tracker application template.

[0146] Downtime Tracker Application Template

[0147] **FIG. 27** demonstrates the Downtime Tracker application template supports Downtime Recording and Downtime Resolution. Downtime Recording provides the ability to manually capture downtime events against an asset. It supports automatic recording of downtime events from automated machinery or assets. Downtime Resolution, on the other hand, provides the ability to resolve downtime events against an asset, and requires selection of resolution code from a configurable list.

[0148] Specification Management Application Template

[0149] **FIG. 56** demonstrates the Specification Management application template Graphical User Interface (GUI). The Specification Management application template sup-

ports Specification Definition, Specification Display and Parameter Download. Specification Definition provides the ability to define one or more specifications for a given material/item at a given work center. Specification Display provides visibility to specification parameters for a given work order at execution time. Parameter Download provides the ability to download specification data to an OPC server.

[0150] Shipping Application Template

[0151] **FIG. 46** demonstrates the Shipping application template Graphical User Interface (GUI). The Shipping application template under Depot Manager supports the shipping features of Reservation, Data Collection, and Order Shipment. Reservation provides the ability to reserve product against a particular work order and/or customer order for shipment. Data Collection is designed to capture data against the shipped entities. Order Shipment is then utilized to support the ability to ship one or more Inventory entities against a customer order.

[0152] Return Merchandise Authorization Application Template

[0153] The Return Merchandise Authorization application template supports Product Return, Product Repair, and Product Shipment. Product Return receives a returned product into the system for repair. It also provides the ability to document the symptoms and problems of the returned product, then determining the disposition of the product as either repair or scrap. Product Repair supports the ability to initiate the repair process and document the repair procedures via pre-configured repair codes. Product Repair can recommend repair procedures based upon repair history. Finally, Product shipment provides the ability to ship the repaired product after all the symptom and repair procedures are well documented.

[0154] **FIG. 28** demonstrates the GUIs that support the Repair function under the Return Merchandise Authorization application template. The Repair handles product return, repair, and shipment. It receives returned product to the system for repair and documents symptoms, problems, and repair procedures via pre-configured repair codes. The Repair is able to initiate the repair process and the disposition of the product to repair or scrap. It also recommends repair procedures based upon repair history and, afterwards, ships out the repaired product.

[0155] Engineering Change Order Application Template

[0156] The Engineering Change Order (ECO) application template supports the features of Engineering Change Requests (ECR) and ECO Management. At first, ECR submits Engineering Change Requests that may suggest or recommend the possible use of new or changed materials, products, procedures, processes, or methods. Subsequently, ECO provides the ability to initiate and manage the authorization process centered around the use of new or changed materials, products, procedures, processes, or methods within a manufacturing organization.

[0157] Support Applications

[0158] The Interwave Coordinator CMES application includes support applications to further support its collaborative infrastructure. They are Lab Manager and Shop Scheduler.

[0159] Lab Manager Support Application

[0160] Lab Manager provides basic Laboratory Information Management System (LIMS) functions to assist engineers and technicians with managing lab data in a manufacturing environment. Lab Manager is a highly configurable LIMS application that supports Sample Management, Lab Test Data Collection, Lab Test Template Maintenance and Lab Instrumentation Management.

[0161] The Sample Management function provides automatic (CSV file) and manual sample logging. The manual logging manually logs in samples via a configurable template, as shown in **FIG. 29**. The configurable template offers multiple or single sample login process and prints out sample ID labels. It also provides visibility to samples and associated test and result data. Furthermore, it provides comprehensive audit trail and enforces a configurable electronic signature scheme, such as Performed By and Verified By.

[0162] **FIG. 30** shows the GUI that supports Lab Test Data Collection activities. The Lab Test Data Collection function can be easily performed manually or automatically, and displays result entry schemes through a GUI window. A browser can also be activated to allow easy review of the collected lab test data.

[0163] The Lab Test Data Collection function supports result entry against a group of samples to reduce data entry and partial result entry. It can also enforce automatic holds when specification limits have been exceeded. Repetitive entry schemes are also supported to enhance data entry capabilities. Lab Test Data Collection allows displays of specification limits and supports many types of results, such as textual, list select, or file.

