

Managing Process Manufacturing & The Challenges of a Hybrid Process and Discrete Environment

APICS

Fox River Chapter 207

March 2011

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Speaker Introduction



- Married 11 years
- 2 daughters
ages 7 and 4
- Grew up in Buffalo
Grove, IL
- Have lived in Elgin, IL
since 1997

PepsiCo (Gatorade and Tropicana)

- Supply Chain Optimization – Total Beverages
- Supply Chain Planning – Chilled Juices
- Brands: Tropicana, Dole, Naked, Gatorade

Diageo

- SAP Implementation
- Materials Management
- Production Planning / Scheduling
- Spirits, Wine, and Beer
- Brands: Smirnoff, Sterling Vineyards, Guinness

Consolidated Container Company

- Material Planning, Production Planning,
Productions Supervision, Industrial Engineering
- Extrusion Blow Molding (Plastic Bottles)
- Customers: P&G, Mobil Oil, Minute Maid

Agenda

1. Definitions / Terminology
2. Beverage Supply Chain / Process
3. Challenges of a Process Environment
 - Procurement
 - Quality
 - Batching
 - People
4. Challenges of a Hybrid Process / Discrete Environment (Mixed Mode)
 - Tank Storage / Capacity
 - Process Equipment Design
 - Packaging
 - ERP System Compatibility
5. Q & A

Process vs. Discrete Manufacturing?

When defining manufacturing procedures and methods, there are two essential terms to keep in mind: **Process manufacturing**, and **Discrete manufacturing**.

Process manufacturing results in finished goods that cannot be disassembled back into their original components.

Discrete manufacturing results in finished goods that can be disassembled back into the original components.

Source: <http://www.wisegeek.com/what-is-process-manufacturing>.

Process Manufacturing

Process manufacturing is associated with formulas and manufacturing recipes.

Once an output is produced by this process, it cannot be distilled back to its basic components.

- A can of soda cannot be returned to its basic components such as carbonated water, citric acid, potassium benzoate, HFCS, and other ingredients.
- Juice cannot be put back into an Orange.

Process manufacturing is common in the food, beverage, chemical, pharmaceutical, and biotechnology industries.

In process manufacturing, the relevant factors are ingredients, formulas, and bulk.

The terms characterize distinct manufacturing approaches.

Source: http://en.wikipedia.org/wiki/Process_manufacturing

Typical Process System (Batch or Continuous)



Tropicana Naked Juice Blending Process (CA)

Typical Process System (Batch or Continuous)



Fosters Wine Blending Process (CA)

Typical Process System (Batch or Continuous)



ConAgra Popcorn Process (Mexico)

Discrete Manufacturing

Discrete Manufacturing - concerned with bills of material and routing. The manufacturing floor works off orders to build something. Examples include toys, medical equipment, computers and cars. The resulting products are easily identifiable.

Can be disassembled and its components, to a large extent, returned to stock.

Discrete manufacturing is often characterized by individual or separate unit production.

- Units can be produced in low volume with very high complexity or high volumes of low complexity.
- Low volume/high complexity production results in the need for an extremely flexible manufacturing system that can improve quality and time-to-market speed while cutting costs.
- High volume/low complexity production puts high premiums on inventory controls, lead times and reducing or limiting materials costs and waste.

Source: http://en.wikipedia.org/wiki/Discrete_manufacturing

Typical Discrete System



Automotive Assembly (Detroit)

Typical Discrete System



Pepsi Bottling Ventures (Idaho)

Typical Discrete System



Rügen Fisch - Germany

Process vs. Discrete Inventory Terminology

A significant difference between the major manufacturing disciplines is in inventory terminology.

- Processed goods are a result of the blending of raw materials, ordinarily inventoried in bulk.
- Discretely manufactured goods are a result of the assembly of parts, inventoried as items, or units.

- Process manufacturing effects a chemical change in ingredients resulting in either a solid or a liquid.
- Discrete manufacturing, conversely, effects a structural change in components resulting solely in a solid item.

Source: <http://www.wisegeek.com/what-is-process-manufacturing>

Process vs. Discrete Manufacturing?

Process Manufacturing - Production that adds value by mixing, separating, forming, and/or performing chemical reactions. It may be done in either *batch* or *continuous* mode.

Discrete Manufacturing - The production of distinct items such as automobiles, appliances, or computers.

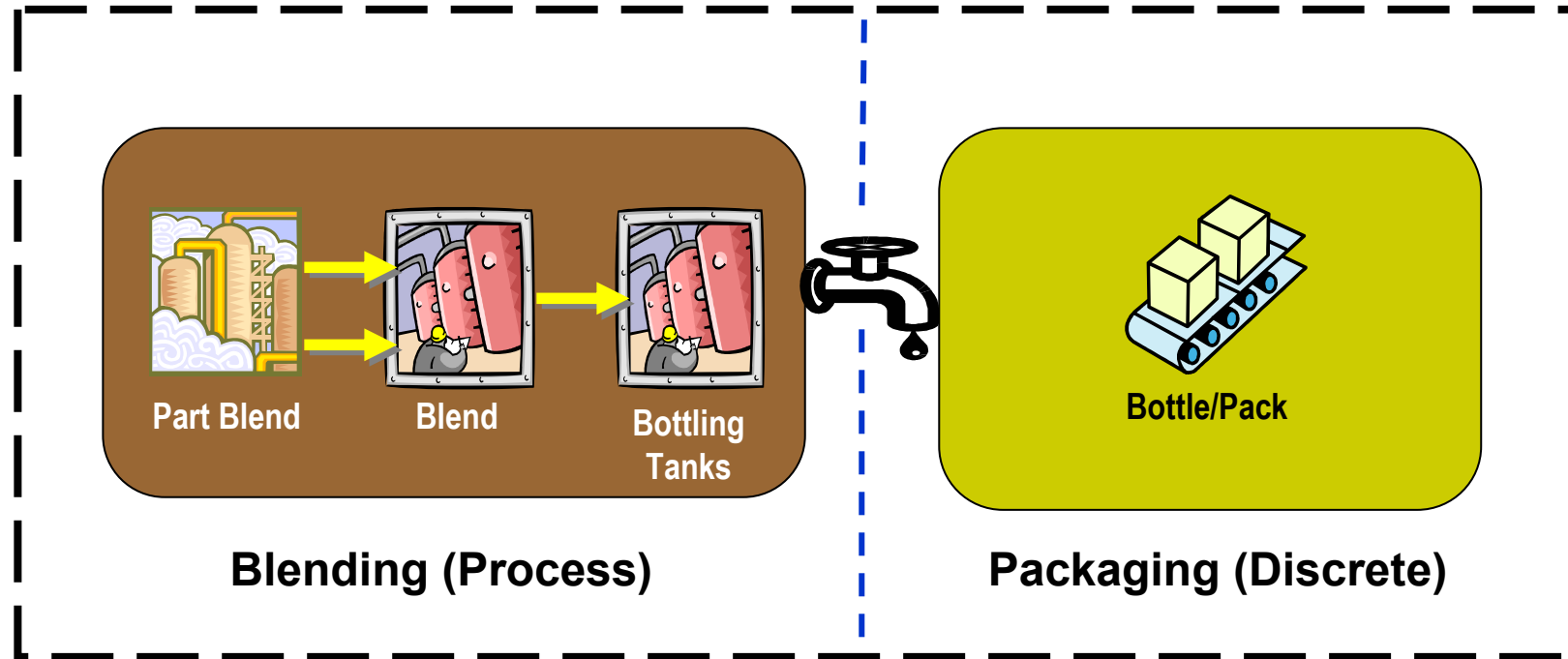
Mixed Mode Manufacturing – Manufacturer with elements of both Process Manufacturing and Discrete Manufacturing.

What are the challenges of Mixed Mode Manufacturing?

