Demand-Driven Forecasting

Charles.Novak@Jaguar-APS.com
Who we are and what we do....

Our Services
- Training Programs
- Opportunity Assessment
- Business Transformation
- Package Selection
- On-Demand

Some of our clients....

Who needs forecasting?
Forecasting Where?

- Time series forecasting is applicable to almost all organizations that work with quantifiable data.
  - Retail stores forecast sales
  - Energy companies forecast load and reserves, production, demand and prices
  - Educational institutions forecast enrollment
  - Passenger transport companies forecast future travel
  - Banks forecast new home purchases
  - Service companies forecast staffing needs
  - Hospitals forecast surgeries
  - FMCG forecast demand for their products
  - Other …
Introduction: Recent Developments

Demand forecasting drives real value within the supply chain.

Demand-driven forecasting has become a discipline that senses, shapes and responds to the real demand.

Predictive analytics used to:

- Uncover patterns in consumer behavior.
- Measure effectiveness of marketing investment.
- Optimize financial performance.
- Shape and proactively drive demand using what-if simulations.
- Sense demand signals and shape the future demand supported by data mining technologies.
Predictive Analytics and Supply Chains

**Why Not**
- Cost perceived too high
- Focus on investments that provide immediate and tangible results.
- Too complex to connect the data nodes across extended supply chain.
- Big data is a distraction at the moment.
- Skillsets in supply chain and IT are limited.
- Disconnect between the need and silo managed IT and other departments.
- Demand planning not a Core Competence.

**Why Yes**
- Strong potential to transform the way in which supply chain managers lead and supply chains operate.
- Senior management’s need to grow the business profitably.
- Multi-echelon supply chains require quick and correct signals to operate effectively.
- “Heads-up” to help sense, analyze, and better respond to market changes.
- Data equals information and information equals profit.
- Pressures to synchronize demand and supply to understand why consumers buy products.
Data Mining

- **Descriptive analysis**
  - **Association** - looking for patterns where one event is connected to another event.
  - **Sequence or path analysis** - looking for patterns where one event leads to another later event.
  - **Classification** - looking for new patterns. (May result in a change in the way the data is organized but that’s ok.)
  - **Clustering** - finding and visually documenting groups of facts not previously known.

- **Predictive analysis**
  - **Forecasting** - discovering patterns in data that can lead to reasonable predictions about the future (This area of data mining is known as predictive analytics.)

Data mining is sorting through data to identify patterns and to establish relationships.
Managing by Analytics

- Analytics resolve differences of opinion.
- Initial discussion based on opinions but has to be supported by numbers.
- Cross-functional involvement to improve alignment.
- Typically, managing by analytics is a MAJOR CHANGE.
- Teams work best when analytics rule discussion.
Demand-Driven Forecasting & Supply Chain

- Demand Translating
- Demand Shaping
- Demand Sensing
- Demand Orchestration
- Demand Sensing
- Demand Shaping
- Demand Orchestration
Monthly Demand-Driven S&OP Process

Step 1: Run Forecast Reports

Step 2: Demand Planning Phase

Step 3: Supply Planning Phase

Step 4: Pre-S&OP Meeting

Step 5: Exec. S&OP Meeting

Management Forecast

Statistical Forecasts

End of Month

Capacity Constraints

Recos and Agenda for Exec. S&OP

Decisions Authorized Game Plan

Demand Orchestration

Demand Shifting Demand Shaping

Demand Sensing Demand Shaping

Source: T.F. Wallace
Traditional

- Static analytical methods based on trend and seasonality.
- Aggregate level (SKU national, SKU market, …)
- Manual overrides to history and/or future – judgemental approach.
- Standalone product generation strategies and rigid monthly process.
- Does not capture changing market dynamics.

Demand-Driven

- Shift from trend and seasonality to dynamic demand signals
- Focus on demand-driven framework of shaping and sensing, and orchestrating demand across products, geographies, channels, and customers.
- Integrated, focused, analytic-driven process supported by predictive analytics, market intelligence, more sophisticated technologies.
- ‘Real-time’ forecasting based on market volatility and dynamics – sensing demand signals weekly and managing demand orchestration daily for rapidly changing markets.

What is Demand-Driven Forecasting?
Inside-out (Push) strategy issues

“If replenishment takes care of inventory problems, what caused the inventory problems in the first place?”

- Downstream demand accumulated ad presented as aggregate total.
- Delay in the initial demand from original customer.
- Service level need is an average.
- Upstream supply expected to be at 100% service level.
Supply Chain Trends… Evolution from Push to Pull

Push / Inside-Out

- SELL what you MAKE
- Is the demand the result of consumption at a store level?
- Is the demand upstream the result of the downstream consumer demand or the downstream warehouse demand?
- How long is it before a forecast becomes true demand?
- Does the demand signal become true just because you believe it to be true?

Current supply chains catch orders and shipments and assume that they are representative of the market.

