Scotsburn Dairy Production Scheduling

Andrea Friars and Glen Caissie

May 23, 2014
Agenda

- Introduction to Scotsburn and Ice Cream Production
- Past Production Scheduling
  - Manual process
  - Based on limited, short term information
- Present Production Scheduling
  - Hierarchical Scheduling
  - New Gram Line Installation
- Future Production Scheduling
  - Where Scotsburn is headed
  - New challenges / improvement opportunities
Scotsburn Dairy Group

- Largest producer of ice cream and frozen novelties in Atlantic Canada
- Scotsburn brand distributed exclusively in Atlantic Canada
- Co-packer for major retailers with sales across Canada and worldwide
- Three production plants:
  - Saint John, NB (popsicles, fudgesicles) [60]
  - St. John’s, NL (premium bars, cones, sandwiches) [170]
  - Truro, NS (ice cream tubs, premium bars) [480]
Introduction to Ice Cream

1. Make mix in batches (hold < 4 days)
   - One batch makes many different SKUs
2. Add flavours and colours
3. Freeze into ice cream (no holding)
4. Add nuts, fruit, ripples, etc.
5. Fill containers
6. Blast freeze and palletise
Ice Cream Scheduling Challenges

- Demand is seasonal and highly variable
  - Last minute promotions / weather
  - 12/52 weeks of the year, sales exceed production capacity
- Sequencing constraints due to variety of allergens
- Sharing equipment across production lines
- Product shelf life of 9 months to 2 years
- Daily wash is required due to use of dairy ingredients
Production Scheduling: Past

- SCOTSBURN FRENCH VANILLA YOGOURT 11.4 L
- SCOTSBURN VANILLA I/C 11.4 L
- SCOTSBURN REG FRENCH VANILLA I/C 11.4 L
- SCOTSBURN VANILLA I/C 473 ML
- SCOTSBURN O/F FRENCH VANILLA I/C 11.4 L
- SCOTSBURN LIGHT VANILLA I/C 1 L
- SCOTSBURN LIGHT VANILLA I/C 1.89 L
- SCOTSBURN FAT FREE FRENCH VANILLA YOG 1 L
- SCOTSBURN FROZEN VANILLA YOGOURT 1.89 L
- SCOTSBURN VANILLA ICE CREAM 4 L
- SCOTSBURN LACTOSE FREE VANILLA 11.4 L
- SCOTSBURN NSA FRENCH VANILLA 11.4 L
- SCOTSBURN VANILLA I/C 1 L
- SCOTSBURN VANILLA I/C 946 ML
- SCOTSBURN VANILLA I/C 1.89 L
- SCOTSBURN FRENCH VANILLA I/C 1.89 L
- SCOTSBURN FAMILY FAVORITES VANILLA 1.5 L
The Production Meeting

- Wednesday meeting to discuss production requirements for following Monday
- Which SKUs should we produce? How much of each SKU should we produce?

- Buyer’s Guide (Billing and Inventory System)

- Last year’s promotions included, no reviews by Sales, no new products, discontinued products still included
- Sales memos (promotional notification, no volumes)
- Next 2 weeks of customer orders
- “Gut feelings” (weather, recent trends)

- Sales manager thinks we need “vanilla”

<table>
<thead>
<tr>
<th>ITEM#</th>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CASES</th>
<th>AVAIL</th>
<th>BUYER'S GUIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>07-Nov</td>
<td>14-Nov</td>
<td>21-Nov</td>
</tr>
<tr>
<td>2xxxx7</td>
<td>7</td>
<td>SCOTSBURN ORANGE PINEAPPLE I/C 11.4 L</td>
<td>202</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>2xxxx9</td>
<td>4</td>
<td>SCOTSBURN GRAPENUT I/C 11.4 L</td>
<td>314</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2xxxx6</td>
<td>3</td>
<td>SCOTSBURN CHERRY VANILLA I/C 11.4 L</td>
<td>406</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Schedule Creation

- Production manager determines line assignment and sequencing for all SKUs
  - “As Soon As Possible” first
  - No Sugar Added at the start of the week
  - 4L tubs at the start of the week
  - Yogourts at the end of the week
  - Allergens at the end of the day
  - Vanilla first, chocolate last
- Schedule is unofficially written on paper
  - Quantities based on amount of packaging on a pallet
- Not in user friendly format, not circulated, not checked for errors/omissions
- No data available from this time period
Component Procurement

