



Changing the rules of business™

# From Planning to Operations: The Ever-Shrinking Optimization Time Horizon

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# Deriving Benefit from Increased Solver Power



- Revisit previously shelved applications
- Build bigger, more accurate models
  - *Example:* Recent supply-chain model with 10 million constraints, 19 million variables (solve in 1.5 hours)
- Optimize “globally”, over entities that were previously treated separately
- *Move from the traditional Operations Research domain of planning to (real-time) operations: Business execution*

# Three Success Stories



## Using real-time optimization

### **“Tales from the cutting edge”**

Ann Bixby & Brian Downs, Aspen Technologies

### **“The dance of the thirty-ton trucks”**

Martin Durbin, Decisive Analytics

Karla Hoffman, George Mason University

### **Real-time production-line scheduling for front-end semiconductor fabs**

ILOG

- **Each of these applications uses optimization**
  - Linear and Mixed-Integer Programming
- **Question: Did increased solving power really make a difference? Could we have done this 5 years ago?**



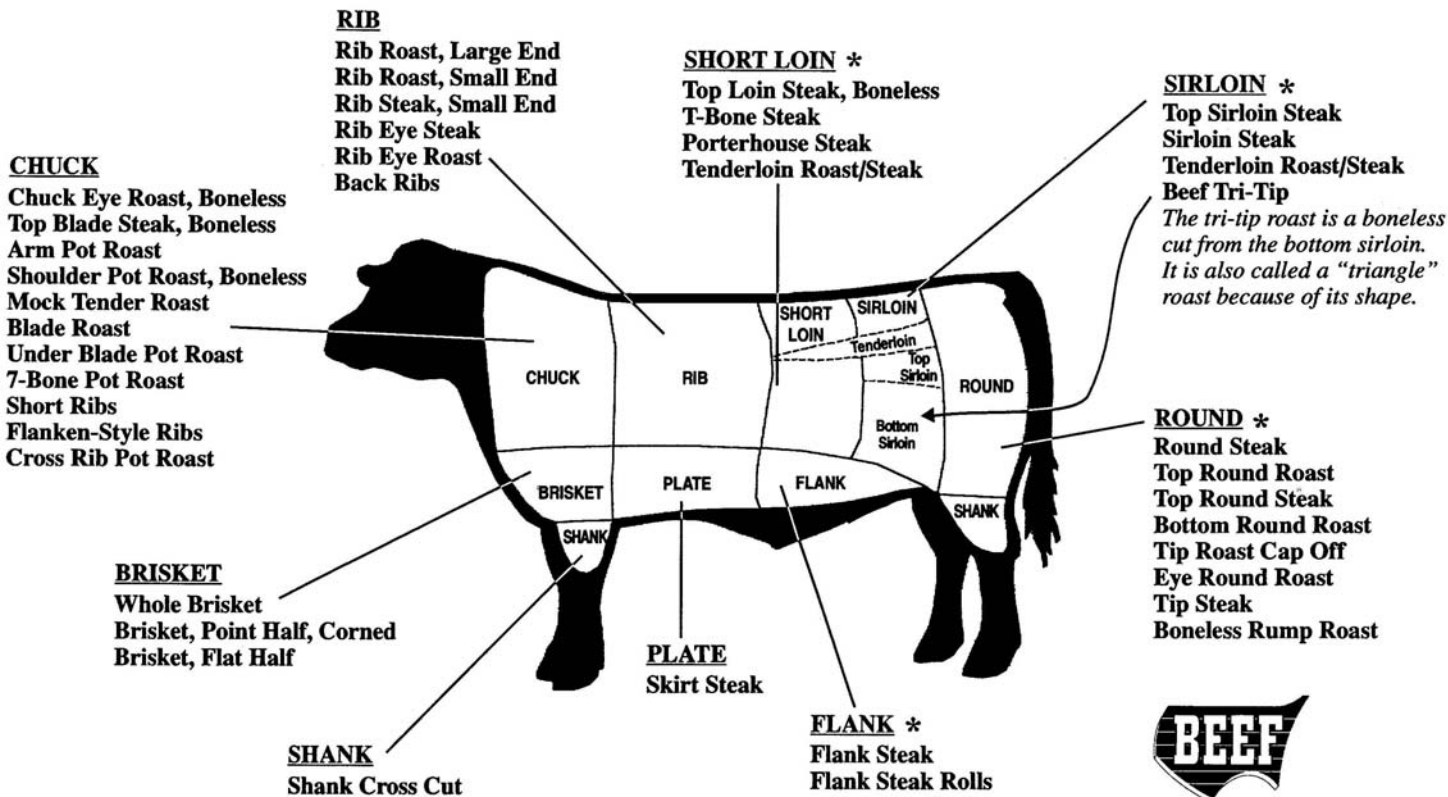
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**Tales from the Cutting Edge: A  
real-time capable-to-promise  
model for meat disaggregation  
at Swift & Co.**