Pull / Outside-In

- MAKE what you can SELL
- From INSIDE-OUT to OUTSIDE-IN
- It is all about intellectual property, managing, and owning the channel, and products from manufacture to their sale in the market and alert the right person at the right time to make the right action.

Supply chain leaders can sense dynamics in the market and alert the right person at the right time to make the right action.
Data Analysis

Data Patterns – Attributes and Variables
Application of SPC to Forecasting

- SPC (Statistical Process Control) focuses on Variables and Attributes in the dataset.
  - **Attributes data** = specific values that we DO EXPECT in our data
    - Level, Trend, Seasonality, Moving Holidays, Promotions, Competitive Activity, etc.
  - **Variable data** = any value that we DO NOT EXPECT / WANT in our data
    - Out-of-Stock, Trend Intervention, Irregularly Scheduled Promotion, Competitive Activity, Economics, etc.
  - Normal Distribution - Control charts
Understanding Your Data

- Line graph is ideal for visualization of time series.
Recognizing Data Attributes

Level
Recognizing Data Attributes

Level

Trend
Recognizing Data Attributes

Level

Trend

Seasonality
Recognizing Data Attributes & Variables

Trend @ 36, 24, & 12 periods
Recognizing Data Variables

Pipeline Fill — Unrealistic Trend

Expected Trend
Recognizing Data Variables

Negative Sales
Recognizing Data Variables

Trend and intervention

![Graph showing trend and intervention]
Recognizing Data Variables

Missing Data
Recognizing Data Variables

Lumpy / Intermittent Demand
Recognizing Data Variables

High Variability / Short History
Data Patterns

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<th>Type</th>
<th>Act$</th>
<th>Act$/Fct$</th>
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<td>10,585,250</td>
<td>13,329,607</td>
<td>13,329,607</td>
<td>17,899,919</td>
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- Is this product stable or dynamic?
- Are there any changes in data that we need to build in the forecast?
- Are there any issues we need to correct?
- Is this product trended?
- Is this product seasonal?
Are there any changes in data that we need to build in the forecast?

Is this product stable or dynamic?

Are there any issues we need to correct?

Is this product seasonal?

Is this product trended?

With help of SPC and visualization of the data, the questions can be answered with more accuracy than just a gut feel.
Recognizing Data Variables: Sigma Alert

- Standard deviation of last six months history is significantly higher/lower than previous 18 months.
- Indicates change in recent history that needs to be understood and either cleansed or incorporated in forecast adjustments or forecast model.
Data Pre-Processing / Cleansing

- **Extreme Values**
  - Unusually large or small compared to other values in series (Outliers).
  - Unusually different values within the series close to mean (Inliers).
  - **Automatic versus manual correction of Extreme Values**
    - Most forecasting systems can do it. Not all can do it well. Use judgement and domain knowledge to remove or keep it.

- **Choice of Time Span**
  - How many historical periods will be used for the forecast?
    - Simple Exponential Smoothing and Averages need 2-3 values
    - Double Exponential Smoothing needs 4 values
    - Triple Exponential Smoothing needs 24-36 monthly or 154 of weekly values
SPC Control Chart: Identifying Patterns

Center value and UCL/LCL definitions: There is a difference between Mean and Median, 1σ and 3σ, … Rule of thumb – start with Mean 18 Months and 1.5σ
Data Segmentation
Segmenting Products to Choose Appropriate Forecasting Method

- Time series analysis $\Rightarrow$ demand patterns $\Rightarrow$ forecastability.
- Value to the company + forecastability $\Rightarrow$ correct forecasting method.

Source: Charles Chase, SAS
Data Segmentation - Forecastability

High Volume / Low Variability
- High Runners
- Commodities
- Predictable

High Volume / High Variability
- Seasonal Items
- Promotions
- Short Lifecycle
- Determine if variability is predictable (Seasonal)
- Disruption Spikes

Low Volume / Low Variability
- Consistent low runners
- Longer Lifecycles
- Predictable
- Disruptions can have big impact (often tied to lead time)

Low Volume / High Variability
- Specialty Items
- Custom Orders
- Can Have High Margins
- Consistent Disruptions
- Often Tied to Other SKUs

Source: Gartner
Data Segmentation - Forecastability

HIGH VARIABILITY, LOW VOLUME, 287

HIGH VARIABILITY, HIGH VOLUME, 393

LOW VARIABILITY, HIGH VOLUME, 16

LOW VARIABILITY, LOW VOLUME, 38

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<td>BNDR TTL BRAND</td>
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<td>BNL LARGE</td>
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<td>BNL OPEN STOCK</td>
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<td></td>
<td>BNL SMALL</td>
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<tr>
<td></td>
<td>BNL TTL BRAND</td>
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<tr>
<td></td>
<td>LMW base</td>
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<td>LMW base TTL</td>
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<td>LMW PROMO TTL</td>
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<td>LMW TTL BRAND</td>
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</table>

LOW VOLUME

HIGH VOLUME

LOW VARIABILITY

HIGH VARIABILITY
Four Quadrants Based on Portfolio Management

**New Products**
- **Product Line Extensions:** (Evolutionary New Products). Some ‘Like’ history available.
- **Short Life Cycle Products:** Many ‘Like’ products available.
- **New Products:** (Revolutionary New Products) No ‘Like’ history available.

