



# ***Nested Material Manufacturing Technology Improvement Project***

**Deliverable 4.2  
Industry Briefing**

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**Senior Industrial Engineer**  
**GD/NASSCO**

12 December 2007

# Agenda

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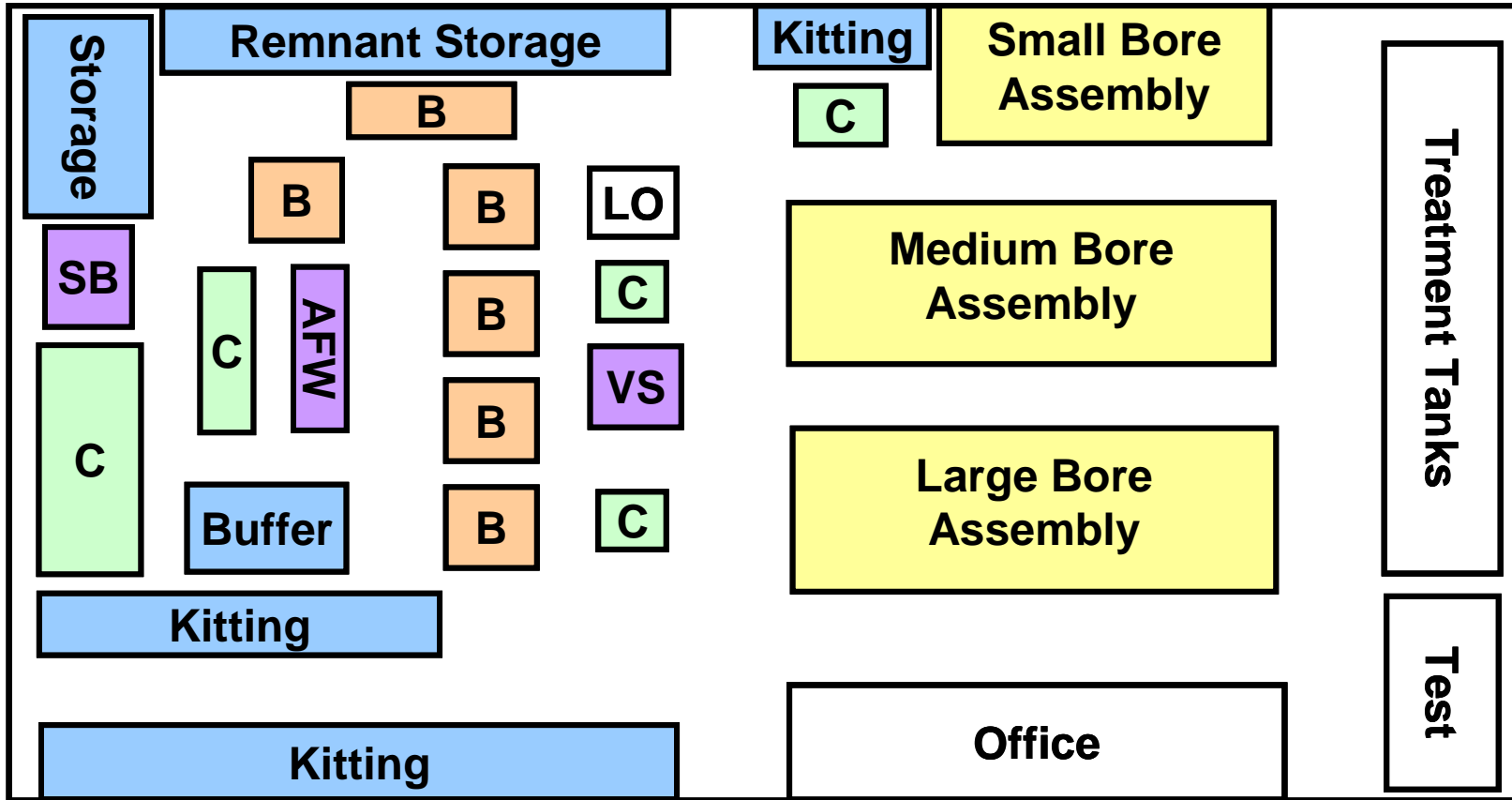
1. Need for and Design of the Pipe Shop Management System
  - Defining the issues
  - Designing the system
2. Implementation of the Pipe Shop Management System
  - How the system works
3. Results from the Pipe Shop Management System
  - Goals and results
  - Other benefits
4. Questions and Discussion

# ***Need for and Design of the Pipe Shop Management System***

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**Defining the Issues and  
Designing the System**

# Defining the Issues: Pipe Shop Layout



# Defining the Issues

- Planning
  - ↗ No view of work content, planning done by quantities of spools
  - ↗ Material use not specifically planned
  - ↗ Release of work manually intensive and reactive not proactive
  - ↗ Spools structured as parts and not assemblies
- Production
  - ↗ Batch type processes at machines, JIT at assembly
  - ↗ Work content mix managed on the fly by Shop Foremen
  - ↗ Limited ability to optimize material manually
  - ↗ Process control manually intensive and not transparent

*These issues lead to a very dynamic system that is not work content based, and does not accommodate the ability to efficiently preplan or optimize.*

# Designing the System - Objective

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*To develop and implement an automated pipe nesting process. This automated pipe fabrication system will combine defined rules for pipe component routing and nesting, with the ability to account for work plan changes, emerging schedule changes and shop loading.*