Source: APICS Dictionary, 12th Edition – 2008

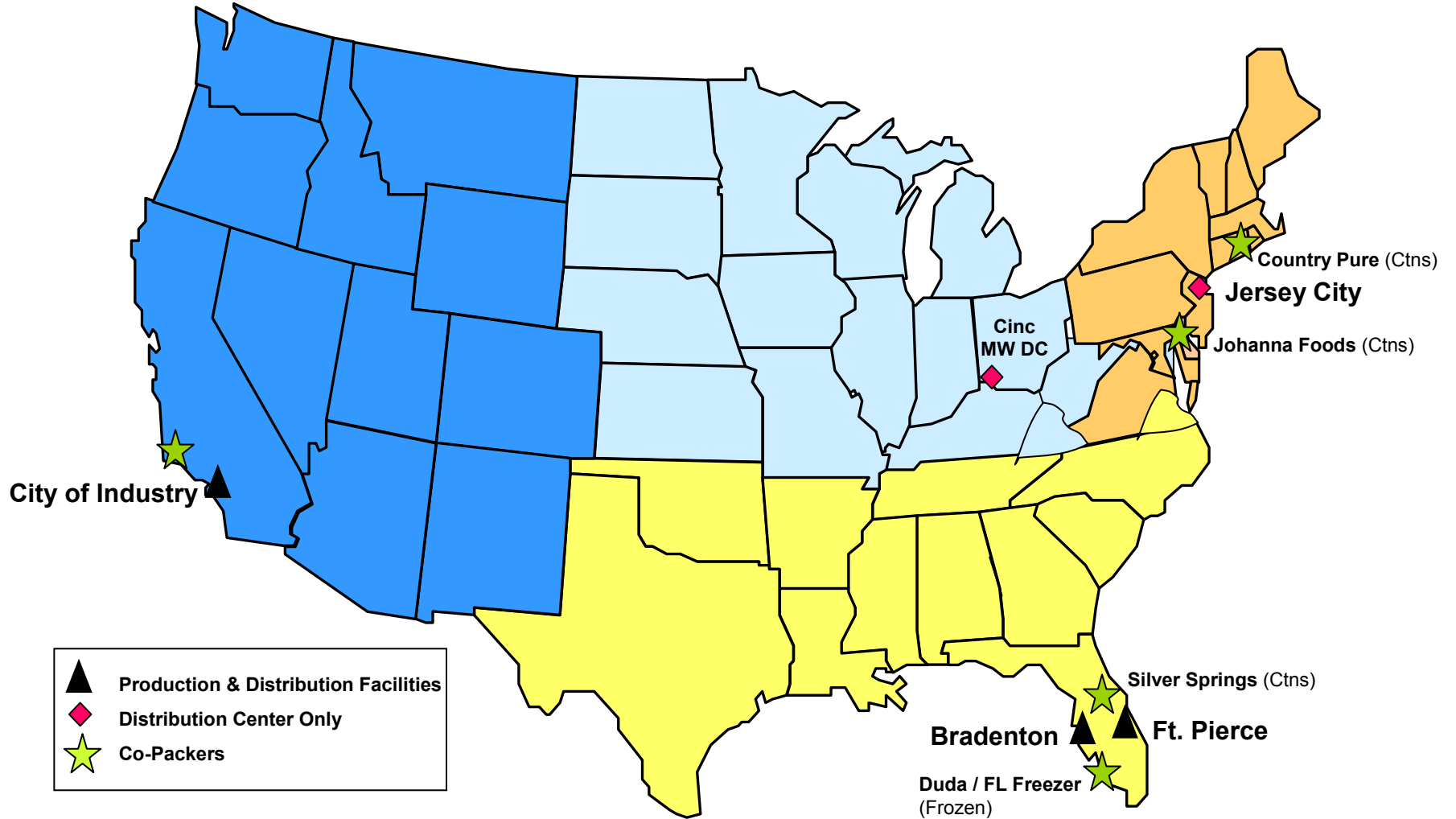
<http://www.erpsoftwareblog.com/2009/07/process-discrete-and-mixed-mode-manufacturing-3-business-issues-3-dynamic-solutions/>