[0164] The Lab Test Template Maintenance function supports the ability to configure lab test templates on an item or item class basis, as shown in **FIG. 31**. It supports template versioning and enables modification of existing templates or browsing of previous revisions. Lab Test Template Maintenance further tracks changes to templates and enforces electronic signatures. Specification limits can defined on a per parameter basis with auto hold capability.

[0165] **FIG. 32** shows the access windows of the Lab Instrumentation Management function within the Lab Manager support application. The Lab Instrumentation Management function provides the ability to easily define lab instruments and associated calibration schedules. Lab Instrumentation Management supports two types of calibrations, i.e., the "time" based calibration intervals and "use" based calibration intervals, and defines one or more calibration tasks for a particular instrument. Lab Instrumentation Management issues warnings whenever an instrument requires calibration or service. Finally, the Lab Instrumentation Management function records calibration results that are configurable for each instrument type and provides a comprehensive audit trail and electronic signature.

[0166] Shop Scheduler Application Template

[0167] The Shop Scheduler support application is ideal for finite capacity scheduling, which optimizes the efficiency of manufacturing resources, in dynamic environments. The dynamic environments, as shown in **FIG. 33**, are environments that focuses on fulfilling established work priorities,

such as due date, etc. The application pro-actively schedules items in a changing environment, rather than optimizing a stable environment. Shop Scheduler supports the ability to rebuild a production schedule around changing orders, priorities, inventory, or resource availability.

[0168] The Shop Scheduler leverages the planning and scheduling capability native to MS Project, which is shown in **FIG. 34**. MS Project can be used to display, analyze, and manually adjust the resulting schedule. For example, the calculated schedule is displayed in MS Project, including dependencies and summarization of tasks. The MS Project displays can be manually adjusted by using the drag-n-drop features. Furthermore, the Shop Scheduler is featured with an auto update function that automatically updates Shop Scheduler with the changes made within MS Project.

[0169] The Shop Scheduler is aimed to provide Finite Capacity Scheduling functions to assist manufacturers in coordinating manufacturing activities on the shop floor and generating realistic production sequences. Moreover, it enables the users to visualize the effects of schedule changes and significantly improves accuracy and timeliness of production schedule in dynamic production environment.

[0170] Furthermore, the Shop Scheduler enables enterprises to improve their ability to react to business changes rapidly. Shop Scheduler provides the feature of real-time scheduling that quickly updates schedules as changes occur on the factory floor. The visualization feature enables accurate available-to-promise delivery for customer service, and end users get to the visualize impact of, for example, inserting a "hot" order on the schedule before dispatching.

[0171] In **FIG. 35, a** flexible and easy way to use the Shop Scheduler is demonstrated by two GUI panels. One panel shows an intuitive user interface that does not require complex synchronization, scripts or functions to create a Schedule Calendar. The second panel shows user-defined prioritization rules in scheduling a particular machine for a job. Besides machines and assembly lines, tools and inventory can be addressed by Shop Schedule. With respect to tool configuration, whether to utilize the tools, and whether to assign a machine, or what assignment to which machine need to be scheduled. With respect to inventory configuration, whether to use inventory, and whether to delay start based on inventory or even the availability dependency all need to be scheduled. The scheduling granularity can be work orders, batches, individual items, or mixed granularity.

[0172] **FIG. 36** illustrates the scheduling parameters that are addressed by the Shop Scheduler. There can be up to n assembly lines and n machine groups available to the Shop Scheduler for scheduling work orders. Furthermore, the Shop Scheduler can address n number of dependencies between machine groups and assembly lines.

[0173] The Shop Scheduler functions as a pure scheduling engine and retrieves required input constraint information from external systems to eliminate the need of maintaining redundant data within the application. The data import and export routines are customizable to support a variety of external system interfaces.