# — BEEF CUTS —

## Where They Come From



National Cattlemen's Beef Association  
 444 North Michigan Avenue  
 Chicago, Illinois 60611  
 (312) 467-5520

\* Beef primals that feature cuts lowest in fat.

# Beef Disaggregation



- **The problem**

- 5 meat processing plants
- Carcass inventory at each plant at shift start must be processed by shift end. Cut into 7 primals, USDA graded, “disaggregated” into pieces, and packaged.
- This process must be scheduled, taking into account existing orders and *current forecast*.
- **Schedule must interact with the sales process.**

# A Carcass Disaggregation Tree



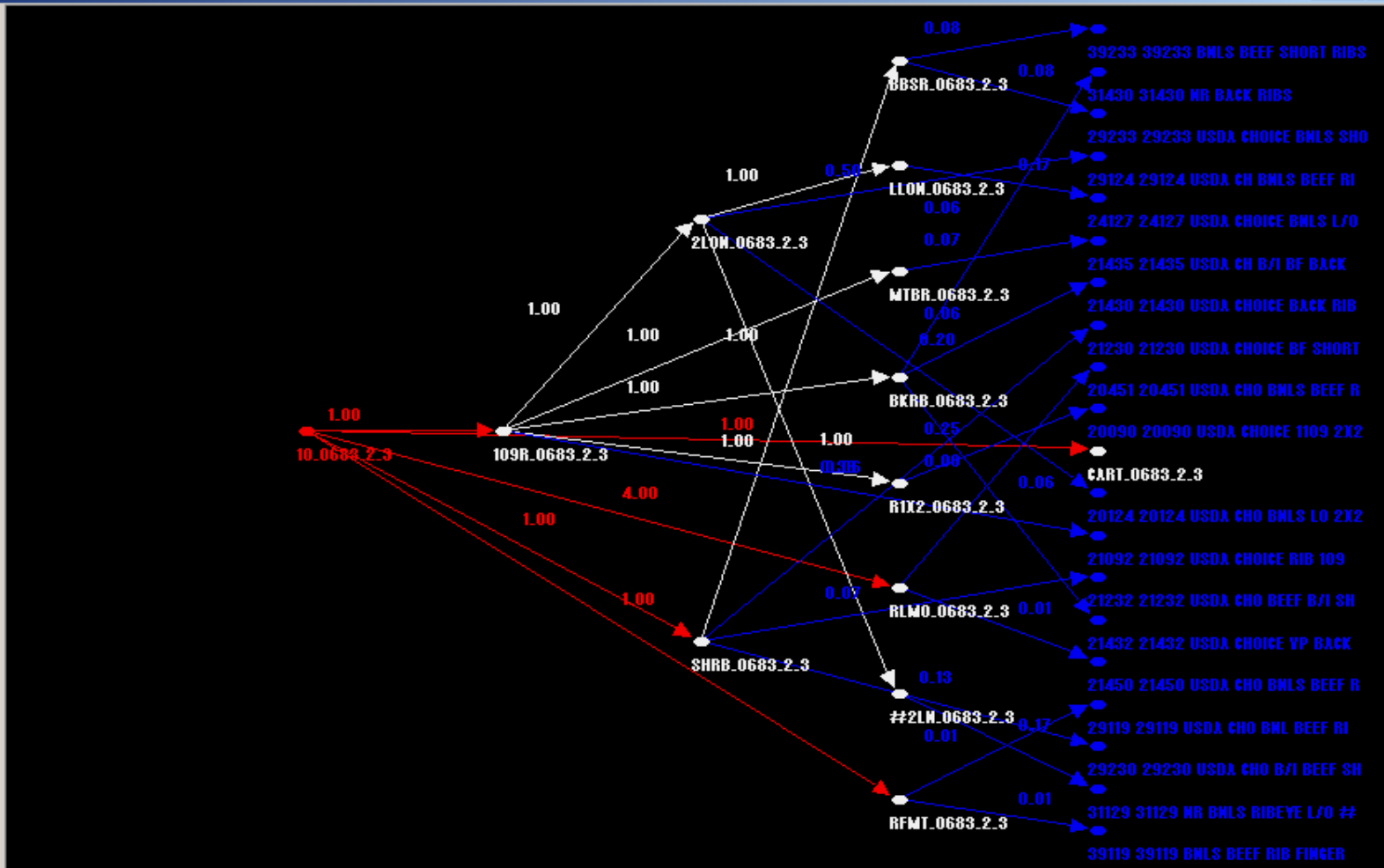
MIMI - 501BBD\_NON\_OPT

File Data View Menus Options Window Help



## Beef Disaggregation

- [-] Pack. Operations
  - [+] Carcass Data
  - [+] Inventory Data
  - [+] Demand Data
  - [-] Production Data
    - [-] Cutting Opr. Costs
    - [-] Pkg. Opr. Costs
    - [-] Frozen Cutting Sch.
    - [-] Frozen Pack. Sched.
    - [-] Carcass Disagg.
    - [-] Bill of Materials
    - [-] Condemnation %
    - [-] Fin. Prod. Recipes
    - [-] Disagg. Diagram
    - [-] RCODE Limit Def'ns
    - [-] RCODE Limits
    - [-] FIN Limit Def'ns
    - [-] FIN Limit
- [+] Solution Generation
- [-] Solution Analysis
  - [+] Schedule Report
  - [+] Revenue Report
  - [-] Detail Reports
    - [-] Raw Material Usage
    - [-] Cut Schedule
    - [-] Co-Prod. Production
    - [-] Piece Production
    - [-] Box Production
    - [-] Fresh Sales
    - [-] Frozen Sales
    - [-] Fresh Short Dem.
    - [-] Frozen Short Dem.
    - [-] Fresh Inventory
    - [-] Frozen Inventory
    - [-] Inv. Storage Viol'n.