Blending vs. Packaging

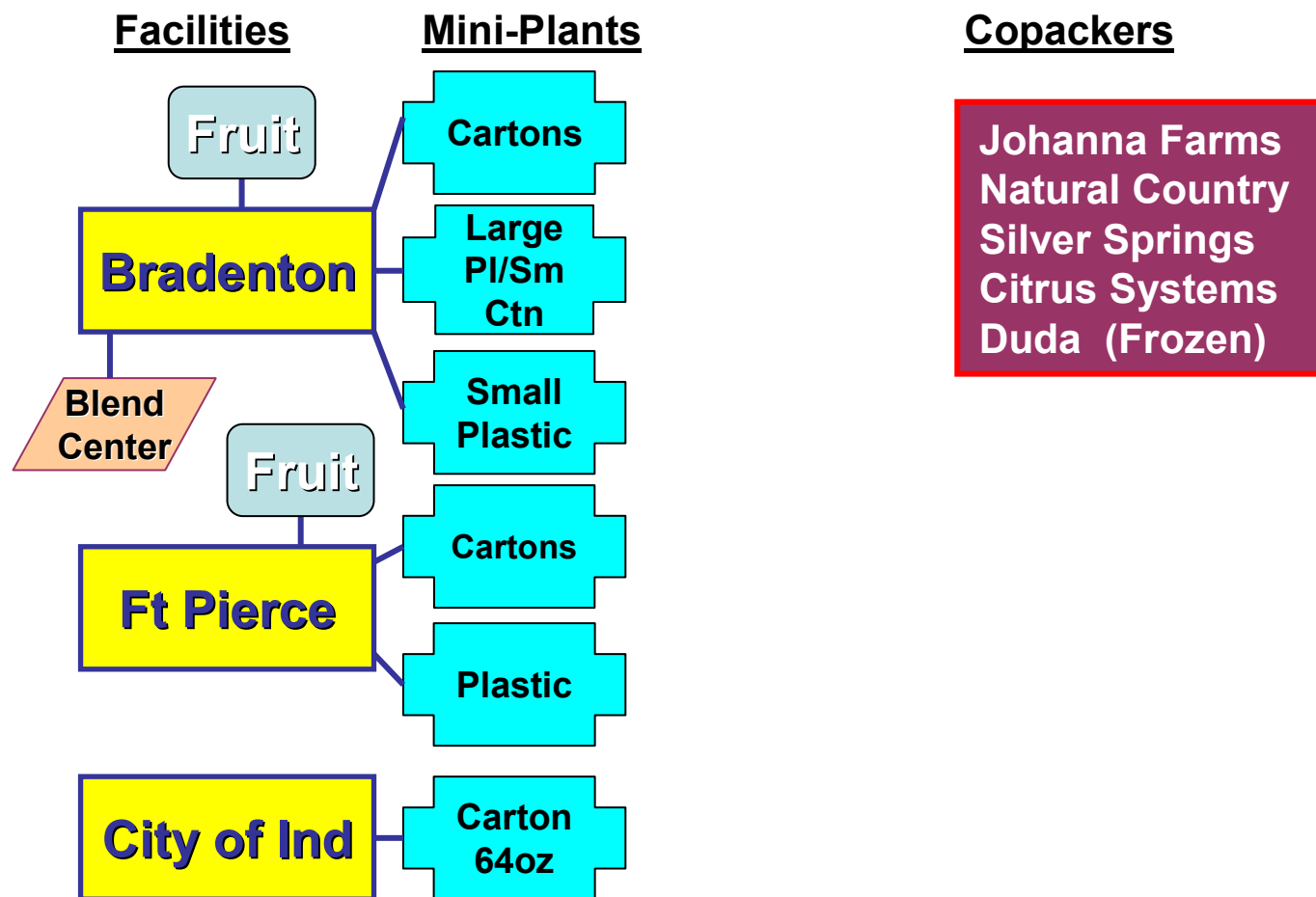


Mixed Mode manufacturing contains both
Process and Discrete

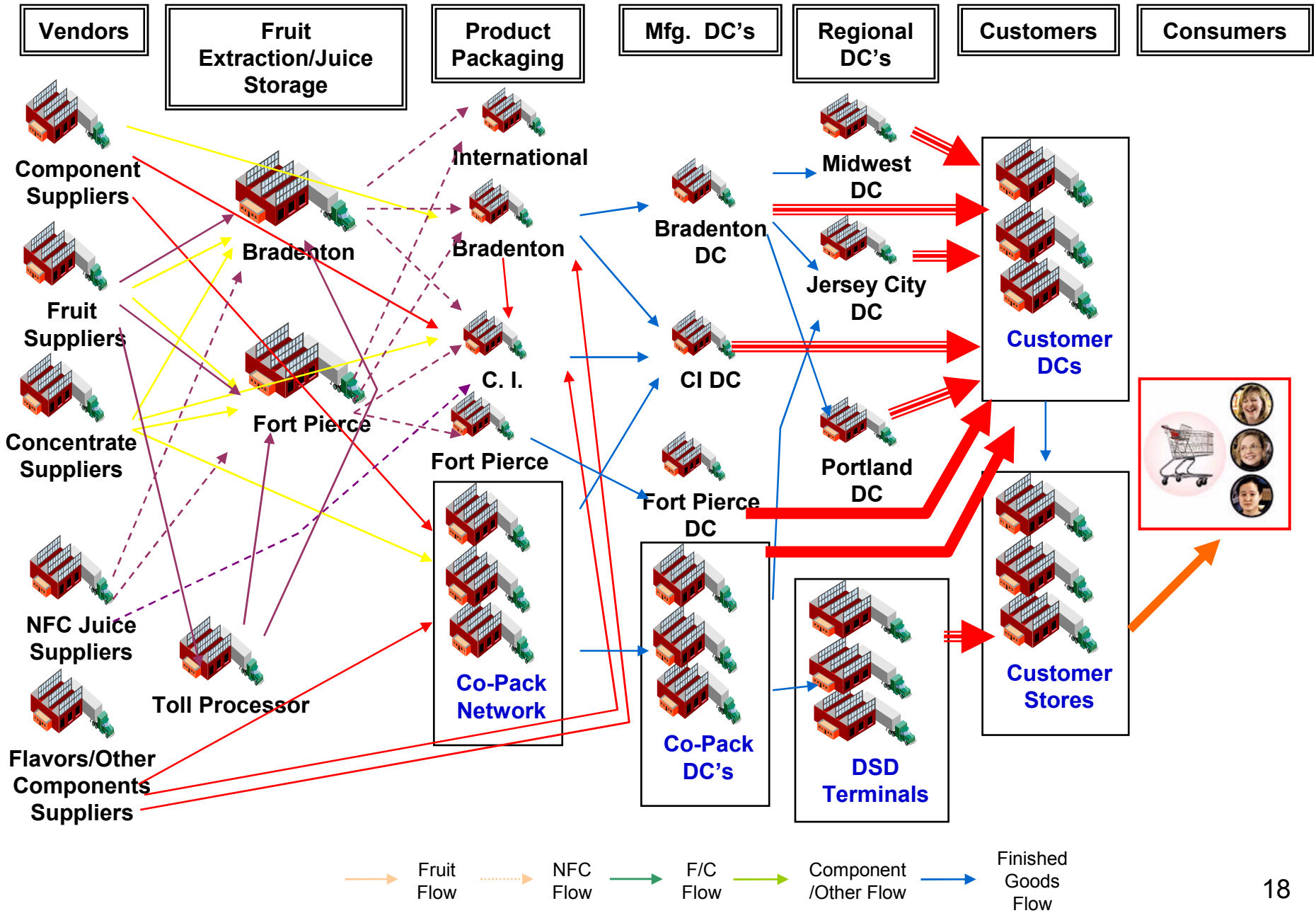
Tropicana Chilled Locations - 2011



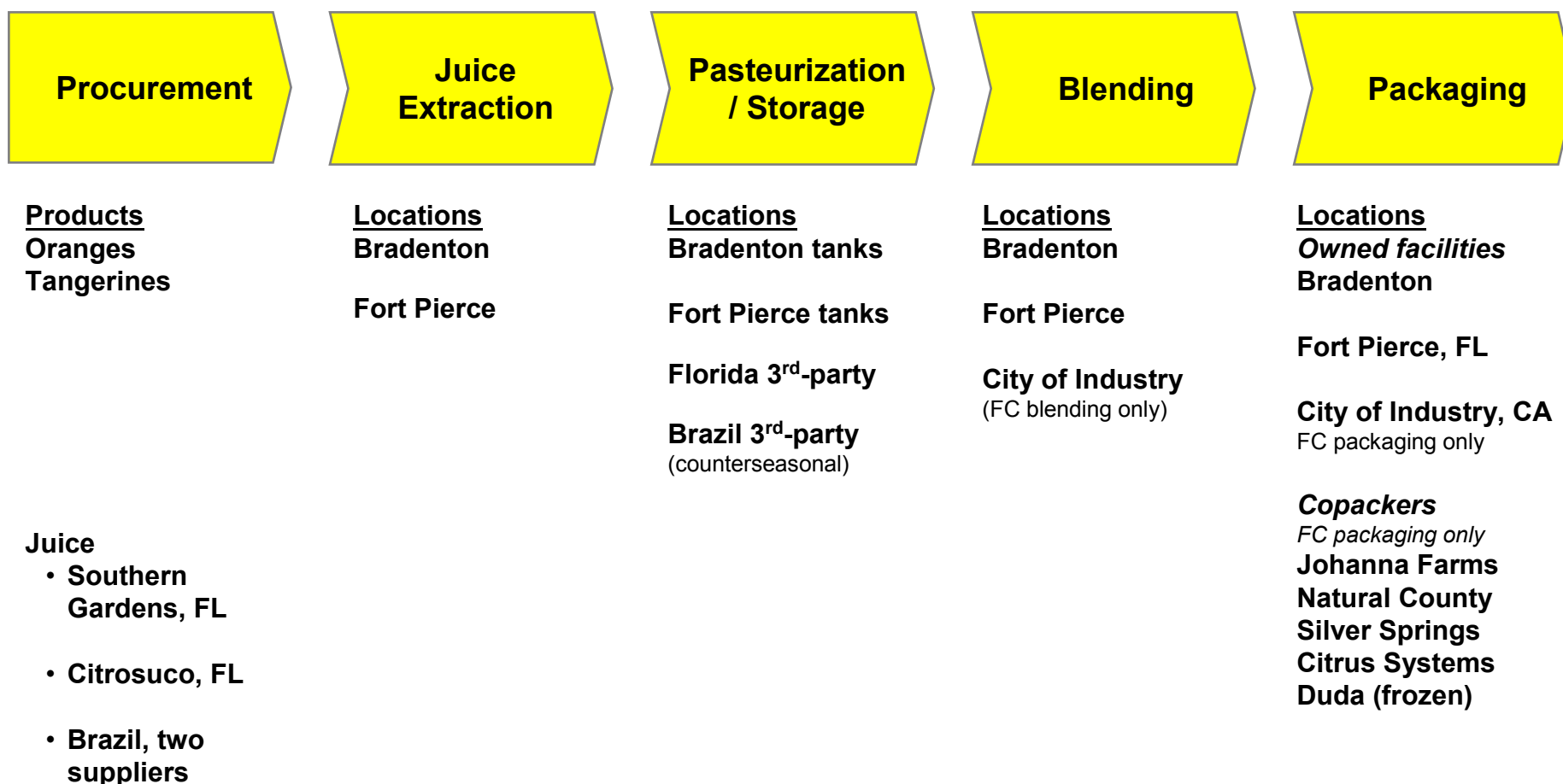
Complex Supply Chain, Managing 3 Tropicana manufacturing sites, multiple production lines plus Co-Pack facilities



The "Simple" Supply Chain?