- Call packaging supplier on Thursday morning for Monday
  - “Send me some vanilla tubs for Monday”
- Check this month’s inventory counts for ingredients
  - Ingredients are stocked based on gut feel each month
  - “Vanilla” flavouring
- Change schedule based on ingredient availability
  - Order additional ingredients if lacking (for later use)
- Monday morning: truck arrives with packaging
- Receiver opens doors to find out what is on truck (or not)
  - Generates a Purchase Order based on what was shipped
  - Puts vanilla packaging by production doors
Production

- Go to run vanilla - what happens next?
  - Scheduled Scotsburn 1.89L Vanilla IC
  - Packaging arrived for Scotsburn 1L Vanilla IC
  - Flavour in warehouse was for Scotsburn 1.89L French Vanilla IC
- Production calls Sales Manager to advise
- Sales Manager replies “But I wanted the 4L Vanilla IC! And by the way, we also need chocolate...”
The Need for Change

- Plant was under utilised and focused on quality, not quantity (2001)
  - Traditional methods (paper, spreadsheets, verbal) difficult to maintain and implement
  - Planning for production and inventory becoming increasingly complex
  - Hundreds of SKUs with varying production rates, costs, demand patterns, etc.
  - More allergens and allergen restrictions
  - More complicated setups
  - Opportunities for significant cost savings
Dalhousie Industrial Engineering

- Senior design project in 2003 (Marc Oostvogels, Nick Malone)
  - Yearly overview to balance cumulative production with requirements
  - Early efforts to determine run quantities by SKU by week
  - Assumed all litres were created equal

- Senior design project in 2006 (Jennifer Pryor, Kevin Ostrovsky, Stefan Linder)
  - Focused exclusively on mix loss
  - Developed the basis for mix loss tracker
Dalhousie Industrial Engineering

- Master of Applied Science in 2007 (Andrea Friars)
  - Joint venture between Scotsburn and Dalhousie
  - Funded by Scotsburn, NSERC, MITACS
  - Supervised by Dr. Corinne MacDonald and co-supervised by Dr. Eldon Gunn

- Production Management System
  - Database for storing schedule, product formulations
  - Utilise Material Requirements Planning
  - Facilitate communication between departments

- Thesis focused on long and medium term scheduling
  - Yearly labour and storage plan (Model A)
  - Weekly production quantities by SKU (Model B)
Production Scheduling: Present

- Master’s project led to full time employment as Industrial Engineer

- Work includes:
  - Long term production planning for all facilities
    - Manage utilisation of plant capacity
    - SKU assignment by branch
    - Advising on new business
  - Improving medium and short term production scheduling
    - Production and Inventory Management System
    - Continuous improvement projects
Hierarchical Production Planning

- Long Term (Strategic) 1 year
  - Labour plan / plant capacity
  - Storage requirements
  - Decision makers: Myself, Operations, Finance, Sales

- Medium Term (Tactical) 1-2 months
  - Schedule SKUs and volume by week
  - Decision maker: Production Scheduler

- Short Term (Operational) 1-2 weeks
  - Daily line assignments, product sequencing
  - Decision makers: Production Scheduler / Manager
Hierarchical Considerations

- Levels may have conflicting goals
  - Operations wants to run 1 flavour per line per day
  - Scheduler wants to keep inventory costs low
- Difficult to evaluate all stages simultaneously
  - Complex to model
  - Computationally intensive
  - Of little value
- Partition decisions into natural hierarchy
  - Simplifies problems and solutions
  - Supports managerial input
Strategic 1 Year Plan

- Aggregate products (420) into like groups (20)
  - Similar holding costs and storage requirements
  - Similar production speeds and labour requirements

- Solve mixed integer programming problem
  - Objective: minimise holding and labour costs
  - Constraints:
    - Meet demand
    - Warehouse capacity
    - Production capacity by labour scheme
  - Output: Weekly labour scheme and storage requirements

- Re-solve the model on a rolling horizon or as needs dictate
Strategic Model A Results

Truro Production Plan

- Required
- Planned

[Graph showing production plan from January 2014 to December 2014 with increasing trend]
Tactical 1-2 Month Plan

- Constrained by the Strategic labour scheme
- Maximise utilisation of plant capacity
- Aggregate products (420) into families (115)
  - Shared set up costs
  - Same mix and allergens
- Solve mixed integer programming problem
  - Objective: minimise holding and setup costs
  - Constraints:
    - Meet demand and safety stock levels
    - Utilise all available production capacity (Model A)
- Output: family schedule by week (only implement 1 week)
- Used to order ingredients and packaging
Tactical Scheduling Challenges