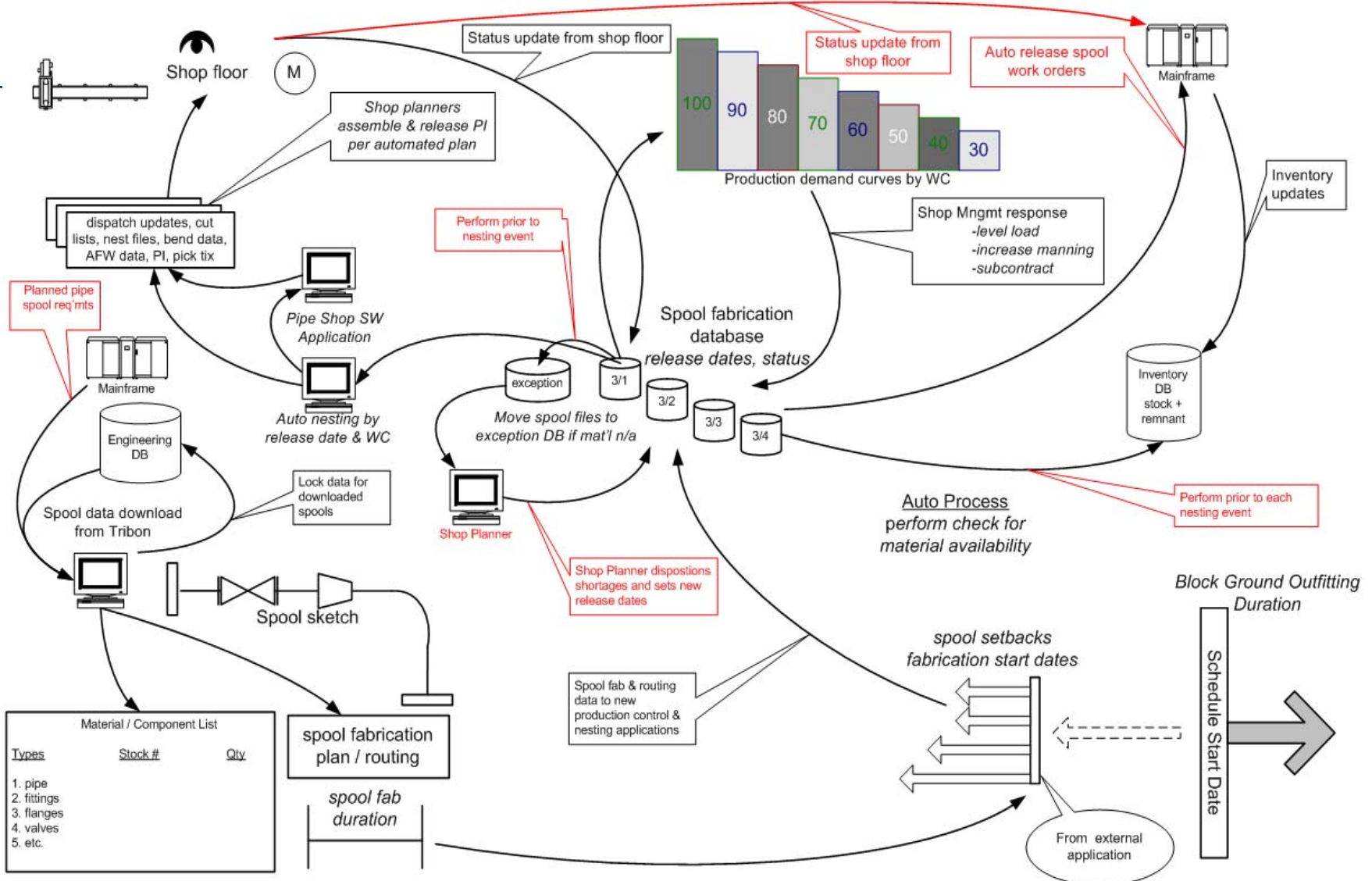
*Pipe Shop Management System - PSMS*

# Designing the System - Project Plan

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- Create functional specification
- Benchmark and research
- Create design specification
- Build system
- Implement system
- Observe system and processes
- Refine system and/or processes