[0174] The scheduling engine of Shop Scheduler is illustrated in **FIG. 37**. As shown in **FIG. 36**, the scheduling engine has many user friendly GUI features for easy access, such as drop-down menu and radio buttons. The radio buttons selection facilitates forward or backward job-step scheduling and drop-down menu specifies the schedule period. It can also coordinate dependant orders by using existing or planned inventory, and incorporate changeover times and yield constraints as well.

[0175] Shop Scheduler also includes many standard or custom displays and report capabilities, as shown in FIGS. **38-42**. **FIG. 38** shows a total schedule GANTT chart display with detailed order input window and a spreadsheet display of resultant schedule. **FIG. 39** shows a machine GANTT display with a overview of machine schedule and a particularly selected machine. **FIG. 40** shows a order GANTT display with a overview of order and a particularly selected order. **FIG. 41** shows an Ad-hoc Query Generator with a query input window and a result display window. **FIG. 42** shows a Web-enabled view of the schedule dispatch report, which can be easily transformed into a Schedule GANTT display via IE 5+ browser.

[0176] Industry Applications

[0177] The Interwave Coordinator CMES application includes industry applications to accelerate time-to-deployment and leverage industry best practices and standards. The industry applications utilize and extend the basic functionality in the universal application templates to address the unique information requirements of a particular manufacturing industry. The specific industry applications claimed by this invention are Roll Tracker, Discrete Assembler, Pharma Manager, MedDevice Tracker and Food Processor.

[0178] Roll Tracker Industry Application

[0179] The Roll Track industry application provides basic roll tracking functions for manufacturers in the roll goods industry. Roll Tracker is also a highly configurable MES application that supports the capability to coordinate the track the many to one, and one to many production scenarios typical in the roll goods industry.

[0180] Specifically, Slit Optimization is included to accommodate unique industry requirements with respect to slitting production items. Slit Optimization applies order cut requirements and calculates allocation for order set up. It also enables fast execution, which significantly reduces time when the number of orders and widths increase. Slit Optimization further supports use of "overage" to improve optimization results and integrates work order output with external scheduling systems.

[0181] Discrete Assembler Industry Application

[0182] The Discrete assembler industry application provides discrete assembling and tracking functions to customers in the discrete manufacturing sector. Discrete Assembler is a highly configurable MES application that supports component tracking and validation features necessary in the assembly of a discrete product.

[0183] Electronics Box Builder Industry Application

[0184] Electronics Box Builder industry application provides basic assembly and test functions for manufacturers in the electronics industry that relies heavily on contract equipment manufacturers for board assemblies and components.

[0185] Surface Mount Technology (SMT) Assembler Industry Application

[0186] SMT Assembler industry application provides surface mount component placement and printed circuit board tracking/testing functions for manufacturers in the electronics industry printed circuit board manufacturing.

[0187] High-speed Data Acquisition is particularly included to accommodate unique industry requirements. Specifically, there are two features involved in High-speed Data Acquisition, they are AutoTracker and AutoCollector. AutoTracker is designed for highly-automated production lines to track electronic components through highly-automated work centers. AutoTracker is configurable for work center tracking stations. Further, AutoTracker recognizes bar code ID and is able to register each process step in MES. AutoTracker also recognize out-of-sequence production and is able to do bi-directional feedback to control layer.

[0188] AutoCollector supports product genealogy and is designed for automatic collection of quality data from installed test stations. Furthermore, AutoCollector provides the ability to configure collection frequency and times, such as data source.

[0189] Semiconductor Assembler Industry Application

[0190] Semiconductor Assembler Industry Application provides basic wafer tracking and data collection for manufacturers in the semiconductor industry. The present invention, a CMES application, can improve the production work flow a great deal.

[0191] Pharma Manager Industry Application

[0192] The Pharma Manager industry application provides recipe/specification management, batch execution, on-line data collection and genealogy for pre-weigh and dispensing operations under Food and Drug Administration (FDA) control. Further, Pharma Manager implements all its functionalities in compliance with 21 CFR Part 11 security, and electronic record management guidelines.