    - [-] RCODE Lim. Viol'n.
    - [-] FIN Lim. Viol'n.
- [+] Summary Reports
- [-] Scenario Management



Select Primal:

10.0683.2.3

View Co-Products for Selected Node



# What Drove the Application



- **The process**

- The schedule decides for each carcass a full disaggregation and packaging plan.
- When you take an order, you would like to know what you are “capable” of supplying, not just what’s in the schedule. This requires “moving up the tree”: **HUMANS can’t do it – not during a sales call!**

- **The result**

- Lost sales, unfulfilled orders, dissatisfied customers.

# Beef Disaggregation



## The solution

- Started as 1 million variable “textbook” LP model.
  - After one year of model reductions (many very complex), the model was reduced to meet memory and *resolve-time limits (< 10 seconds)*
- The Environment:
  - 300 queries and commits (LPs) handled per hour by each model
  - A total of 45 models are running fully automated handling queries and commits 24 hours per day
- The savings:
  - **\$13 million/year (determined by internal benefits study)**
  - **Inventory sold increased from 10% to 80%**
  - **Most important: Business changed fundamentally**

# An LP Instance from a CTP Model



**Size: 241321 constraints; 297517 variables**

- Resolve-time requirement:** **<10 seconds**
  
- Query solve:** Resolve from advanced basis with a small number of added rows and columns
  - CPLEX 9.0 (2004) 0.7 secs
  - CPLEX 5.0 (1997) 1.2 secs
  - CPLEX 1.0 (1988) 4.4 secs
  
- Machine speed adjustment:**
  - CPLEX 5.0 (1997 PC -- 20x slower) 24 secs

**Was increased solving power essential to this application?**