# Designing the System - Functional Diagram



# Designing the System - Benchmarking at Kawasaki Shipbuilding Corporation - Sakaide, Japan



**Large Bore Shop**



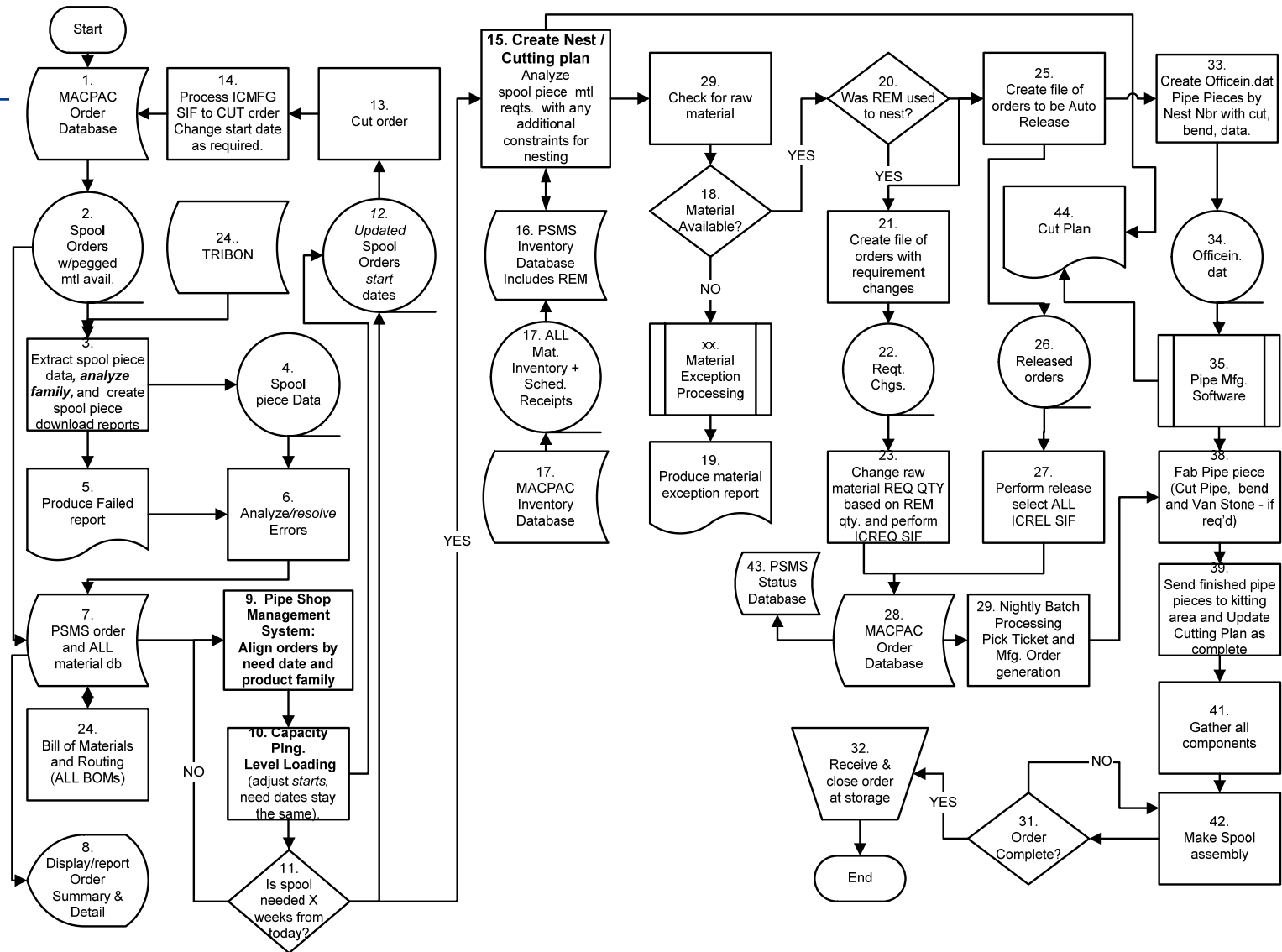
**Medium Bore Shop**



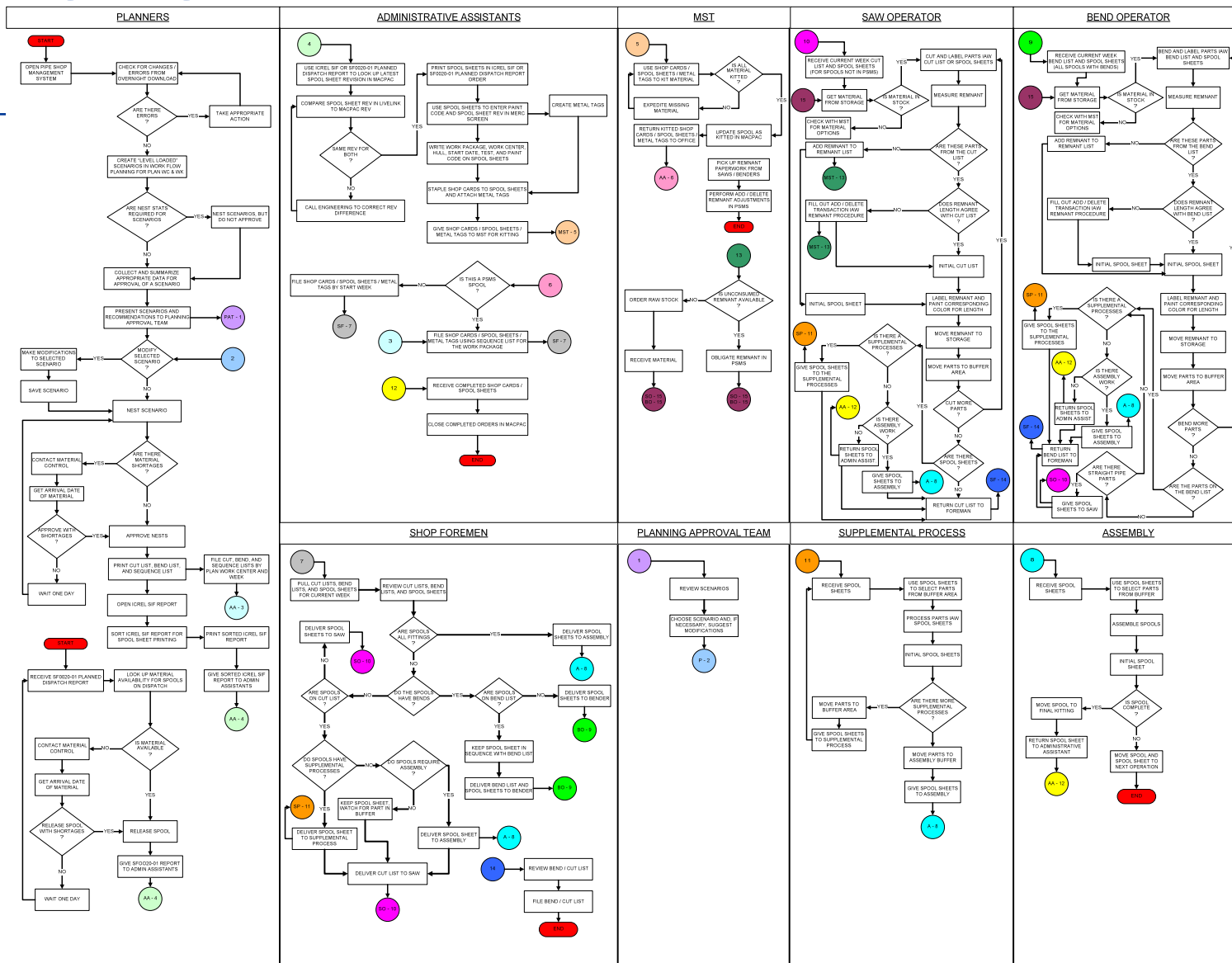
**Small Bore Subcontractor**



# Designing the System - Data Flow Specification

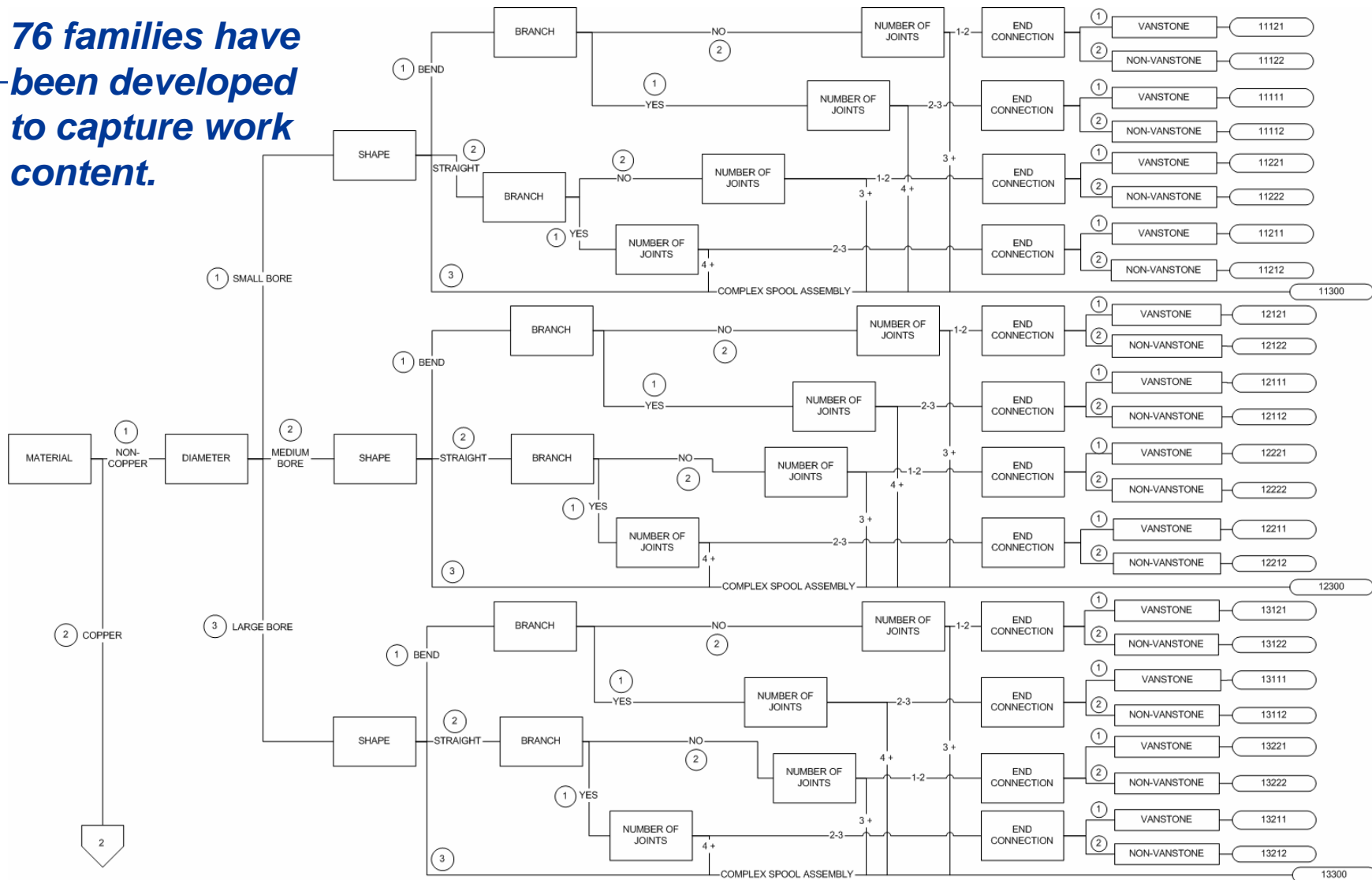


# Designing the System - Process Flow Specification



# Designing the System - Family Definition

*76 families have been developed to capture work content.*



# ***Implementation of the Pipe Shop Management System***

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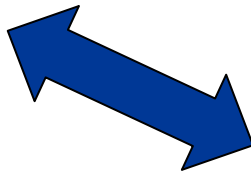
## **How the System Works**