[0193] MedDevice Tracker Industry Application

[0194] The MedDevice Tracker industry application provides basic tracking, genealogy, quality management and data collection functions for manufacturers in the medical device industry under FDA control. Further, MedDevice Tracker implements all its functionalities in compliance with 21 CFR Part 11 security, and electronic record management guidelines.

[0195] Food Processor Industry Application

[0196] The Food Processor industry application provides basic tracking, genealogy and quality control of inventory and product in the regulated food industry. Moreover, Food Processor industry application implements its functions in accordance with the United States Department of Agriculture (USDA) and Hazards Analysis and Critical Control Points (HACCP) standards.

[0197] Food Processor is utilized to track waste against production orders for both individual components and finished goods. It also increases WIP visibility and control with on-line KPI's and embedded reporting. Food Processor is able to configure and enforce electronic signature schemes and improve the flexibility of the production process. The Food Processor industry application further includes a plurality of food processing features, such as Formulation, Production and Packaging, QA Product Evaluation, QA Product Test, QA Environmental Test, QA Product Retention, QA Checklist, and HACCP Enforcement.

[0198] **FIG. 43** shows the Formulation overview and Batch History of the Food Processor. The overview panel of Formulation displays formulation ingredients and required amount, and records execution of formula, such as the quantity, ingredient lot number, operator, date, time, etc. The overview panel also supports and tracks deviations, i.e., additions and modifications, to production formula. Furthermore, the panels enforce a configurable electronic signature scheme. All the entries and deviations are recorded as part of the Batch History.

[0199] Particularly, Formulation supports containerization, which is production of multiple batches or containers against a single production order. It also tracks scrap produced against production order, such as ingredients and/or finished product. Further, Formulation displays formulation step and order specific instructions and current batch history for each production order.

[0200] **FIG. 44** shows the Production and Packaging function within Food Processor industry application. The Production and Packaging monitors one or more work centers (or "machine groups") from the same GUI panel. It supports palletized and non-palletized production reporting. The Production and Packaging tracks scrap produced against the production order, components of either finished or unfinished product, and tracks complete production and consumption genealogy.

[0201] The Production and Packaging GUI displays label printing requirements, label format, product specifications, product recipes, and performance information, i.e., target vs. produced quantity and yield. Moreover, the Production and Packaging GUI displays and enforces bill of material requirements and HACCP data collection requirements.

[0202] The QA Lab Product Evaluation function within Food Processor industry application is shown in **FIG. 47**. The GUI panel provides the ability to configuring product evaluation specifications on a production item basis, and further, define one or more evaluation specifications for a production item. The panel is also capable of enforcing a configurable electronic signature scheme. Moreover, the GUI panel is able to link evaluation data to a plurality of production lots and enter evaluation data against multiple samples for a particular production lot.

[0203] The QA Lab Product Test function within the Food Processor industry application is shown in **FIG. 48**. The GUI panel supports the ability to enter test data against multiple samples for a particular production lot and define minimum and maximum values for each parameter within a test specification. The end users can easily configure product test specifications on a production item basis and define one or more test specifications for a production item through the GUI panel. The panel further links test data to production lots and enforces a configurable electronic signature scheme.

[0204] The QA Lab Environmental Test function within the Food Processor industry application is shown in **FIG. 49**. The GUI panel provides the ability to configure environmental test specifications on a location basis and define

one or more test specifications for a location. It is also capable of defining minimum and maximum values for each test specification parameter and enforces a configurable electronic signature scheme.

[0205] The QA Hold Management function within the Food Processor is shown in **FIG. 50**. The QA Hold Management is used to issue multiple holds against a production entity and for issuing individual releases. The QA Hold Management is able to prevents raw materials from being consumed with a status of HOLD and prevents production entities from being shipped with the status of HOLD. Further from being able to capture hold and release reason codes, the QA Hold Management is able to enforce configurable electronic signature under Performed By and Verified By scheme.