Orange Processing Flow



Overview of Fruit Processing

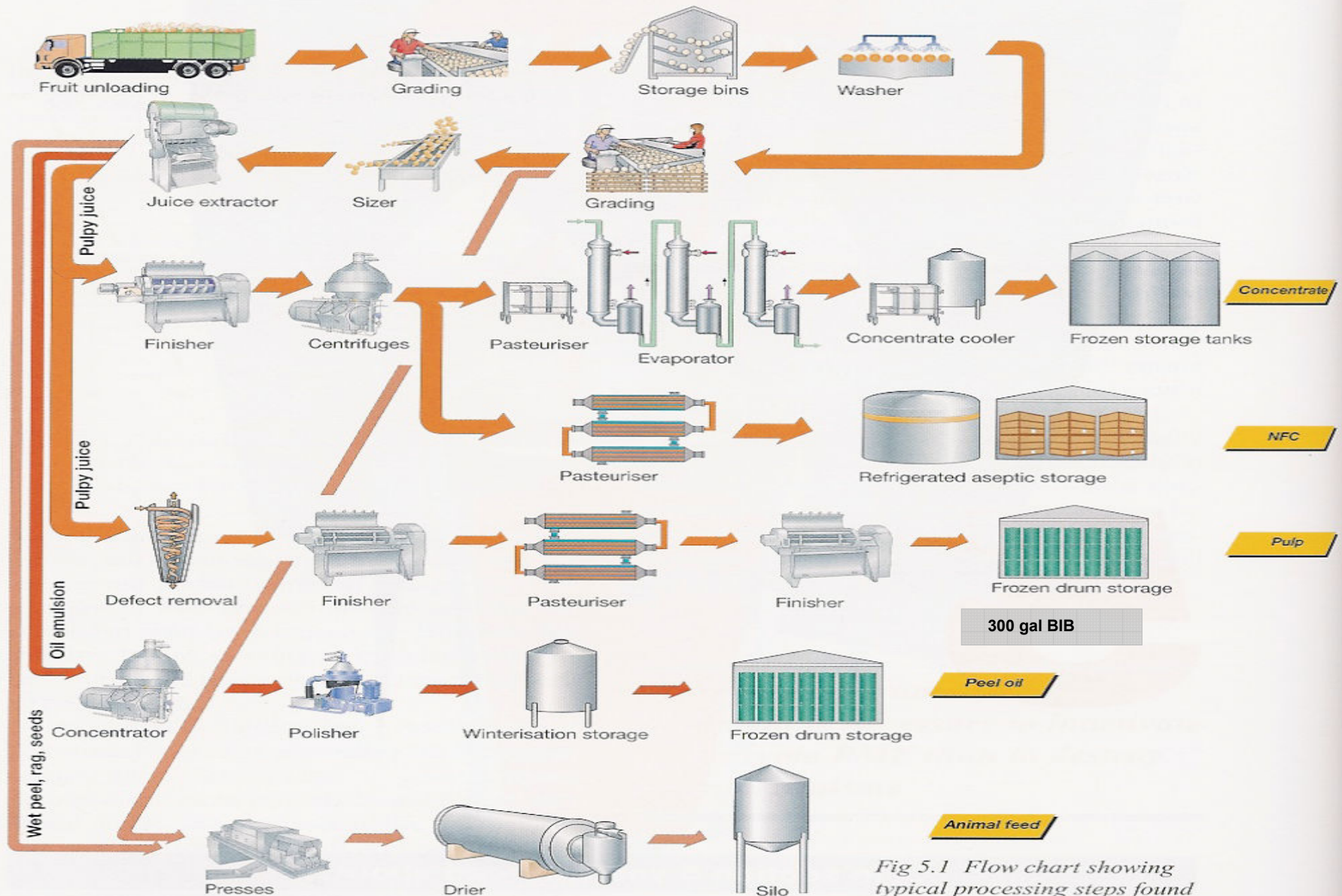
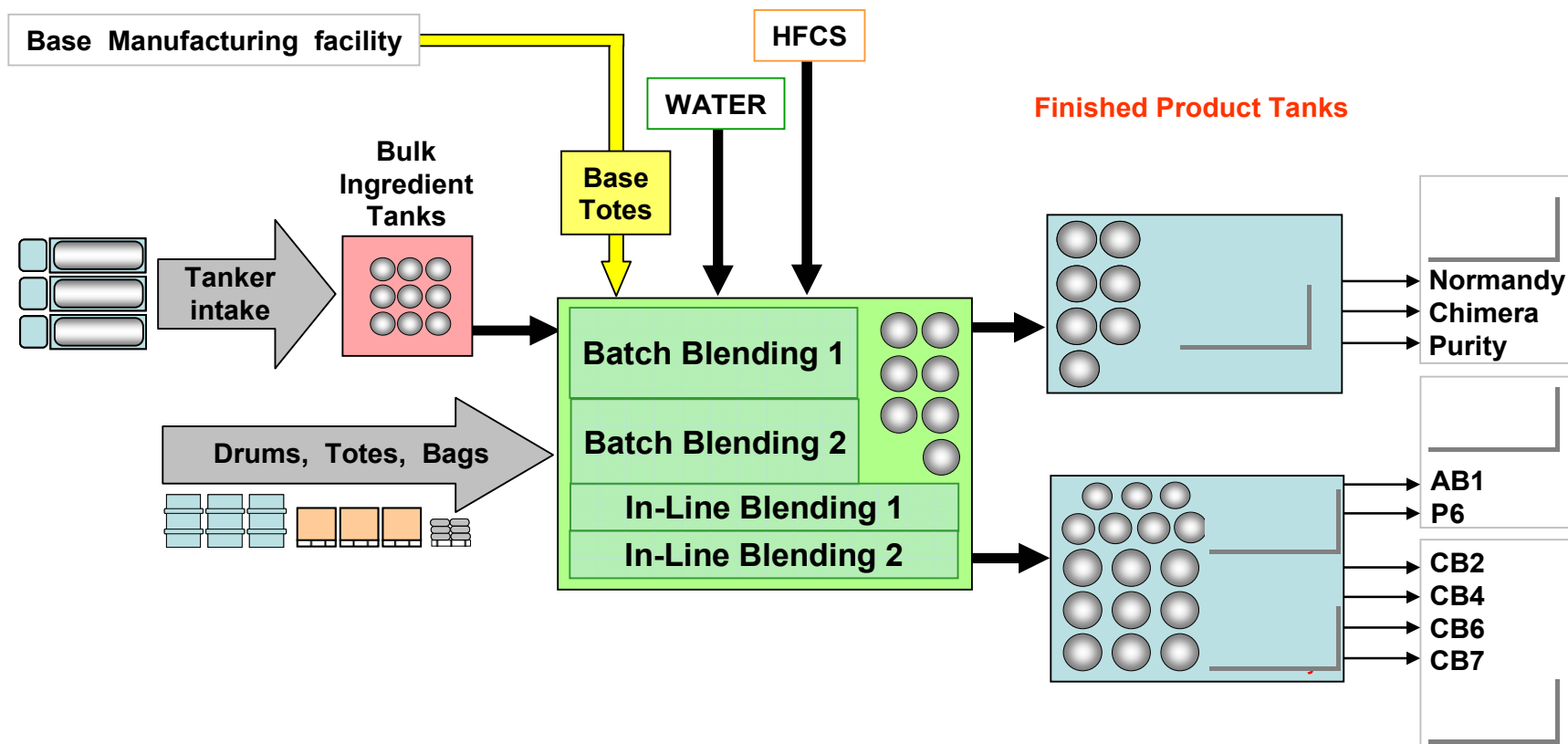


Fig 5.1 Flow chart showing typical processing steps found in an orange processing plant.

Juice Blending Concept (Batch Process)



Chilled Juice Inventory Cycle

Chilled is a short shelf life product requiring a short cycle process with minimum inventories.

7.8 finished goods days of supply from packaging to customer ship



Carton SS,
Copack/CI location,
labels & caps

Mainly on Trains

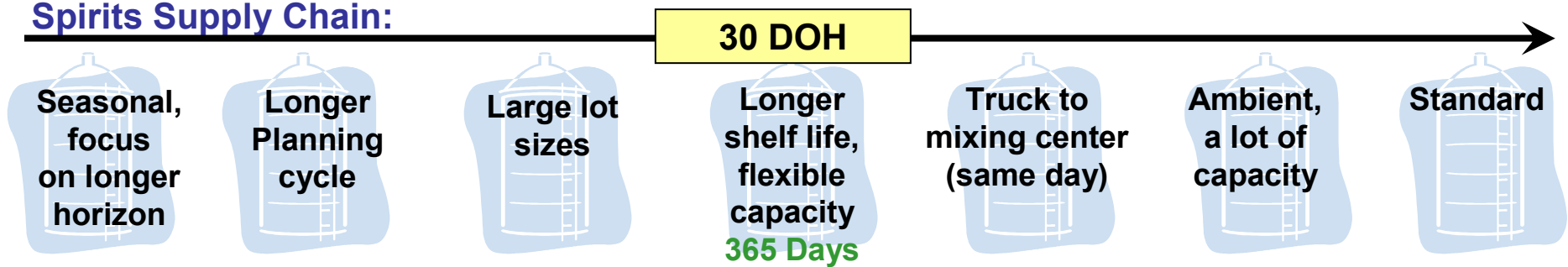
Material Suppliers also carry tight inventories:
e.g. Bradenton
Bottles
Corrugated
Cartons

- Predominantly 63 day shelf life
- Minimum 30 days to customer
- Most product ships within 7 days of production

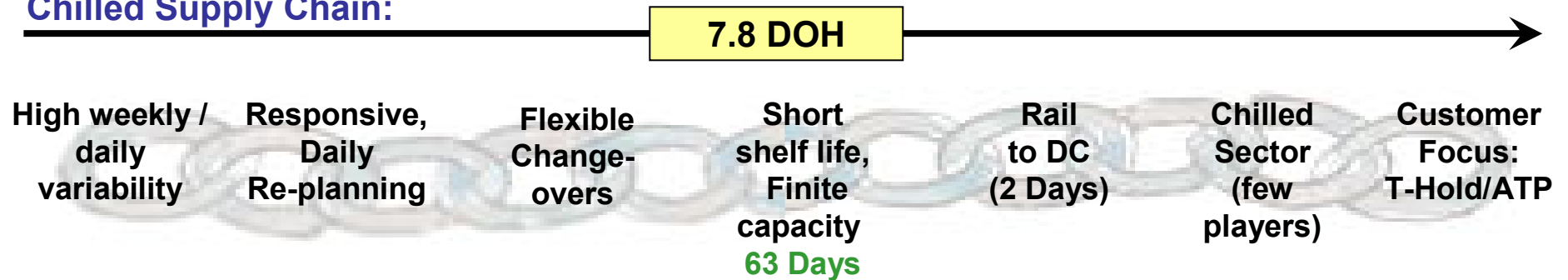
FG's Inventory depends on product type



Spirits Supply Chain:



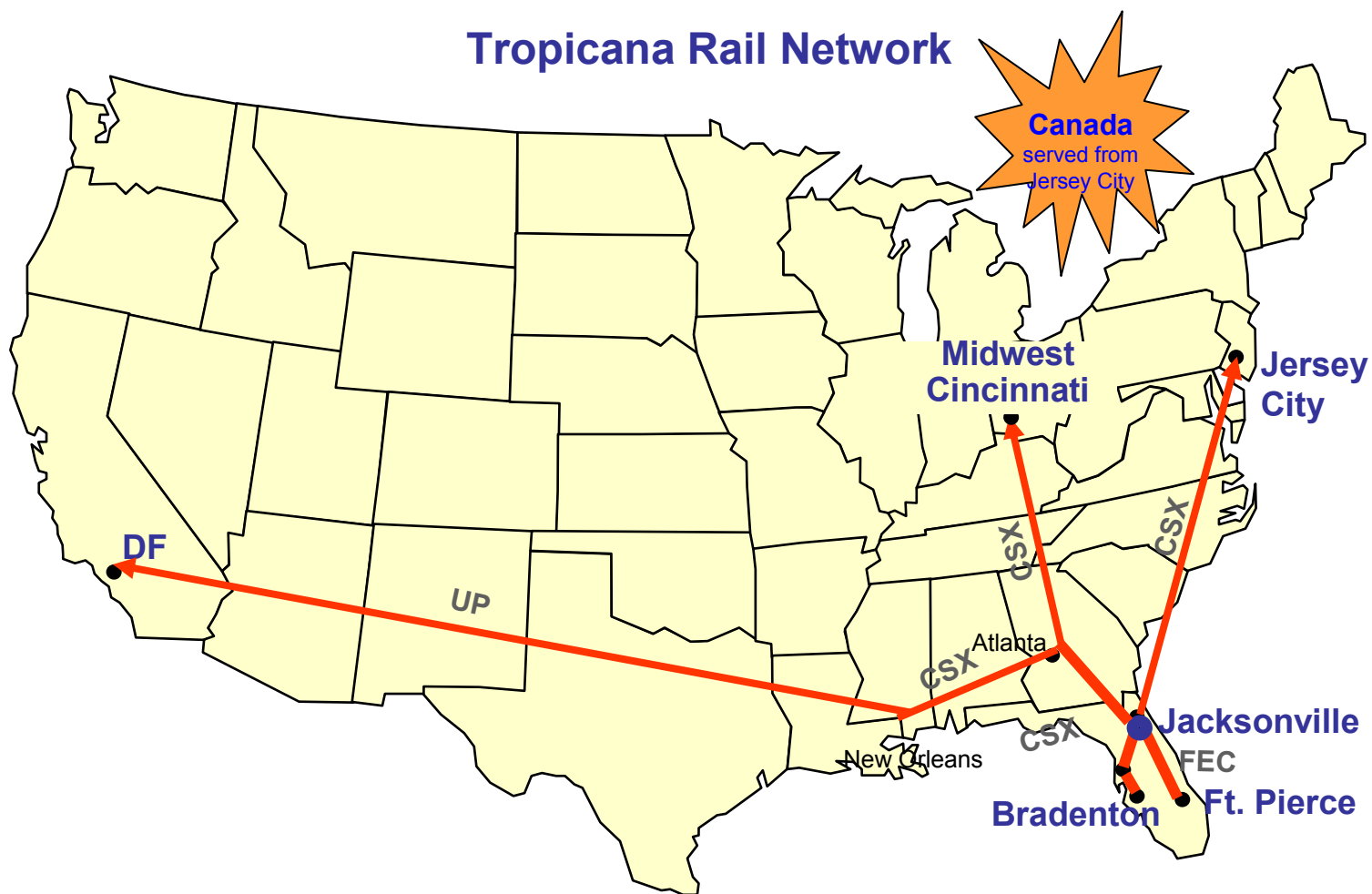
Chilled Supply Chain:



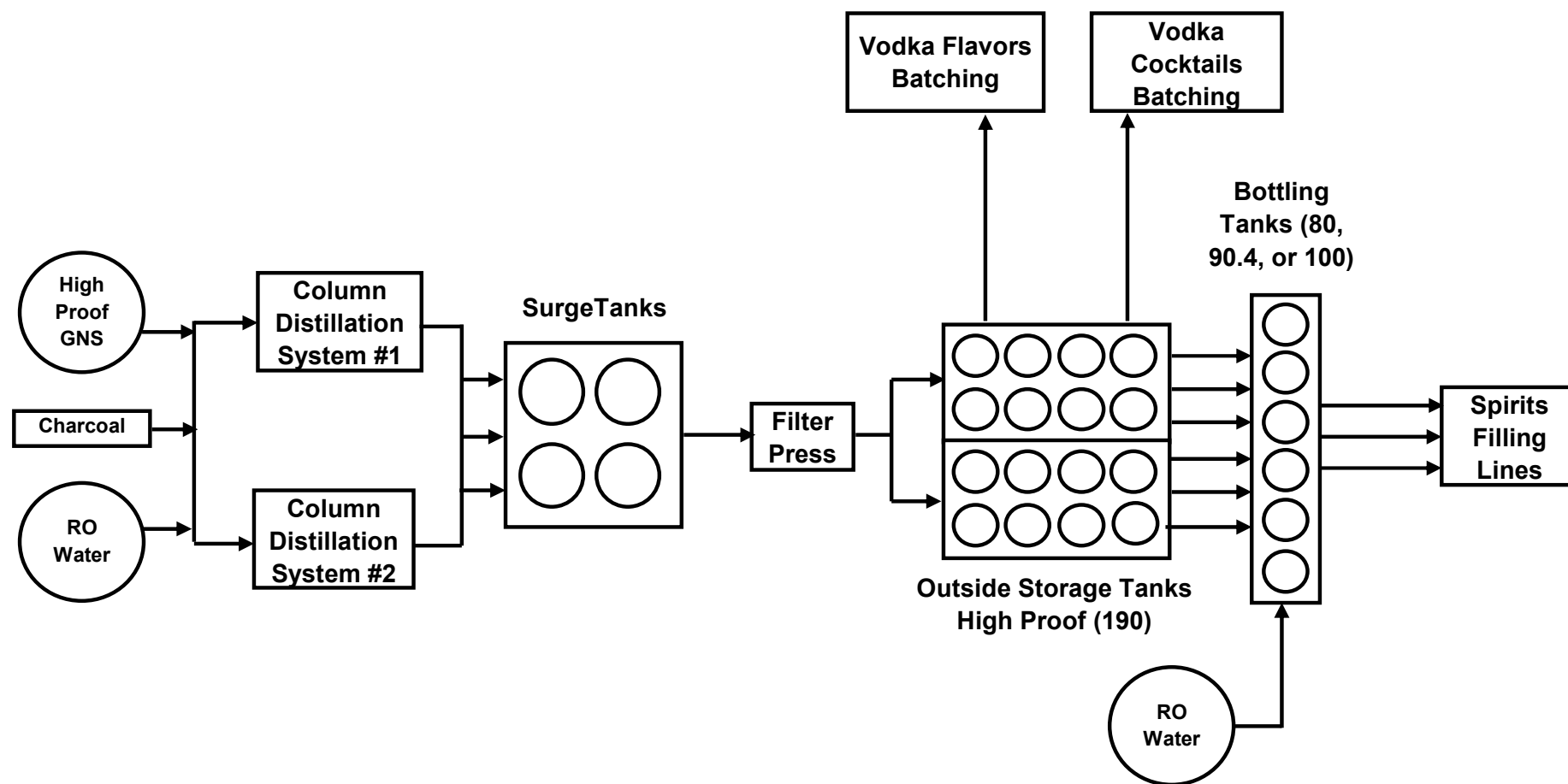
Chilled requires a tightly Integrated Supply Chain to manage all the increasing constraints, simultaneously, in a short time period.

Distribution From Five DCs

Distributed via tightly coordinated rail distribution network



Vodka Distillation (Continuous Process)



Charcoal used to filter out Congeners

10 of 11 Columns in use at all times (1 out of service for cleaning)

Continuous Process (Vodka) is less complex process than Batch Process (Juice) – Can be automated

Challenges of a Process Environment

- Procurement
 - Ingredient delivery
- Quality Control
 - Ingredient quality (lot to lot variations)
 - Lot Control (Track & Trace)
- Batching
 - Blending
 - Batch shelf life
- People
 - Skill level
 - Technology

Procurement

- Manufactured ingredients and flavors are typically consistent
 - Ex: Vanilla Extract, Lemon Extract
- Natural ingredients vary due to variations in nature and differences in growing regions around the globe
 - Ex: Strawberry Concentrate, Acai Berry Concentrate
- Incoming container sizes have to be compatible with blending equipment capabilities
 - Pail, Bucket, Drum, Tote, Tanker, Bag, Super Sack
 - Automation vs. Hand Additions
- Ingredient cost
 - Flavors can be high \$\$ items
 - Ex: Vanilla Extract \$1,400 / gal
 - Slight overuse or spillage can be very costly
 - Track Gain/Loss at the batch level