# How the System Works: PSMS Components



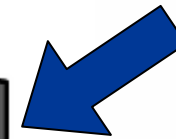
## MACPAC (Mainframe)

- Order information
- Spool order start dates
- Order transactions
- Material inventory
- Order status



## PSMS Software (Oracle DB, C# Code, Excel, VBA)

- Work planning (level loading), new start dates
- Nesting
- Production information lists
- Remnant material control



## Tribon (Server)

- Spool part geometry

# How the System Works: PSMS Home Screen



*The PSMS functions are divided into four main groups – Work Flow Planning, Pipe Spool Nesting, Data Maintenance, and Production Information.*

# How the System Works: Identifying Spool Order Changes & Issues



*Because the PSMS stores data outside of MACPAC, checks are required to ensure accuracy. The PSMS produces a report to identify changes to stored data and issues arising during the download.*

# Identifying Spool Order Changes & Issues: Data Maintenance Screen

Pipe Shop Management System

<< Back Home Fwd >>

### Data Maintenance

About PSMS Material Substitution

Configuration Parameters Spring backs

Families Remnant

Work Centers Scrap and Nest Statistics

Download/Upload Reports

Select other items to view

View Other Item

# Identifying Spool Order Changes & Issues: Download / Upload Reports Screen

The screenshot displays the 'Pipe Shop Management System' interface. At the top right, there are navigation buttons: '<< Back', 'Home', and 'Fwd >>'. The main content is divided into two columns: 'Uploads' and 'Downloads'.

**Uploads Section:**

- Section title: 'Work Package'
- Dropdown menu: 'WPIPE110-0741-01'
- Checkbox:  Orders Released
- Button: 'Released Orders Reports'

**Downloads Section:**

- Section title: 'Download Date'
- Dropdown menu: '11/13/2007 14:02:05' (indicated by a blue arrow pointing to it)
- Checkbox:  Spool Order Changes
- Button: 'Download Report' (indicated by a blue arrow pointing to it)

*Changes and issues in the data include – start date changes due to NHA reschedule, part geometry changes, missing part geometry, and future material availability issues.*

# Identifying Spool Order Changes & Issues: Spool Order Changes Report

Created by ISD on: 12/04/2007 @ 1:07 PM  
Report#: PSMS700P1-01 SPOOL ORDER DOWNLOAD CHANGES

## National Steel and Shipbuilding Company Spool Order Download Changes

ORDER NUMBER	HULL	SPOOL NUMBER	QUANTITY	STATUS	WORK CENTER	PLN START	CHANGE CODE	CHANGE DESCRIPTION
MU S18449424	475	LZ 16001CW 169-01	1	FRM	PIPE110	12/14/2007	103	MAC PAC Message Flag is 'Y'
MU S18449416	475	LZ 16001CW 170-01	1	FRM	PIPE110	12/14/2007	103	MAC PAC Message Flag is 'Y'
MU S18590848	475	LZ 16 10 1 CW 175- M1	1	CUT	PIPE110	12/13/2007	103	MAC PAC Message Flag is 'Y'
MU S18590836	475	LZ 16 10 1 CW 176- M1	1	CUT	PIPE110	12/13/2007	103	MAC PAC Message Flag is 'Y'
MU S18423604	475	LZ 16 10 4 W D 546- 01	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18423599	475	LZ 16 10 4 W D 546- 02	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18423594	475	LZ 16 10 4 W D 546- 03	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18423589	475	LZ 16 10 4 W D 546- 04	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18590762	475	LZ 16 10 4 W D 546- M1	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18497060	475	LZ 16 20 4 W D 546- 01	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18497046	475	LZ 16 20 4 W D 546- 02	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18497040	475	LZ 16 20 4 W D 546- 03	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18497035	475	LZ 16 20 4 W D 546- 04	1	CUT	PIPE110	12/10/2007	103	MAC PAC Message Flag is 'Y'
MU S18272582	476	LV35902PW 190-01	1	CUT	PIPE110	12/07/2007	103	MAC PAC Message Flag is 'Y'
MU S18147136	477	L125 101AF004-02	1	PLN	PIPE 110	02/01/2008	101	Order on both Macpac and PSMS and information different - Not Nested - PSMS information updated
MU S18422697	477	L125 101AF004-04	1	PLN	PIPE 110	02/01/2008	101	Order on both Macpac and PSMS and information different - Not Nested - PSMS information updated

CHANGE CODE	CHANGE DESCRIPTION
103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
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103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
103	MAC PAC Message Flag is 'Y'
101	Order on both Macpac and PSMS and information different - Not Nested - PSMS information updated
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# How the System Works: Automatic Work Content Planning

Pipe Shop Management System

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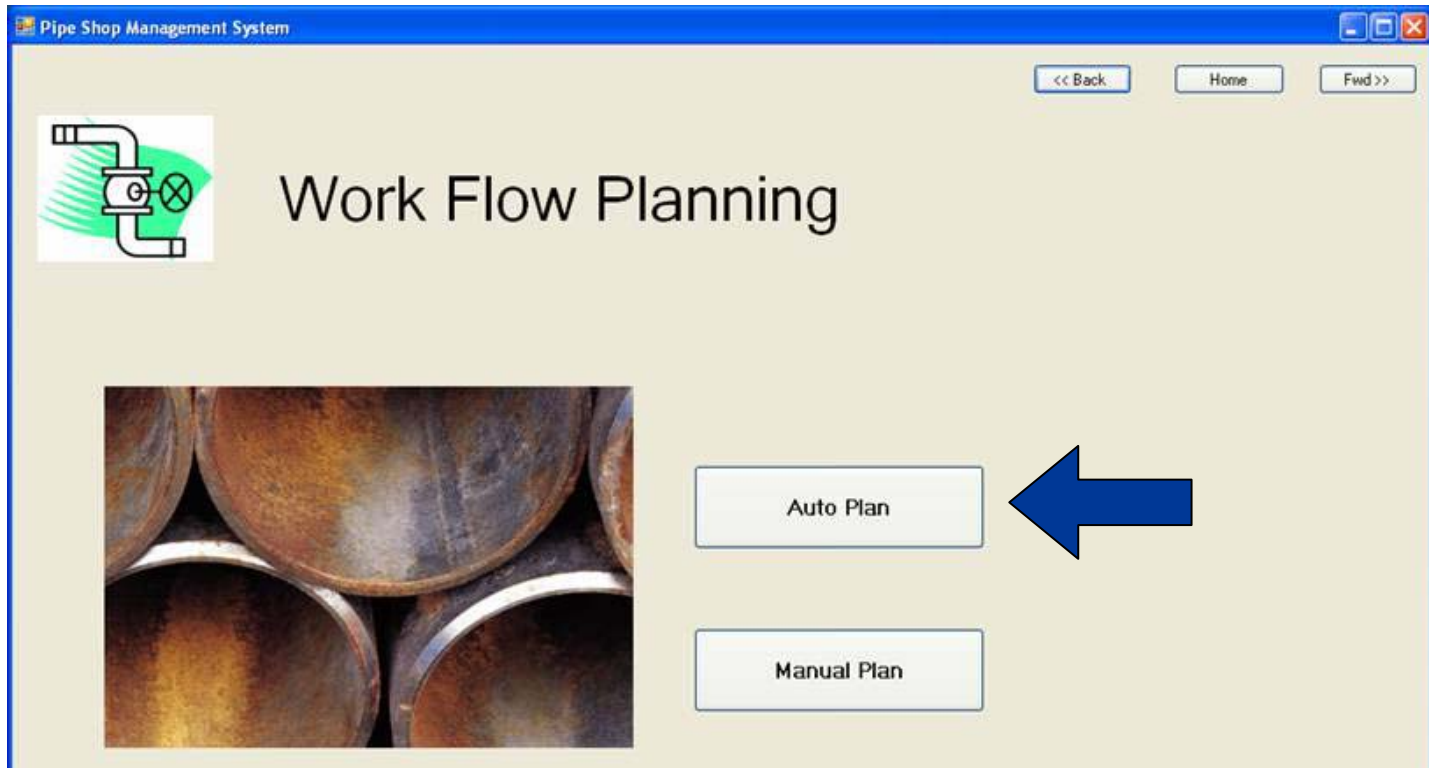
Pipe Shop Management System