[0206] The QA Product Retention function within Food Processor is shown in **FIG. 51**. The GUI panel provides the ability to enter product retention samples and associated data, disposition samples to other locations within the system, and discard retained samples that have exceeded the required retention window. Furthermore, the QA Production Retention function links retention samples to production lots for genealogy and product recall purposes. As other GUI panels discussed above, the QA Product Retention function enforces a configurable electronic signature scheme.

[0207] The QA Checklist function within Food Processor is used to define an execution schedule for each checklist, and to log a deficiency and corrective action, and preventive measure for each item in a checklist. The QA Checklist displays required and actual execution date and time for each checklist, as shown in **FIG. 52**, and enforces a configurable electronic signature scheme.

[0208] In **FIG. 53, a** HACCP Data Entry window and a HACCP Data Collection Log window of the HACCP Enforcement functions within Food Processor are shown. Both quantity and time based HACCP data collection schemes are enforceable by the HACCP Enforcement function. Data is collected through the configurable data collection templates. Further, it supports full audit trail of data collection activities, and displays the history of HACCP data collection activities for a particular work order.

[0209] Connectors

[0210] The Interwave Coordinator CMES application includes two connector modules to provide a standardized mechanism to interface with the business system and plant floor automation systems. These connectors are the XML Business System Connector and the OPC Shop Floor Connector.

[0211] XML Business Connector Module

[0212] The XML Business Connector module provides connectivity to upply chain modules/business systems such as ERP, APS, PDM, etc. It provides a standard mechanism (XML schema) for receiving work orders, bill of materials (BOM), bill of routes (BOR), and tooling. Additionally, the XML Business Connector provides a standard mechanism (XML schema) for reporting material consumptions/issues, scrap and production associated with a work center.

[0213] Ole for Process Control (OPC) Shop Floor Connector Module

[0214] The OPC Shop Floor Connector module provides connectivity to the shop floor control automation systems via an OPC connection. It also provides a standard mechanism for downloading machine setup/recipe information, or work order specification information from the production management layer to the shop floor automation system. Furthermore, the shop floor automation system sends alerts and events to the production management layer via the OPC Shop Floor Connector module.

[0215] Visualization

[0216] The Digital Dashboard module is a visualization module included in the Interwave Coordinator CMES application. It provides visibility into the performance of the manufacturing enterprise. The Digital Dashboard module enables the configuration of a personalized performance dashboard view on an individual user basis.

[0217] **FIGS. 15 through 21** show the various reports generated by the Digital Dashboard module. These include the WIP Status Report, as shown in **FIG. 15**, the Material Genealogy Report, as shown in **FIG. 16**, the Route Genealogy Report, as shown in **FIG. 17**, the Inventory Summary Report, as shown in **FIG. 18**, the Work Order Status Report, as shown in **FIG. 19**, the Defect Data Report, as shown in **FIG. 20**, and the Downtime Report, as shown in **FIG. 21**.

[0218] Utilities

[0219] The Interwave Coordinator CMES application includes six utility modules to perform standard utility type functions. These are Event Messenger, Work Traveler, Label Manager, Data Archiver, Auto Tracker and Auto Collector. Each of these modules has strengthened the performance of the CMES disclosed in the present invention.

[0220] Event Messenger Module

[0221] Event Messenger module provides the ability of sending e-mail or text based pager messages to users based upon production events or upset conditions that affects the manufacturing production. It is also able to configure user groups and associate event messages with user groups.

[0222] Work Traveler Module

[0223] Work Traveler module supports the ability to define the content of the traveler from pre-configured option lists (.i.e., BOM, routing, work instructions, etc). Work Traveler specifies the text displayed in the header and footer of the traveler, and further assigns work traveler definitions to products or classes of products. Furthermore, Work Traveler prints travelers on demand or automatically at the start or completion of a process step/operation. Work Traveler is also able to store travelers in a central location to reduce maintenance and deployment costs.

[0224] Label Manager Module

[0225] Label Manager module supports the ability to define the content of a label from pre-configured option lists (i.e., BOM, routing, work instructions, etc.). Label Manager assigns label definitions to products or classes of products, and further prints labels on demand or automatically based upon an event (i.e., the start or completion of a work order).