- Advantage of families is shrinking
  - More mixes: from 30 to 60
  - More allergens: pistachio, fish oil, no more “tree nuts”
  - Smaller families = less cost saving opportunities

- Upcoming schedules are based on expected attainment
  - If a product in a family doesn’t get produced, we’ve lost our cost savings

- Very sensitive to upcoming forecast
  - Necessitates frequent updates for improved accuracy

- Daily cleaning is like a reset button every morning
Operational Scheduling

- **Objective:** Sequence products to minimise changeover costs
- **Input:** Production quantities (Model B)
- **Constrained by:**
  - Labour scheme (Model A)
  - Allergen rules
  - Mix tank capacity
  - Product type (lactose-free run 1st)
  - Line restrictions
  - Shared line equipment
- **Manual process for the production scheduler**
Production Scheduling - Future

- Develop Model C to schedule products by line
  - Determine whether we have sufficient means to meet current requirements
  - Assess expected improvements to schedule to justify capital investments
  - Eliminate last minute changes to plan because conflicts were not caught sooner
  - Use to ensure Model B results are valid without actually committing to a schedule yet
  - Need large amounts of sequencing data!
Production Scheduling - Future

- Acquiring new plant in Lachute, QC
  - Proximity to market a bigger factor
  - How do they schedule production? What are the challenges? What do they do better than us?

- Constantly working to improve customer relationships
  - Better notification of promotions or changes in orders
  - Sales team working on real-time forecast updates
  - Consolidate similar products to utilise the same mix and components
Gram Installation Project

- Premium stick bars
- One in NL at maximum capacity
- Largest market growth potential
- Installed one in Truro in February 2014

- Strategic
  - Split up volume among both plants
  - Easy products in Truro
  - Truro line runs 30-50% faster than NL’s

- Tactical
  - Time each handoff so we don’t stock out
  - Customer approval required
NEW FOR 2014

Butter Maple MMMadness: Creamy butter toffee flavoured ice cream with a sweet maple fudge ripple and chewy chunks of maple fudge make for magnificent, mouth-watering maple madness for your taste buds. MMMmMM! (SLP)
Salted Caramel Cookie Chunks: Sweet and creamy vanilla flavoured ice cream with chunks of cream filled chocolate cookie pieces and ribbons of salted caramel swirling throughout. Like your hand in the cookie jar, it’ll be tough to keep from scooping more! (G.S.W)
Sprinkled Marshmallow Sundae: Ripples of butterscotch swirl through mounds of marshmallow flavoured ice cream with a multitude of chocolate sprinkles to create a sundae in a scoop. (S)