Work Flow Planning Pipe Spool Nesting Data Maintenance Production Information

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*Work flow planning is based on the spool load determined by start dates and the families defined in the PSMS. The result is an evenly distributed flow of work content through spool assembly that meets the requirements at the next stage of construction.*

# Automatic Work Content Planning: Work Flow Planning Screen




*Planning for the shop can be accomplished in two modes – manual and automatic. In automatic mode the work is planned according to programmed logic and constraints. In manual mode, planning can be done without any constraints.*

# Automatic Work Content Planning: Auto Plan Screen

Pipe Shop Management System

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 Auto Plan

Work Center To Plan

PIPE110

Start Week

47

Start Year

2007

Run UnRestricted Capacity

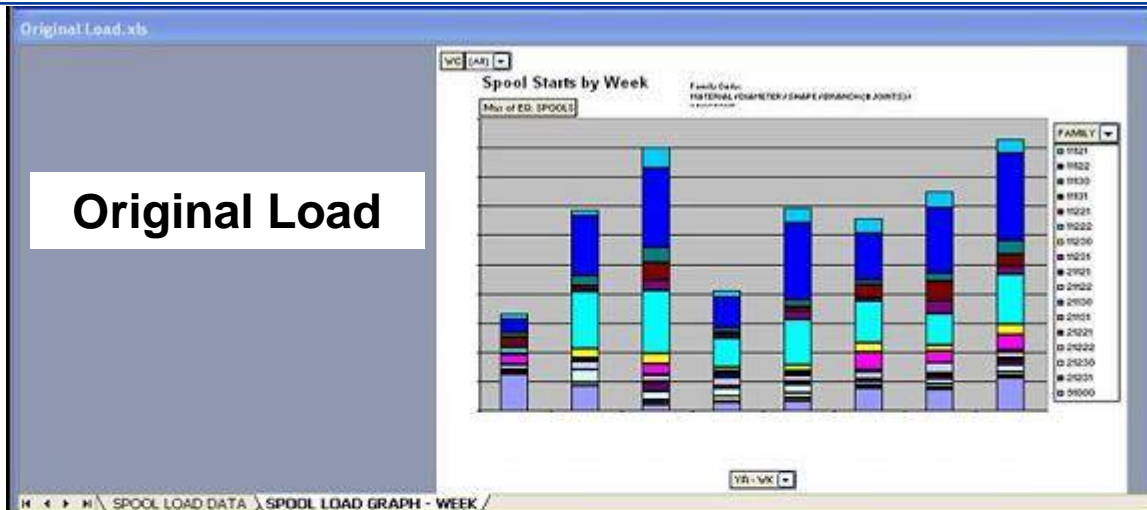
Unrestricted Process Options

Drive To Average

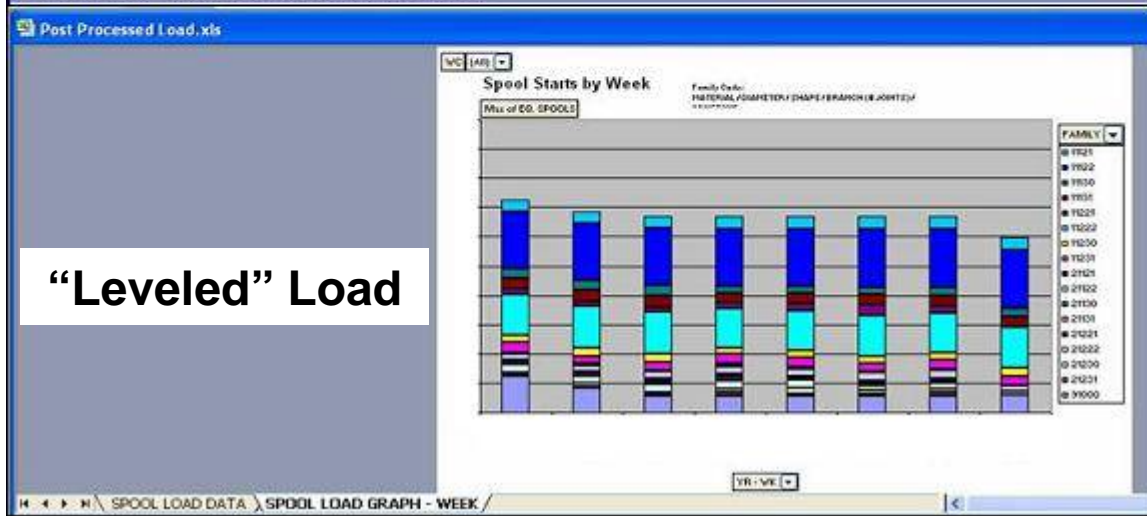
*Although a single week is being planned, several weeks are analyzed to determine the load for that week. This process is referred to as “level loading.”*