Finally, Label Manager store labels in a central location to reduce maintenance and deployment costs.

[0226] Data Archiver Module

[0227] Data Archiver module provides the ability to configure an archiving scheme for the production database to increase system performance. Further, Data Archiver supports the ability of archiving data to a data warehouse and deleting information from the production database.

[0228] Auto Tracker Module

[0229] Auto Tracker module provides the ability to track WIP items through highly automated work centers via barcode technology. Furthermore, it supports the ability to create and configure tracking stations, and attach specific tracking attributes. Finally, Auto Tracker sends alerts and events to the shop floor automation system to annunciate upset conditions and events that occur in the production management layer.

[0230] Auto Collector Module

[0231] Auto Collector module provides the ability to automatically collect quality data from test machines against a particular production entity. Furthermore, it supports the ability to define collection scenarios such as collection frequency and data source.

[0232] While the invention has been particularly shown and described with reference to a preferred embodiment or a specifically designed template, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A manufacturing process, comprising:

providing a work flow from a business decision making layer to a production line and decision making layer; and

implementing a real-time integration of said work flow.

2. The process of claim 1, further comprising:

determining business objectives at said business decision making layer;

performing said business objectives at said production line and decision making layer; and

carrying out said real-time integration of said business decision making layer and said production line and decision making layer by a collaborative infrastructure.

3. The process of claim 2, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

4. The process of claim 3, further comprising:

receiving a report containing analyzed result from said reporting process; and

adjusting said business objectives according to said report.

5. The process of claim 4, wherein said report comprises a plurality of formats, including Spreadsheet and GANTT Chart.

6. The process of claim 2, wherein said collaborative infrastructure further comprises a first coordinator connector providing interface for said collaborative infrastructure and said business decision making layer.

7. The process of claim 6, wherein said first coordinator connector is a web-based open technology for electronic data interchange.

8. The process of claim 7, wherein said first coordinator connector is the Extensible Mark-up language (XML) Business Connector.

9. The process of claim 6, wherein said collaborative infrastructure further comprises a second coordinator connector providing interface for said collaborative infrastructure and said production line and decision making layer.

10. The process of claim 9, wherein said second coordinator connector is an Application Programming Interface (API).

11. The process of claim 10, wherein said second coordinator is the Ole Process Control (OPC) Shop Floor Connector.

12. The process of claim 11, further comprises integrating said business decision making layer, production line and decision making layer by said collaborative infrastructure through an Intranet or the Internet.

13. The process of claim 2, wherein said production line and decision making layer further comprises a plurality of business rules.

14. The process of claim 13, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

15. The process of claim 14, further comprising:

receiving a report containing analyzed result from said reporting process; and

automatically adjusting said business rules based on said report.

16. The process of claim 13, wherein said collaborative infrastructure further comprises a plurality of configurable module templates.

17. The process of claim 16, wherein said collaborative infrastructure further comprises a graphical user interface capable of configuring and modifying said plurality of business rules.

18. The process of claim 16, wherein said configurable application templates are capable of synchronizing and optimizing execution activities at said production line and decision layer.

19. The process of claim 18, wherein said infrastructure is a Manufacturing Executive System (MES).

20. The process of claim 19, wherein said infrastructure is a Collaborative Manufacturing Executive System (CMES).

21. The process of claim 13, wherein said collaborative infrastructure further comprises a plurality of scalable application templates.

22. The process of claim 21, wherein said collaborative infrastructure comprises at least one custom application constructed with at least one scalable application template.

23. The process of claim 13, wherein said collaborative infrastructure further comprises a plurality of maintainable application templates.

24. The process of claim 23, wherein said maintainable application templates increase the updating and debugging abilities of said collaborative infrastructure.

25. A manufacturing method, comprising:

providing a work flow from a business decision making layer to a production line and decision making layer; and

implementing a real-time integration of said work flow.

26. The method of claim 25, further comprising:

determining business objectives at said business decision making layer;

performing said business objectives at said production line and decision making layer; and

carrying out said real-time integration of said business decision making layer and said production line and decision making layer by a collaborative infrastructure.