Quality Control

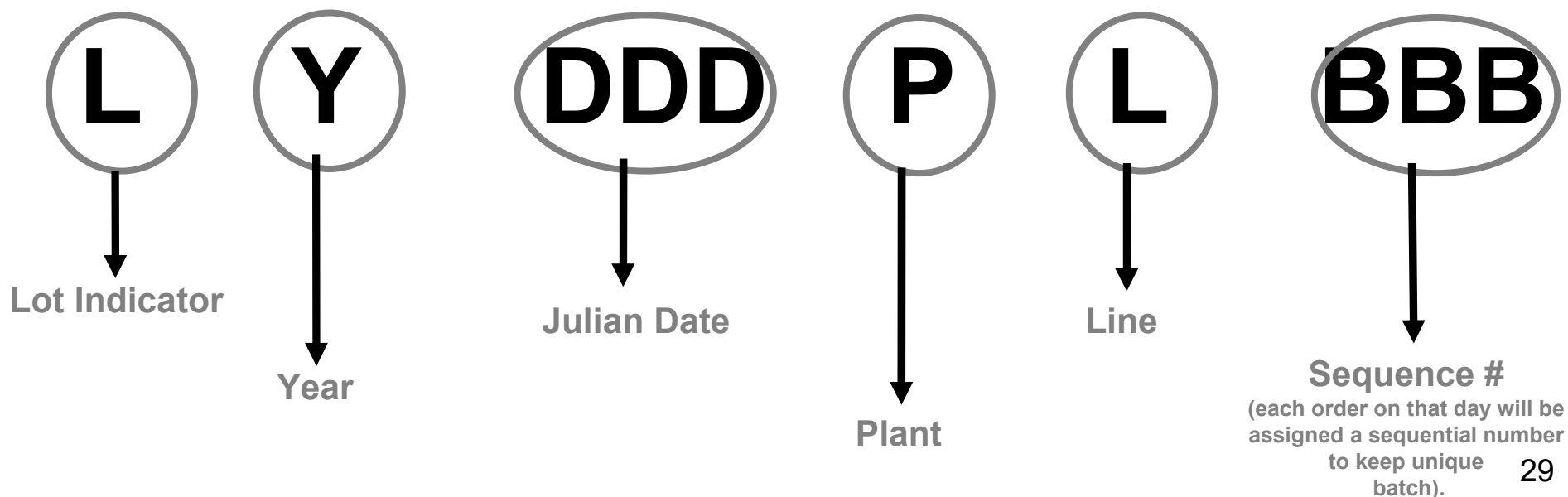
- Incoming ingredients are segregated and put into Quality Inspection (totes, bucket, sack)
- Incoming Bulk checked before received into storage tank (Sugar, HFCS, GNS)
- Attributes are checked against agreed to specifications.
- If OK, released for production to use.
- If borderline, a determination is made on disposition.
 - Adjust Batch if close
 - Reject back to supplier
- Formulas with micro concerns have a 5 day Hold period
 - FG's can be deployed to internal company DC's, but not shipped to customer during this 5 day period
 - Need to factor this incubation time into production schedule

Lot Control (Track & Trace)

- Ingredients → Bulk Liquid → Finished Goods
- Gov't Regulations: FDA (Food), TTB (Alcohol)
- Need to be prepared for a potential recall
 - Detailed record keeping is very important
 - Trace back to ingredient level
 - Need to know which batch lots went into which FG lots
 - Typically multiple batches in one FG lot
 - Have to track case number range each shift for each batch

Standard 10 digit batch

The following lot code must be added to the case & bottle:



Blending

- Not an exact science
 - No two batches are exactly the same
 - Valves open and close at different rates
 - Tank scale variation / fluctuation
 - Incoming ingredient variation
- For Alcohol, typically hold back 10% of water from final blend
 - Quality checks to see what adjustments are needed to get to final blend and proof
 - Decision matrix to guide what final additions are needed (based on historical data)
 - Could run out of tank space, require splitting a batch into two batches
- For Orange Juice, trying to reach a predetermined brix (sugar) and acid
 - Brix to acid ratio
 - Mix different Orange varieties and different Groves / Lots to maintain a consistent final blend year round
- Innovation
 - Pilot Plant to test new formulations; Does not always transfer to production
 - Batch time concerns
 - New Innovation is typically low volume / high complexity
 - SKU proliferation

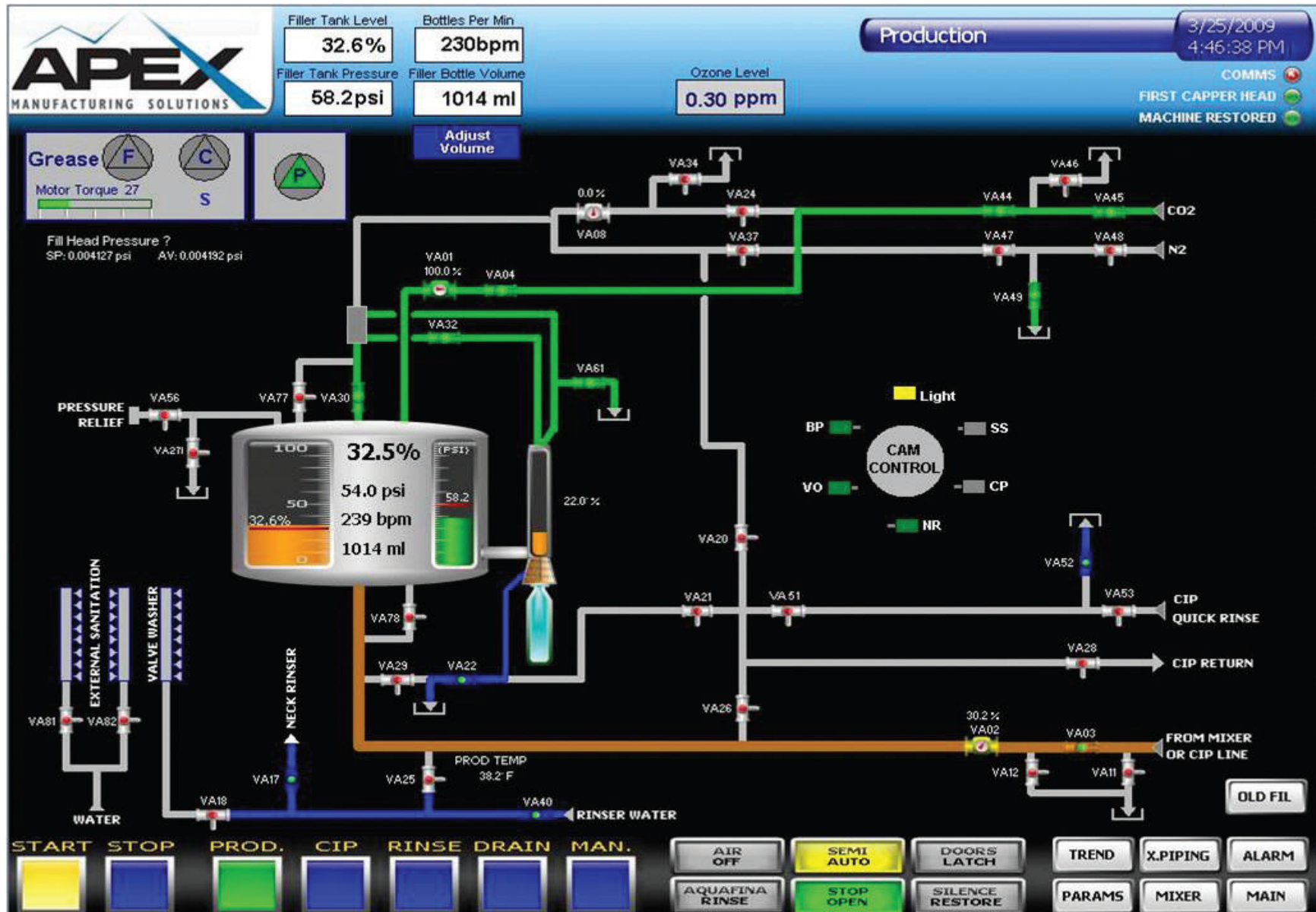
Batching Shelf Life

- Final batches have a set shelf life
 - Microbial growth concerns
 - Maintaining mix and items in solution
- Need to put into a package to maintain freshness
 - Perishable: Typically 2 to 3 days (chilled)
 - Non-perishable: Typically 1 week (ambient)
- Means batching can't get too far ahead of packaging
 - Major mechanical breakdowns
 - Might need a backup outlet to package the perishable blend into
 - Ex: 8-oz line down, part is 2 days away, package into 64-oz
 - Package quality issues have a snowball effect
 - Ex: Rejected 750ml Glass, need to run out liquid on 1L Glass
- Can get “Tank Locked” if major issues and no viable backup
 - Ex: 4 of 6 batch tanks tied up with Margaritas