# Automatic Work Content Planning: Before & After Views by Week

Original Load

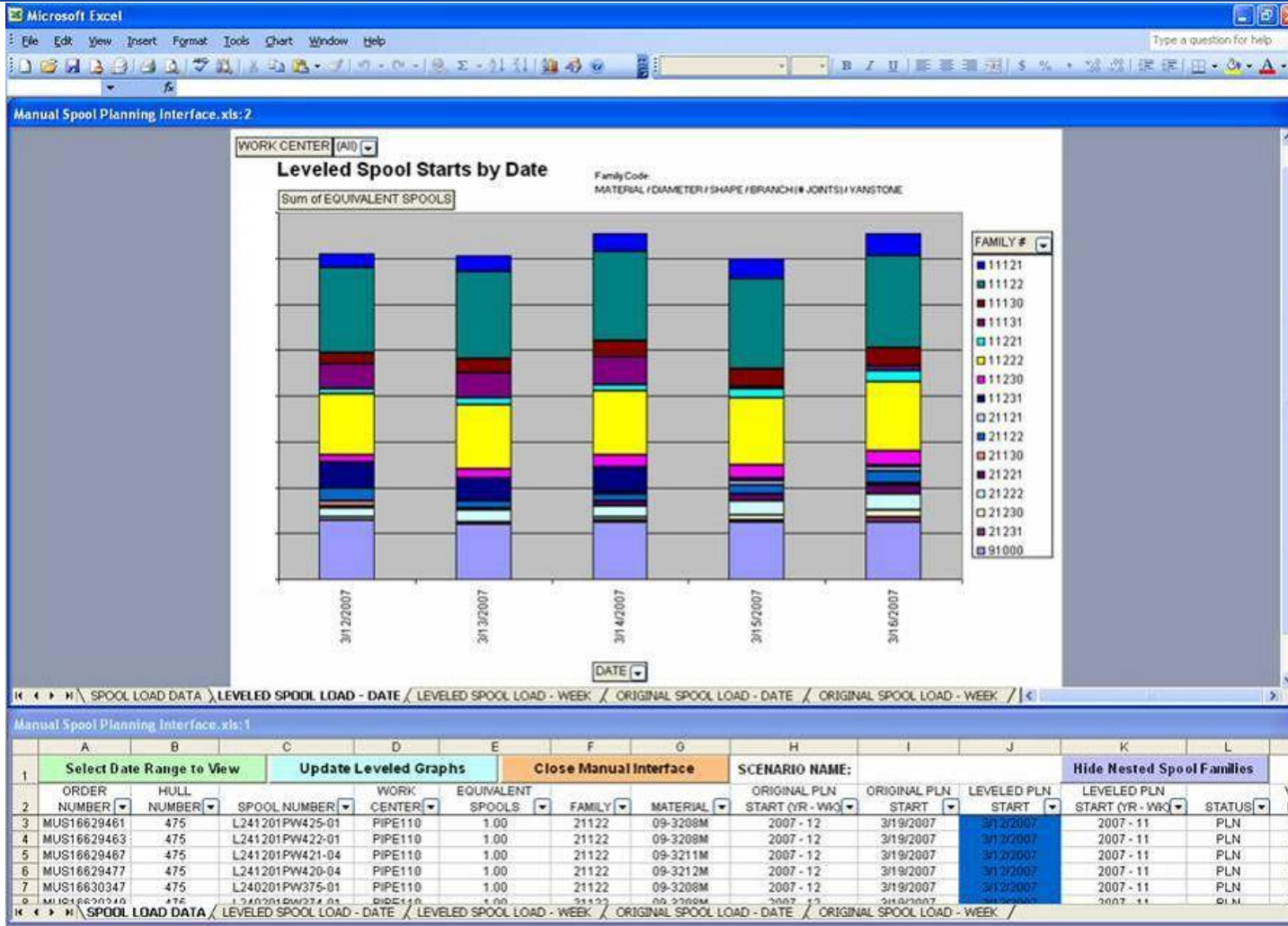


“Leveled” Load



*The planned week's load is determined by calculating the highest average production requirement per week to determine the load and horizon, then evenly distributing the families across each of the weeks in the horizon.*

# Automatic Work Content Planning: Excel Interface to Manage Results



The load for the planned week is also distributed by families across each work day. The results are shown in an Excel interface and can be modified by the Planner before saving the scenario. Many different scenarios can be created for the same plan week.

# How the System Works: Pipe Spool Nesting

Pipe Shop Management System

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Pipe Shop Management System

Work Flow Planning Pipe Spool Nesting Data Maintenance Production Information

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*The geometry of the spools and level loaded dates are used to create bending and cutting nests. Remnant is favored when possible and the current material inventory is checked to ensure material availability.*

# Pipe Spool Nesting: Nesting Screen

Pipe Shop Management System

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Nesting



Work Center PIPE110

Plan Week

Plan Year

Scenario Name

Run Nest Process

Nest Batch

Daily  Half Ranges  Full Range

Approve Nests and create SIFs View Material Shortages

Spools Nested  
Spools Not Nested  
Nest Efficiency  
Scrap Rate


*Nesting is done by work center, plan week, and scenario. The Planner has the option to enlarge the pool of parts to nest together by choosing daily, half week, or full week batches. Different scenarios can be tested before approving final nests.*

# Pipe Spool Nesting: Nesting Statistics

Pipe Shop Management System

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Nesting



Raw Pipe Material Shortages

SPOOL_NUMBER	PART_NUMBER	ORDER_NUMBER	HULL	MATL_CODE
LZ16003RA137-...	L16003RA137-M...	MUS17770852	475	02-2112M

Approve Nests and create SIFs

View Material Shortages

Spools Nested: 724  
Spools Not Nested: 1  
Nest Efficiency: 90.400%

NEST_DATE	TOTAL_NESTED_	TOTAL_INTRAPAI	TOTAL_RECYCLE	TOTAL_REMNAN	TOTAL_RAW_STC	SPOOLS_NESTED	SPOOLS_EXC
6/20/2007 12:40:	1497602	0	0	514078	1497602	724	1