27. The method of claim 26, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

28. The method of claim 27, further comprising:

receiving a report containing analyzed result from said reporting process; and

adjusting said business objectives according to said report.

29. The method of claim 28, wherein said report comprises a plurality of formats, including Spreadsheet and GANTT Chart.

30. The method of claim 26, wherein said collaborative infrastructure further comprises a first coordinator connector providing interface for said collaborative infrastructure and said business decision making layer.

31. The method of claim 30, wherein said first coordinator connector is a web-based open technology for electronic data interchange.

32. The method of claim 31, wherein said first coordinator connector is the Extensible Mark-up language (XML) Business Connector.

33. The method of claim 30, wherein said collaborative infrastructure further comprises a second coordinator connector providing interface for said collaborative infrastructure and said production line and decision making layer.

34. The method of claim 33, wherein said second coordinator connector is an Application Programming Interface (API).

35. The method of claim 34, wherein said second coordinator is the Ole Process Control (OPC) Shop Floor Connector.

36. The method of claim 35, further comprises integrating said business decision making layer, production line and decision making layer by said collaborative infrastructure through an Intranet or the Internet.

37. The method of claim 26, wherein said production line and decision making layer further comprises a plurality of business rules.

38. The method of claim 37, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

39. The method of claim 38, further comprising:

receiving a report containing analyzed result from said reporting process; and

automatically adjusting said business rules based on said report.

40. The method of claim 37, wherein said collaborative infrastructure further comprises a plurality of configurable application templates.

41. The method of claim 40, wherein said collaborative infrastructure further comprises a graphical user interface capable of configuring and modifying said plurality of business rules.

42. The method of claim 40, wherein said configurable application templates are capable of synchronizing and optimizing execution activities at said production line and decision layer.

43. The method of claim 42, wherein said collaborative infrastructure is a Manufacturing Executive System (MES).

44. The method of claim 43, wherein said collaborative infrastructure is a Collaborative Manufacturing Executive System (CMES).

45. The method of claim 37, wherein said collaborative infrastructure further comprises a plurality of scalable application templates.

46. The method of claim 45, wherein said collaborative infrastructure comprises at least one custom application constructed with at least one scalable application template.

47. The method of claim 37, wherein said collaborative infrastructure further comprises a plurality of maintainable application templates.

48. The method of claim 47, wherein said maintainable application templates increase the updating and debugging abilities of said collaborative infrastructure.

49. A manufacturing system, comprising:

a work flow from a business decision making layer to a production line and decision making layer; and

a real-time integration of said work flow.

50. The system of claim 49, further comprising:

a plurality of business objectives determined at said business decision making layer and performed at said production line and decision making layer; and

a collaborative infrastructure implementing said real-time integration of said business decision making layer and said production line and decision making layer.

51. The system of claim 50, further comprising:

a result analysis from said production line and decision making layer; and

a report of said result analysis sent to said business decision making layer.

52. The system of claim 51, further comprises an adjustment of said business objectives according to said report.

53. The system of claim 52, wherein said report comprises a plurality of formats, including Spreadsheet and GANTT Chart.

54. The system of claim 50, wherein said collaborative infrastructure further comprises a first coordinator connector providing interface for said collaborative infrastructure and said business decision making layer.

55. The system of claim 54, wherein said first coordinator connector is a web-based open technology for electronic data interchange.

56. The system of claim 55, wherein said first coordinator connector is the Extensible Mark-up language (XML) Business Connector.

57. The system of claim 54, wherein said collaborative infrastructure comprises a second coordinator connector providing interface for said collaborative infrastructure and said production line and decision making layer.

58. The system of claim 57, wherein said second coordinator connector is an Application Programming Interface (API).

59. The system of claim 58, wherein said second coordinator is the Ole Process Control (OPC) Shop Floor Connector.

60. The system of claim 59, further comprises integrating said business decision making layer, production line and decision making layer by said collaborative infrastructure through an Intranet or the Internet.

61. The system of claim 50, wherein said production line and decision making layer further comprises a plurality of business rules.