Birthday Party: Sumptuous round cake pieces with ribbons of blue icing and lots of rainbow candy sprinkles in yummy vanilla flavoured ice cream is the perfect way to celebrate any occasion. (W.G.S.E.S)
Black Raspberry Cheesecake: A premium cheesecake flavoured ice cream with sweet black raspberry fruit purée swirled throughout. Delicious! Melt-in-your-mouth pink bubble gum pieces in blue bubble gum flavoured ice cream. (G.S.W)
Buttermilk Pizzazz: This smooth creamy taste of buttery flavoured ice cream with loads of chunky roasted pecans. (N)
Butterscotch Ripple: Sweet ribbons of butterscotch swirl throughout deliciously creamy vanilla flavoured ice cream.
Chocoholic Confection: Caramel flavoured ice cream ripples with thick caramel and a “touche” of chocolate covered covered marshmallows. (S)
Cherry Vanilla: Vanilla flavoured ice cream with bits of juicy, red maraschino cherry pieces.
Chocolate Truffle: The fine blend of cocoa and sweet creamy ice cream creates a taste of chocolate perfection.
Chocolate Chip Cookie Dough: Like eating a batch of mom’s soft, chewy chocolate chip cookie dough with sweet creamy ice cream, and mini chocolaty chips. (G.S.W)
Choco Fudge: Gooey milk chocolate flavoured ice cream loaded with chocolate chips and a rich fudge ripple swirled throughout. (S)
Chocolate Peanut Butter Portifino: Swirls of thick peanut butter ripple and chocolate covered peanut butter cups nestled in rich chocolate ice cream. (S)
Cowgirl Cream: The unmatchable flavour of the country for that everyone loves.
Death By Chocolate: Rich dark chocolate ice cream with a superb chocolate ripple sprinkled with chocolate brownies and dark chocolate chunks. (G.S.W)
French Vanilla: A traditional recipe using whole cream, sugar, egg yolks and French vanilla flavour creates this ice cream masterpiece. (E)
Gold Mina: Swirls of caramel and chocolate ice cream with ribbons of toffee ripple.
Grapefruit: A unique grapefruit flavoured ice cream filled with the crunchy goodness of grape nuts for a surprisingly delicious treat. (G.W.S)
Heavenly Halo: Crunchy almond pieces with spoons of chocolate chips overflowing in a river of marshmallow and sweet chocolate ice cream for a taste of heaven. (N)
Mocha Magic: Rich and creamy toffee flavoured ice cream swirled with a chocolate fudge ripple and overflowing with heavey melt in your mouth chocolatey caramel cups. (S)
Lactose Free Vanilla: Smooth and creamy lactose free vanilla flavoured ice cream for those who are lactose intolerant. (N)
Molten Volcano: Crunchy roasted walnuts in maple flavoured ice cream. (N)
Marzipan: A creamy light ice cream with citrus and lime flavoured puree blended together to give a refreshingly zesty taste of the tropics.
Mr. Frothy Mochaccino: Winter’s left behind this delicious treat of milk in your mouth vanilla flavoured ice cream, with ripple of peanut butter and a smile of real chocolate chips. Make it a triple scoop! (S)
Pumpkin Chiffon: A mix of banana, spice and bubble gum flavoured ice cream; study out of this world.
Puddin’ on the Loose: Super rich and rich, creamy frozen chocolate mousse; a truly unique taste sensation.
Rum Sugared Almond Vanilla: Creamy and full flavoured with 50% less sugar. Creamy vanilla flavoured ice cream (sweetened with maltitol-based sorbitol).
Orange Pineapple: Tangy chunks of citrus in orange flavoured ice cream.
Peppered Fudge Ripple: A delectable pepper ice cream with a rich fudge sauce and graham cracker crunch pieces. (G.W.S)
Pina Colada: A sweet exotic coconut pineapple flavoured light ice cream with bits of creamy coconut for that true tropical taste of paradise.

Puppy Paws: A chocolate fudge ripple with chocolate covered caramel cups in a delicious, soft, flavoured ice cream. (S)
Strawberry: Delicious,Ship, and strawberry in strawberry ice cream.
Strawberry Daquiri: The perfect balance of sweet strawberries, citrus pith and lime ‘flavoured ice cream with creamy light ice cream to tempt your tropical tummy. (S)
Tiger: Tiger coloured ice cream with dark chocolate stripes.
Toffee Fudge: Toffee, toasted almonds and flourless caramel bits in butterscotch flavoured ice cream. (S)
Udderly Divine: Cold and creamy vanilla flavoured ice cream smothered with chewy chocolate fudge and loaded with delicious chocolatey peanut butter cups. (G.S)
Vanilla: Sweet, classic vanilla is naturally vanilla which makes this smooth and creamy ice cream perfect with anything. The cream of the crop!
Wild Blueberry: Chunky blueberryripple running wild in blueberry flavoured ice cream.

Frozen Yogourt With 60% Less Fat Than Ice Cream

French Vanilla: The smooth flavour of French vanilla blended with our frozen yogourt mix to create a product comparable in flavour to our French vanilla ice cream but with 60% less fat.
Fudge Brownie: Low fat vanilla flavoured frozen yogourt with swirls of chocolate fudge and chewy chocolate brownie pieces.
G.S.W
Strawberry: This unique, low fat flavour sensation, just the right level of tartness brings out all the delicious fruity flavour.

100% CANADIAN MILK

ALLERGY INFORMATION: (N) CONTAINS TREE NUTS AND/OR MAY CONTAIN UNDECLARED NUT RESIDUES; (G) CONTAINS GLUTEN; (W) CONTAINS WHEAT; (P) CONTAINS PEANUTS; (E) CONTAINS EGG; (S) CONTAINS SOY PRODUCTS; (SLP) CONTAINS SULPHITES. ALL FLAVOURS CONTAIN MILK INGREDIENTS AND ARE MANUFACTURED IN A FACILITY THAT PROCESSES PRODUCTS CONTAINING PEANUTS, TREE NUTS, AND INGREDIENTS THAT CONTAIN EGGS, SOY, WHEAT AND SULPHITES.