People

- Process part of a Mixed Mode operation is very complex
- Processing Operators
 - Need to be able to think independently and make logical decisions
 - Technology
 - Math, computers, spreadsheets
 - Automated Operator Interface / Control System
 - Self Directed work teams
 - Operator skill level approaches that of maintenance personnel
- Financial impact from batching errors can be very costly
- Batch Planner in addition to a traditional Production Planner

Batch Process Operator Interface



Challenges of a Hybrid Process & Discrete Environment

- Batching Capacity
- Tank Storage / Capacity
 - Bulk tank
 - Ingredient storage
- Process Equipment Design
 - Flexibility (small batches) vs efficiency (large batches)
- Packaging
 - Coordinating common flavor runs on multiple lines
 - Clean in place (CIP)
 - Scheduling sequence to minimize clean time
- ERP System Compatibility
 - Formulas vs. Bill of Materials

Batching Capacity

- Blending system has to outrun packaging lines
 - Don't want to direct couple blending to packaging
 - Allows clean outs in Blending while Pkg lines are still running
 - Need to be able to batch ahead (WIP) of packaging requirements
- Capacity to handle overall plant demand for blends used across multiple lines
 - Smirnoff 80 proof across 4 lines in parallel
 - Tropicana Pure Premium Original across 5 lines in parallel
- Transfer finished batch into a surge or bottling tank
 - Allows batch tank to continue to be used for batching instead of waiting for packaging
- In-line blending
 - Add water at the filler. Newer technology, reduce asset cost (tanks)
 - Mix ratio adjustment at the filler (water to concentrate)
 - Used in Soda and Malt Beverage bottling applications

Batching vs. Production Planning

- Batching and Production Planning have competing priorities
 - Batching wants long runs
 - Less wash outs
 - More up time
 - Production Planning wants short runs
 - Less inventory
 - Flexibility / Responsiveness
 - Customer Service
 - Need to balance competing priorities and do what is right for the overall business, and operate within system design

Tank Storage / Ingredient Storage Capacity

- Tank Storage
 - Dedicated high volume tanks turn over quickly
 - Sugar, HFCS
 - Need to coordinate deliveries with batching schedule
 - Flexible mixed use tanks
 - Flex between different base products (Rum, Gin, Tequila)
 - Need to fully consume old before filling with new
 - Batch size matches available liquid
 - Schedule packaging to consume batch
- Chilled & Dry Ingredient Storage
 - Space constraints
 - Rotation (FIFO)
 - Humidity / environment

Processing Equipment Design

- Must design batch size to meet multiple criteria
 - Size of market (alignment from marketing)
 - Frequency of run (shelf life)
 - Total plant combined run rate of liquid
- Sizing of batching system
 - Minimum batch size
 - Output rate
- Might have multiple batch systems
 - Large mixing tanks for high output (10,000 gal batches)
 - Small mixing tanks for smaller batch sizes (3,000 gal batches or less)

Packaging

- Common blends across multiple lines
 - High volume “A” items typically not an issue
 - Problem is low volume “C” items
 - Might only run once a month, or once a quarter
 - Keeping the same blend aligned on 2 different lines can be a challenge
 - Typically schedule the smaller draw item just before the large draw item
 - Example: 50ml and 1.75L runs on Smirnoff Black Cherry Vodka
 - » 6,000 gal batch shared between 2 lines
 - » Comparison: 1,700 cases of 50ml = 950 cases of 1.75L
 - » Full shift of 50ml = 1,700 cs = 2700 gals (less than 3,500 gal min)
 - » Problem: 1,700 cs of 50ml Smir = 3 month supply, but not a full batch in blending.
 - » Solution: Run 50ml first to ensure full volume is met
- Separate runs of similar product across multiple Pkg Lines which consume large amounts of batched liquid
 - Alternate between different process systems to allow recovery
 - Examples (each is a different process system)
 - Smirnoff Vodka → Gordon’s Gin → Popov Vodka → (back to) Smirnoff Vodka
 - FC OJ → NFC OJ → NFC Grapefruit → (back to) FC OJ

Packaging Schedule (Discrete)

Optimum Sequence

Line							
1	100 Smir -->	200 Popov -->	200 Gordon -->	200 Smirn -->	375 Smirn -->	375 Popov -->	375 Gordon
2	No preferred sequence.						
	Run 750ml Booths for a full shift						
	If Line 2 and Line 4 are both running Gordons, Run opposite flavor on Line 2 and Line 4 (if possible)						
3	750 Smir -->	750 Popov -->	Liter Popov -->	Liter Smir			
	Run flavors on Tue, Wed, Thur						
	If Line 3 Liter Smir is running, run Gordons or Popov on Line 4 (if possible)						
4	Gordon -->	Booth -->	Popov/Relska -->	Smir Vodka -->	Smir Flavors		
	Single shift - 3 day minimum run						
	Double shift - 2 day minimum run						
5	Smir -->	Gordons -->	Popov				
	2 day run minimum						
6	No preferred sequence.						
	Group IML and PML runs together						
** Line 1 and Line 4 are the most critical lines to follow this sequence. **							

- Common flavor runs together
- Offset same flavors / blend on lines with high consumption rate

Packaging

- Also wants long runs to minimize CIP's (Clean in Place)
 - 4 hr CIP vs. 2 hr CIP vs. Drop and Go
- Develop a set sequence to minimize or eliminate cleaning between runs
 - Kosher vs. Non-Kosher
 - Group Kosher runs together
 - Shared blends for multiple markets
 - US, CAN, Mexico, International unique FG SKU's
 - Might need to run Mexico or International a few weeks ahead of true demand
 - OJ No Pulp → OJ Some Pulp → OJ Lots of Pulp
 - Drop and Go (no CIP needed)
 - Smir 80 Proof → Smir 90.4 Proof → Smir 100 Proof
 - Need to get to specific Proof before running Production cases
 - Could take ½ hr or more to get "in proof"
 - Can go slightly over (pay more in taxes), but can't go under

Packaging Schedule (Discrete)

Cycle Scheduling

Plainfield Line Cycle Scheduling - Draft

Line	Week	Mon 1st	Mon 2nd	Tue 1st	Tue 2nd	Wed 1st	Wed 2nd	Thu 1st	Thu 2nd	
3	1	750 Smir	750 Smir	750 Flavor	750 Flavor	750 Smir	750 Smir	750 Flavor	750 Flavor	
	2	Liter Popov	Liter Popov	Liter Flavor		Liter Smir	Liter Smir	Liter Flavor		
	3	750 Smir	750 Smir	750 Flavor	750 Flavor	750 Smir	750 Smir	750 Flavor	750 Flavor	
	4	Liter Smir	Liter Smir	Liter Flavor		Liter Smir	Liter Smir	Liter Flavor		
4	1	**1.75 Smir	1.75 Smir	1.75 Smir	**1.75 Smir	1.75 Flavor		1.75 Smir	**1.75 Smir	
	2	1.75 Gordon	**1.75 Gordon	1.75 Gordon	**1.75 Gordon	1.75 Gordon	**1.75 Gordon	1.75 Gord/Booth	**1.75 Gord/Booth	C/O
	3	1.75 Popov	**1.75 Popov	C/O	1.75 Smir	**1.75 Smir	1.75 Smir	1.75 Smir	**1.75 Smir	
	4	1.75 Smir		1.75 Gordon	**1.75 Gordon	1.75 Gordon	**1.75 Gordon	1.75 Gordon/Citr	**1.75 Gordon/Cit	