62. The system of claim 61, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

63. The system of claim 62, further comprising:

receiving a report containing analyzed result from said reporting process; and

automatically adjusting said business rules based on said report.

64. The system of claim 61, wherein said collaborative infrastructure further comprises a plurality of configurable application templates.

65. The system of claim 64, wherein said collaborative infrastructure further comprises a graphical user interface capable of configuring and modifying said plurality of business rules.

66. The system of claim 64, wherein said configurable application templates are capable of synchronizing and optimizing execution activities at said production line and decision layer.

67. The system of claim 66, wherein said collaborative infrastructure is a Manufacturing Executive System (MES).

68. The system of claim 67, wherein said collaborative infrastructure is a Collaborative Manufacturing Executive System (CMES).

69. The system of claim 61, wherein said collaborative infrastructure further comprises a plurality of scalable application templates.

70. The system of claim 69, wherein said collaborative infrastructure comprises at least one custom application constructed with at least one scalable application template.

71. The system of claim 61, wherein said collaborative infrastructure further comprises a plurality of maintainable application templates.

72. The system of claim 71, wherein said maintainable application templates increase the updating and debugging abilities of said collaborative infrastructure.

73. A manufacturing apparatus, comprising:

a work flow from a business decision making unit to a production line and decision making unit; and

a real-time integration of said work flow.

74. The apparatus of claim 73, further comprising:

a plurality of business objective schemes determined at said business decision making unit and performed at said production line and decision making unit; and

a collaborative infrastructure implementing said real-time integration of said business decision making unit and said production line and decision making unit.

75. The apparatus of claim 74, further comprising:

a result analyzing unit for result analyzing at said production line and decision making unit; and

a report generator for generating a report after said result analyzing.

76. The apparatus of claim 75, further comprises an adjustment unit at said business decision making unit for adjusting said business objective schemes according to said report.

77. The apparatus of claim 76, wherein said report comprises a plurality of formats, including Spreadsheet and GANTT Chart.

78. The apparatus of claim 75, wherein said collaborative infrastructure further comprises a first coordinator connector providing interface for said collaborative infrastructure and said business decision making layer.

79. The apparatus of claim 78, wherein said first coordinator connector is a web-based open technology for electronic data interchange.

80. The apparatus of claim 79, wherein said first coordinator connector is the Extensible Mark-up language (XML) Business Connector.

81. The apparatus of claim 78, wherein said collaborative infrastructure comprises a second coordinator connector providing interface for said collaborative infrastructure and said production line and decision making layer.

82. The apparatus of claim 81, wherein said second coordinator connector is an Application Programming Interface (API).

83. The apparatus of claim 82, wherein said second coordinator is the Ole Process Control (OPC) Shop Floor Connector.

84. The apparatus of claim 83, further comprises integrating said business decision making unit, production line and decision making unit by said collaborative infrastructure through an Intranet or the Internet.

85. The apparatus of claim 75, wherein said production line and decision making unit further comprises a plurality of business rules.

86. The apparatus of claim 85, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

87. The apparatus of claim 86, further comprising:

receiving a report containing analyzed result from said reporting process; and

automatically adjusting said business rules based on said report.

88. A computer program embodied on computer readable medium with instructions for controlling manufacturing, comprising:

providing a work flow from a business decision making layer to a production line and decision making layer; and

implementing a real-time integration of said work flow.

89. The computer program of claim 88, further comprising:

determining business objectives at said business decision making layer;

performing said business objectives at said production line and decision making layer; and

carrying out said real-time integration of said business decision making layer and said production line and decision making layer by a collaborative infrastructure.

90. The computer program of claim 89, further comprising:

analyzing a result from said production line and decision making layer; and

reporting said analyzed result to said business decision making layer.

91. The computer program of claim 90, further comprising:

receiving a report containing analyzed result from said reporting process; and

adjusting said business objectives according to said report.

92. The computer program of claim 91, further comprises integrating said business decision making layer, production line and decision making layer by said collaborative infrastructure through an Intranet or the Internet.

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