Work Center: PIPE110

Plan Week: 11

Plan Year: 2007

Scenario Name: D2ANoRight

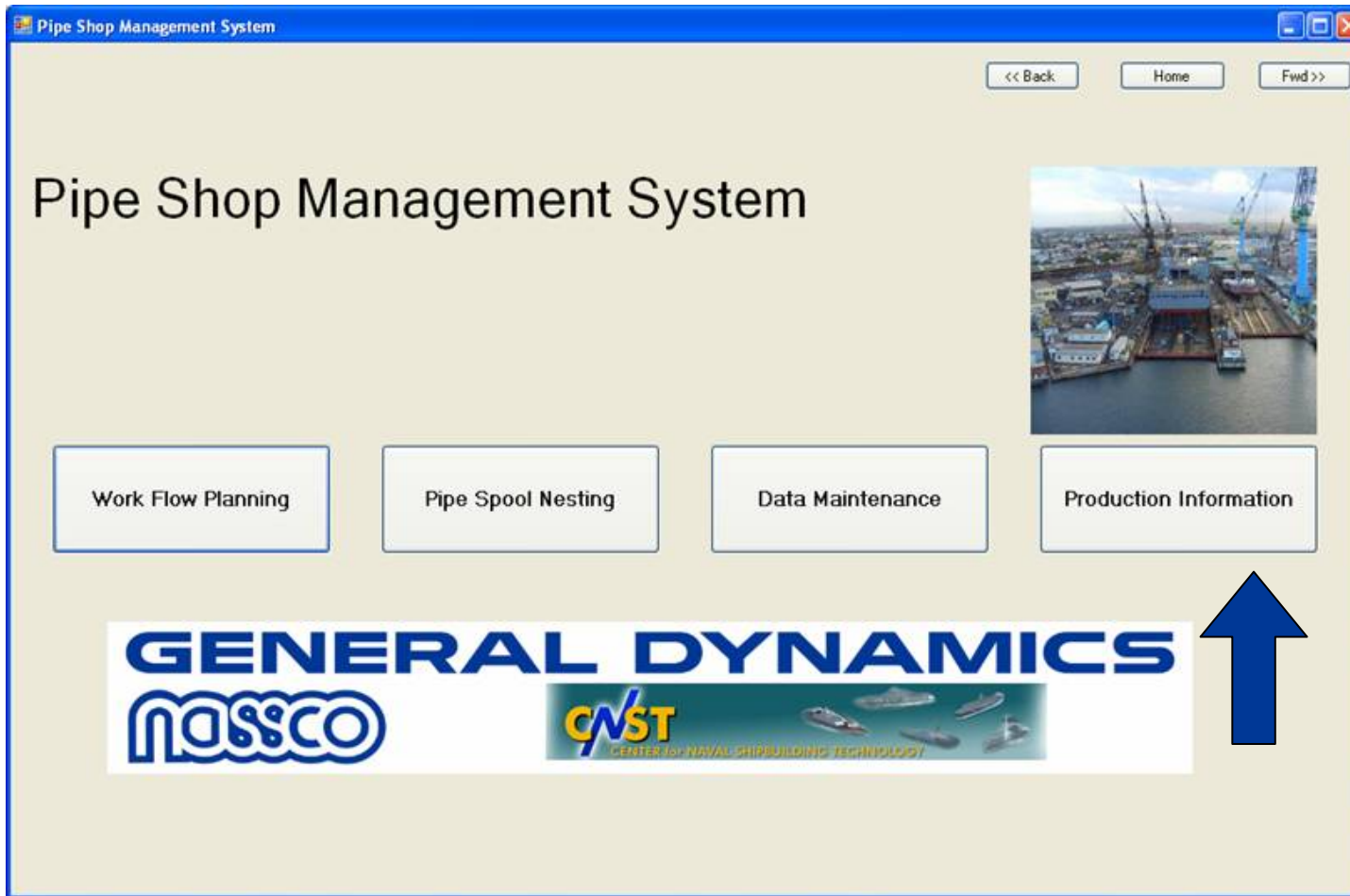
Run Nest Process

Spools :725 Work Package: WPPPIPE110-0711-12 Nest Batch

Daily  Half Ranges  Full Range

*Statistics for material discrepancies, scrap, and nesting efficiency are displayed after the nests are created. Once the nests are approved a batch file is created to automatically perform the release of spools.*

# How the System Works: Printing Production Lists




*Each set of nests is assigned a work package number. The production lists created are used to build the work packages and control work sequence on the production floor.*

# Printing Production Lists: Production Information Screen

Pipe Shop Management System

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## Production Information



Work Package Name

WPIPE110-0711-12

Reports

- Straight Plan w/Saddles
- Straight Plan wo/Saddles
- Bend Plan w/Saddles
- Bend Plan wo/Saddles
- Spool PickList
- Assembly Plan
- All Reports

View Work Package

Print Work Package

*Several different production lists can be viewed or printed.*

# Printing Production Lists: Production Information Sequence List

Created by ISD on 12/04/2007 @ 1:03 PM  
Report #: PSMS300P1- 01  
Spool Sequence List

## National Steel and Shipbuilding Company Spool Sequence List

BLOCK	HULL	SPOOL NUMBER	ORDER NUMBER	PART WC	BEND	SPOOL WC	FAMILY	SEQUENCE	DRAWING REV	PAINT CODE
160	477	LZ16003RA030-14	MUS17717927	PIPE110	Y	PIPE110	11122	B1	-	VG
405	477	L240503RA138-04	MUS17818578	PIPE110	Y	PIPE110	11122	B2	-	MB
160	477	LZ16003RA030-13	MUS17717930	PIPE110	Y	PIPE110	11122	B3	-	VG
160	477	LZ16003RA031-15	MUS17717918	PIPE110	Y	PIPE110	11122	B4	-	VG
160	477	LZ16003RA030-10	MUS17267813	PIPE110	Y	PIPE110	11122	B5	-	VG
405	477	L240503RA138-05	MUS17818577	PIPE110	Y	PIPE110	11122	B6	A	KW
405	477	L240503RA138-01	MUS17818581	PIPE110	Y	PIPE110	11122	B7	-	XG
722	477	LL72201PL415-01	MUS17528434	PIPE110	Y	PIPE110	11132	B8	-	HR
051	477	LL05101PO012-M1	MUS17275538	PIPE110	Y	PIPE110	11122	B9	A	CL
051	477	LL05101OW223-03	MUS17275560	PIPE110	Y	PIPE110	11122	B10	-	CL
102	477	LG10201OW211-01	MUS17278959	PIPE110	Y	PIPE110	11122	B11	A	MB

*Production lists are used to sequence production information and work flow.*

# Printing Production Lists: Production Information Bend List

Created by ISD on 12/04/2007 @ 12:51 PM  
Report#: PSMS100P I-BEND LIST

## National Steel and Shipbuilding Company Bend List

WORK CENTER:	PLAN WEEK:	PLAN YEAR:	SCENARIO:																	
110	49	7	pipe110_071119	NEST NUMBER	RAW STOCK MATL	RAW STOCK LENGTH	ORDER NUMBER	ORDER WORK CENTER	HULL NUMBER	SPOOL NUMBER	FAMILY	ADJUSTED START	PART NUMBER	REQUIRED LENGTH	GENERATED REMNANT LENGTH	GENERATED REMNANT ID	NEST START	NEST PART	LINE ITEM	COMPLETED
				B0711190001	02-2118M	6096	MUS17717927	PIPE110	477	LZ16003RA030-14	11122	12/03/07	L16003RA030-141	1478	9	SCRAP	12/03/2007	B0001	1	
							MUS17818578	PIPE110	477	L240503RA138-04	11122	12/03/07	L40503RA138-041	2163				B0002	2	
							MUS17717930	PIPE110	477	LZ16003RA030-13	11122	12/03/07	L16003RA030-131	2236				B0003	3	
				B0711190002	02-2118M	6096	MUS17717918	PIPE110	477	LZ16003RA031-15	11122	12/03/07	L16003RA031-151	1606	355	SCRAP	12/03/2007	B0004	4	
							MUS17267813	PIPE110	477	LZ16003RA030-10	11122	12/03/07	L16003RA030-101	1952				B0005	5	
							MUS17818577	PIPE110	477	L240503RA138-05	11122	12/03/07	L40503RA138-051	2033				B0006	6	
				B0711190003	02-2118M	6096	MUS17818581	PIPE110	477	L240503RA138-01	11122	12/03/07	L240503RA138-011	899	5107	02-2118MR5	12/03/2007	B0007	7	
				B0711190004	02-3012M	2000	MUS17528434	PIPE110	477	LL72201PL415-01	11132	12/03/07	L72201PL415-013	1750		SCRAP	12/03/2007	B0008 C0001 C0002	8	
				B0711190005	02-3012M	3000	MUS17275538	PIPE110	477	LL05101P0012-M1	11122	12/03/07	L05101P0012-M11	1208	1692	02-3012MR4	12/03/2007	B0009	9	

NEST NUMBER	RAW STOCK MATL	RAW STOCK LENGTH	ORDER NUMBER	ORDER WORK CENTER	HULL NUMBER	SPOOL NUMBER
B0711190001	02-2118M	6096	MUS17717927	PIPE110	477	LZ16003RA030-14
			MUS17818578	PIPE110	477	L240503RA138-04
			MUS17717930	PIPE110	477	LZ16003RA030-13
B0711190002	02-2118M	6096	MUS17717918	PIPE110	477	LZ16003RA031-15
			MUS17267813	PIPE110	477	LZ16003RA030-10
			MUS17818577	PIPE110	477	L240503RA138-05
B0711190003	02-2118M	6096	MUS17818581	PIPE110	477	L240503RA138-01
B0711190004	02-3012M	2000	MUS17528434	PIPE110	477	LL72201PL415-01