- Bottle size and bottle style runs together
- Flavor runs together

ERP System Compatibility

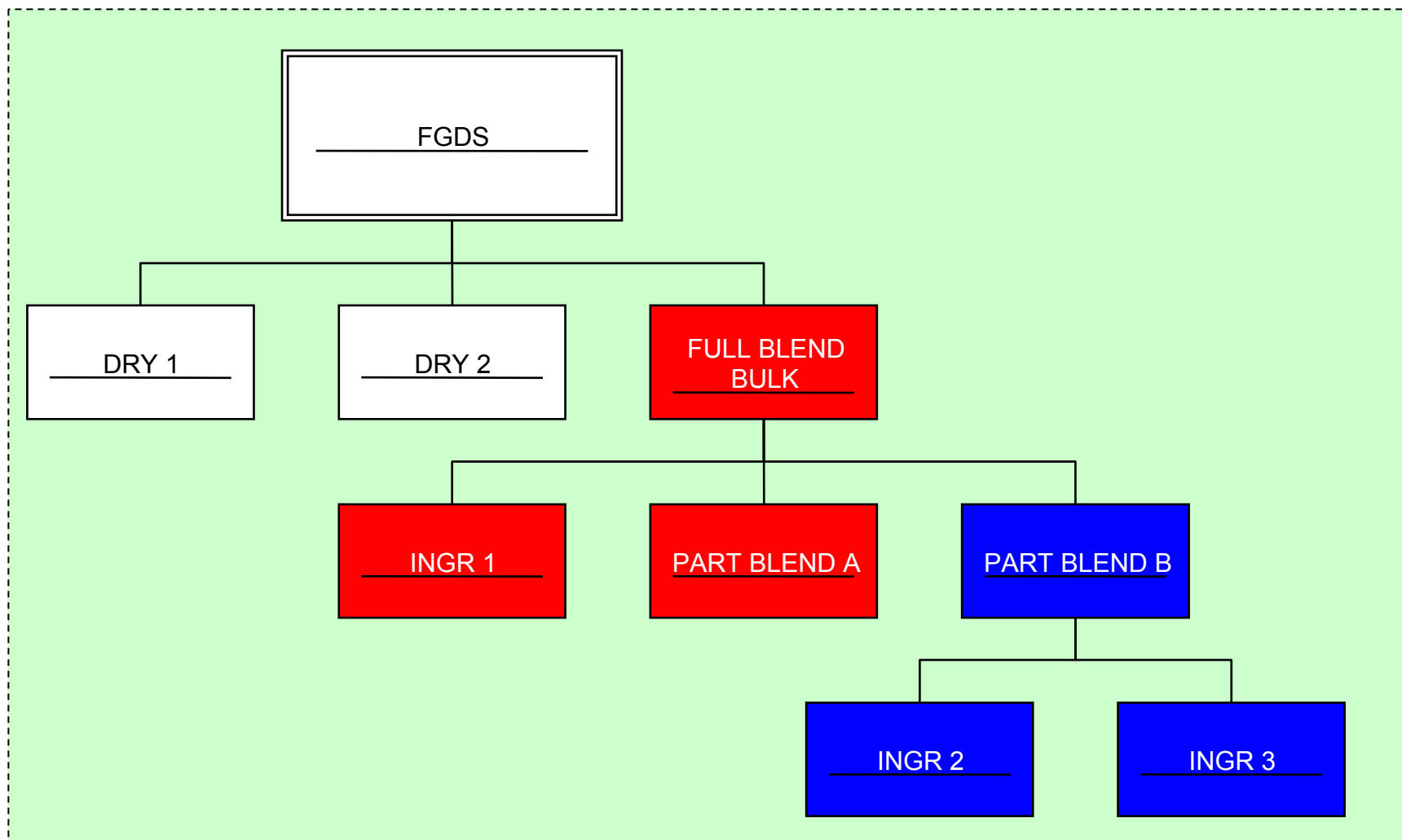
- Most ERP systems do not handle Formulas, need to convert to BOM
- Process (Batching)
 - Formula developed off-line 1st, then converted into BOM for ERP
 - UOM: Lbs, Gals, Ounces
 - 23,775 gal batch Process Order: Smirnoff Citrus Flavored Vodka
 - » 12,601 gals Water
 - » 10,699 gals of 190 Proof Smirnoff Vodka
 - » 238 gals Lemon Flavor
 - » 166 gals Lime Flavor
 - » 71 gals Orange Flavor
- Discrete (Packaging)
 - Bill of Materials (with 2.5% Loss Factor)
 - UOM: Each
 - 10,000 case Production Work Order: Smirnoff Citrus Flavored Vodka
 - » 123,000 Bottles
 - » 123,000 Metal Caps
 - » 123,000 Front Labels
 - » 123,000 Back Labels
 - » 123,000 Neck Labels
 - » 10,250 Corrugated Cases
 - » 10,250 Dividers
 - » 23,775 gals of Smirnoff Citrus 70 Proof Vodka

Bill of Material

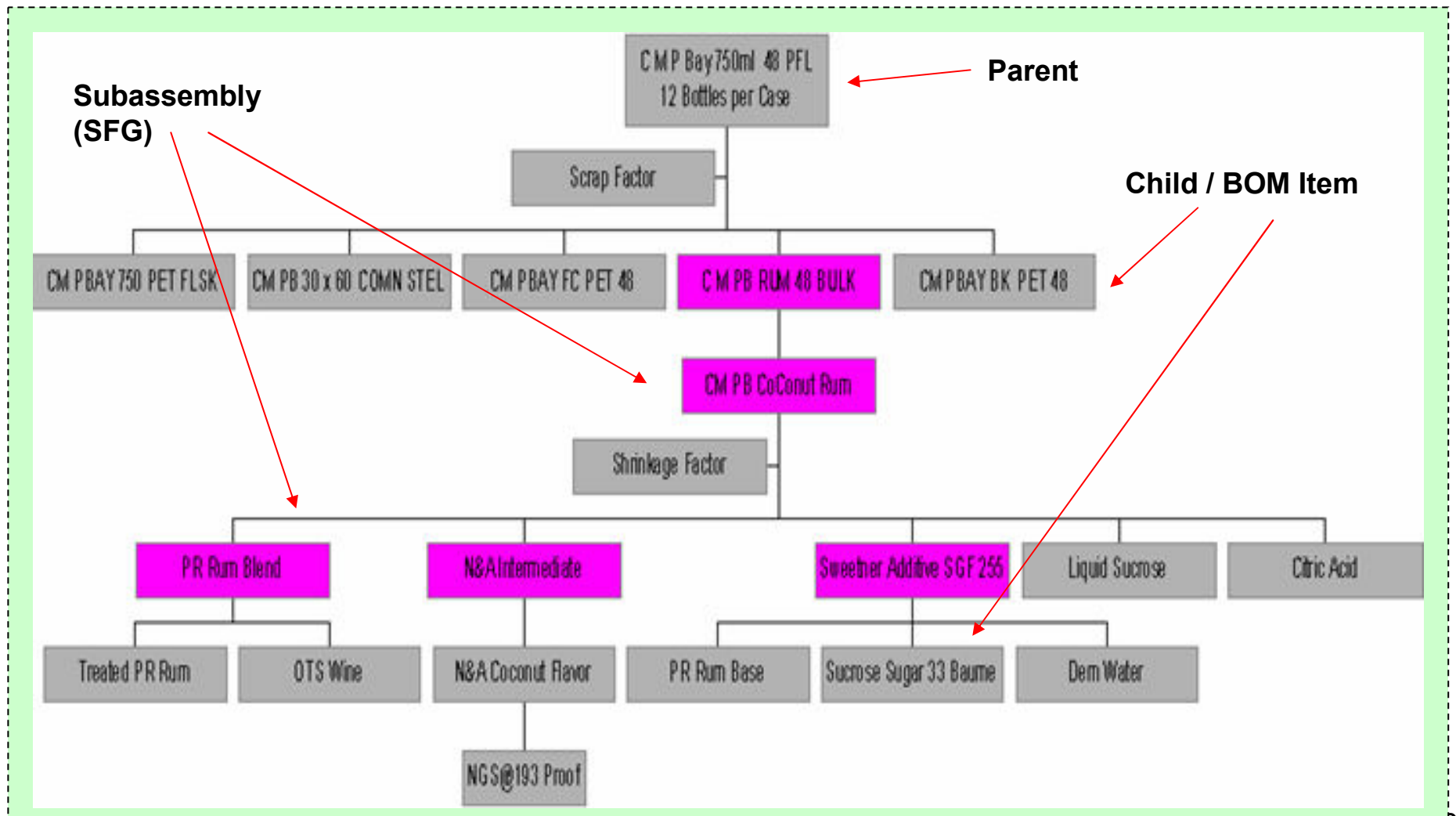
Production BOM's

- A bill of material is a formally structured list of the components 'Children' that are required to manufacture 'Parent' case goods, or bulk spirit. An example of an exploded case goods BOM is shown on the next slide
- The Components each have a material ID with the required quantity, the scrap factor and the specified unit of measure. The components are known as BOM-items.
- For the final BULK liquid there could be many layers of intermediate RAW blends.

Process Multi-Level Bill of Material



Mixed Mode Multi-Level Bill of Material



Key takeaways

- Juice – closely coupled, tight timeline.
- Spirits – longer timeline, constraints and planning remain the same
- Track & Trace – Keep detailed historical Lot information
- Once blending is started, have committed to packaging
- Difficulty is getting product to the package. Packaging is the easy part
- Can't run packaging lines if bulk liquid isn't available
- Packaging Supplier quality issues can be costly if pre-batched liquid can't be consumed in another package
- Multiple factors to take into consideration when scheduling Process & Discrete
- Can't rely only on system generated requirements
 - Systems have limitations, can't do everything
 - Pull ahead low volume items into larger common runs
- Might need to increase Pkg runs due to splitting one batch to get back into specification
- Design the blend / process system to meet anticipated market demand
 - Efficient use of assets
 - Handle low volume Innovation
- Need the right people in key positions
- Nature of hybrid Mfg requires close coordination between Process & Discrete
- Ultimately, need to meet customer requirements

Q&A

What questions do you have?