# Printing Production Lists: Production Information Bend List

Created by ISD on 12/04/2007 @ 12:51 PM  
Report#: PSMS100P1-BEND LIST

## National Steel and Shipbuilding Company Bend List

WORK CENTER:	PLAN WEEK:	PLAN YEAR:	SCENARIO:	ORDER WORK CENTER	HULL NUMBER	SPOOL NUMBER	FAMILY	ADJUSTED START	PART NUMBER	REQUIRED LENGTH	GENERATED REMNANT LENGTH	GENERATED REMNANT ID	NEST START	NEXT PART	LINE ITEM	COMPLETED
110	49	7	pipe110_071119													
B0711190001	02-2118M	6096	MUS17717927	PIPE110	477	LZ16003RA030-14	11122	12/03/07	L16003RA030-141	1478	9	SCRAP	12/03/2007	B0001	1	
			MUS17818578	PIPE110	477	L240503RA138-04	11122	12/03/07	L40503RA138-041	2163				B0002	2	
			MUS17717930	PIPE110	477	LZ16003RA030-13	11122	12/03/07	L16003RA030-131	2296				B0003	3	
B0711190002	02-2118M	6096	MUS17717918	PIPE110	477	LZ16003RA031-15	11122	12/03/07	L16003RA031-151	1606	355	SCRAP	12/03/2007	B0004	4	
			MUS17267813	PIPE110	477	LZ16003RA030-10	11122	12/03/07	L16003RA030-101	1952				B0005	5	
			MUS17818577	PIPE110	477	L240503RA138-05	11122	12/03/07	L40503RA138-051	2033				B0006	6	
B0711190003	02-2118M	6096	MUS17818581	PIPE110	477	L240503RA138-01	11122	12/03/07	L40503RA138-011	889	5107	02-2118MR5	12/03/2007	B0007	7	
B0711190004	02-3012M	2000	MUS17528434	PIPE110	477	LL72201PL415-01	11132	12/03/07	L72201PL415-013	1750	150	SCRAP	12/03/2007	B0008 C0001 C0002	8	
B0711190005	02-3012M	1000	MUS17275538	PIPE110	477	LL05101P0012-M1	11122	12/03/07	L05101P0012-M11	1208	1692	02-3012MR6	12/03/2007	B0009	9	

PART NUMBER	REQUIRED LENGTH	GENERATED REMNANT LENGTH	GENERATED REMNANT ID	NEST START	NEXT PART	LINE ITEM
L16003RA030-141	1478	9	SCRAP	12/03/2007	B0001	1
L40503RA138-041	2163				B0002	2
L16003RA030-131	2296				B0003	3
L16003RA031-151	1606	355	SCRAP	12/03/2007	B0004	4
L16003RA030-101	1952				B0005	5
L40503RA138-051	2033				B0006	6
L40503RA138-011	889	5107	02-2118MR5	12/03/2007	B0007	7
L72201PL415-013	1750	150	SCRAP	12/03/2007	B0008 C0001 C0002	8

# How the System Works: Controlling Remnant Material

Pipe Shop Management System

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Pipe Shop Management System

Work Flow Planning Pipe Spool Nesting Data Maintenance Production Information

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*Remnant is controlled in the PSMS.*


# Controlling Remnant Material: Remnant Screen

Pipe Shop Management System

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## Remnant

	MATL_CODE	LENGTH	REMNANT_ID	CREATING_NEST_ID
	02-2112M	785	3D402F25084113E8E04400306E132202	3D402F25084013E8E04400306E
	02-2112M	794	3D402F25085613E8E04400306E132202	3D402F25085313E8E04400306E
	02-2112M	796	3D402F25085A13E8E04400306E132202	3D402F25085713E8E04400306E
	02-2112M	802	3D402F25085E13E8E04400306E132202	3D402F25085B13E8E04400306E
	02-2112M	802	3D402F25086213E8E04400306E132202	3D402F25085F13E8E04400306E
	02-2112M	807	3D402F25088E13E8E04400306E132202	3D402F25088B13E8E04400306E
	02-2112M	811	3D402F25089213E8E04400306E132202	3D402F25088F13E8E04400306E
	02-2112M	913	3A94937F31CF11F1E04400306E1332E2	MANUALREMNANT
	02-2112M	962	3A94937F31CB11F1E04400306E1332E2	MANUALREMNANT
	02-2118M	9	3F4C89A2025F292AE04400306E132202	3F4C89A2025C292AE04400306E
	02-2118M	253	3A94937F329C11F1E04400306E1332E2	MANUALREMNANT
	02-2118M	319	3F4C89A2031F292AE04400306E132202	3F4C89A2031C292AE04400306E
	02-2118M	355	3F4C89A20264292AE04400306E132202	3F4C89A20261292AE04400306E



Delete Selected Rows

Add Remnant

Show User View

All Remnant  
 Consumed Remnant  
 Available Remnant

*Remnant is issued in 1000mm lengths above 1 meter. Non-nested remnant is available for other uses, and a daily list is posted to show availability.*

# Controlling Remnant Material: Daily Available Remnant List

## National Steel and Shipbuilding Company Available Remnant List for 12/04/2007

MATERIAL CODE	LENGTH
02-2125M	1000
02-2125M	1000
02-2125M	1000
02-2125M	2000
02-2125M	2000
02-2125M	2000
02-2125m	1000
02-3007M	5000
02-3007M	5000
02-3007M	5000
02-3007M	5000
02-3009M	1000
02-3010M	4000
02-3010M	4000
02-3010M	5000
02-301240M	5000
02-3012M	1000
02-3012M	1000
02-3012M	1000
02-3012M	1000

1. Check list for material availability.
2. If material is listed, cross off size and retrieve material from rack.
3. If material is NOT on list, **DO NOT** remove material from rack.

*Available remnant that is removed from storage is crossed off the list. The material handler then updates the PSMS based on this feedback.*

# *Implementation Results from the Pipe Shop Management System*

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**Implementation Goals,  
Results, and Benefits**

# Implementation Goals and Results

- Greatly reduced labor and duration to perform spool release
  - Project goal – minimum 1 man-year cost avoidance
  - Achieved 1 head cost avoidance with rollout to single work center
  - Will achieve another reduction in labor with rollout to other work centers
  - Release time reduced to 30mins for 380 orders vs. 8 hours manually
  - Rollout to other work centers, 45mins/1800 orders vs. 40 hrs manually
- Greatly reduced scrap
  - Project goal – minimum 5% reduction in scrap
  - Demonstrated a 7.5% reduction in scrap (Week Batch)
  - Reduced remnant turnover time
- Increased Efficiency
  - Project goal – 15% improvement in production efficiency
  - Achieved 13% improvement (includes previous process improvements)
  - Reduced late-to-complete by 56%

# Implementation Benefits

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- Product model / production information disagreements caught prior to build
- Increased transparency of fabrication processes
- Drawing revision and paint code checking time reduced through use of PSMS lists
- New software architectures developed & employed
  - Excel interface architecture for reporting
  - Web service shop calendar
  - Clickonce for deploying updates
  - All nesting code inside database

# ***Questions and Discussion***