**Growth Brands**
- **High Priority Products:**
  - Strong Trend
  - Seasonal Fluctuations
  - Possible Cycles
  - Sales Promotions
  - National Marketing Events
  - Advertising Driven
  - Highly Competitive

**Niche Brands**
- **Low Priority Regional Specialty Products:**
  - Some Trend
  - Seasonal Fluctuations
  - Irregular Demand
  - Local Targeted Marketing Events

**Harvest Brands**
- **Low Priority Products:**
  - Strong Trend
  - Highly Seasonal
  - Possibly Cycles
  - Minor Sales Promotions

Source: Charles Chase, SAS
Statistical Methods Selection Based on Segmentation and Portfolio Management

New Products
- High Value
- Low Forecastability

Company Value

Niche Brands
- Low Value
- Low Forecastability

Growth Brands
- High Value
- High Forecastability

Harvest Brands
- Low Value
- High Forecastability

Judgmental
- ‘Juries’ of Executive Opinion
- Delphi Committees
- Sales Force Composites
- Independent Judgment

Causal Modeling
- ARIMAX
  - ARIMA with Interventions and Regressors
- Simple Regression
- Multiple Regression

Multiple Methods
- Combined average:
  - Judgment, Time Series, Causal
- Combined Weighted:
  - Judgment, Time Series, Causal
- Croston’s Intermittent Demand

Time Series
- ARIMA Box-Jenkins
- Winters 2 / 3 Parameter Decomposition
- Simple Moving Average
- Holt’s Double Exponential Smoothing

Forecastability

Source: Charles Chase, SAS
Forecasting Outside-in

Linking Market Data to Shipments – Simplified Example
MTCA – Multi-Tiered Causal Analysis

“Integrating consumer demand into the demand forecasting process to improve shipment (supply) forecasts has become a high priority in the FMCG/CPG industry as well as in many other industries over the past several years.”

Charles Chase, SAS

- Past constraints are becoming non-issue today:
  - Data collection and storage
  - Computing power available
  - Data synchronization capabilities
  - Analytical expertise

- MTCA, a process of nesting causal models together using data and analytics, considers marketing and replenishment strategies jointly, rather than creating two separate forecasts.

Source: Charles Chase, SAS
Growth brand — traditional forecasting approach

What do you think?
Pretty good forecast — isn't it?
Not so fast ...
### MTCA – Multi-Tiered Causal Analysis

#### Market Data from ACNielsen
- Factory shipments

#### Table: 2002 Q4

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<tr>
<th>CATEGORY ($)</th>
<th>ACT</th>
<th>Dec-02</th>
<th>Jan-03</th>
<th>Feb-03</th>
<th>QTR-1</th>
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<tr>
<td>FMCG/MA</td>
<td>30,077,792</td>
<td>2,039,611</td>
<td>2,396,923</td>
<td>2,746,827</td>
<td>2,412,494</td>
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<tr>
<td>FMCG/VNA</td>
<td>59%</td>
<td>74%</td>
<td>74%</td>
<td>4%</td>
<td>2%</td>
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<tr>
<td>Brand SHARE</td>
<td>60%</td>
<td>62%</td>
<td>61%</td>
<td>59%</td>
<td>61%</td>
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<tr>
<td>PPR Shipments</td>
<td>15,950,664</td>
<td>714,011</td>
<td>620,250</td>
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<td>All Outlet Consumption ($)</td>
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<td>2,270,792</td>
<td>2,770,292</td>
<td>2,952,367</td>
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</table>

**ACNielsen:**
- CATEGORY ($): 30,077,792
- Dec-02: 2,039,611
- Jan-03: 2,396,923
- Feb-03: 2,746,827
- QTR-1: 2,412,494

**PPR Shipments:**
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- All Outlet Consumption ($): 2,539,023

**All Outlet Consumption ($)**
- 2012 Q4: 2,539,023
- Coverage Factor: 86%

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- Jan-03: 2,396,923
- Feb-03: 2 Market data from ACNielsen
1. Data Analysis

Comparisson of category consumption and forecast with all outlet consumption for brand. Strong correlation between the two variables is confirming original assumptions of category influencing brand consumption.
2. Development of Consumption Forecast

Running two regressions: first to validate the model, second to use the model to generate forecast for the brand's consumption.

### Regression 1: Last 4 Periods Out of Sample

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<th>b</th>
<th>SE X</th>
<th>SE Y</th>
<th>R²</th>
<th>F</th>
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<th>SS Reg</th>
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- **Bias**
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  - 1,997,206: (131,092)
  - 1,772,187: (44,406)
  - 1,724,543: (11,602)

- **APE**
  - 7%
  - 7%
  - 3%
  - 1%

### Regression 2: All Data In Sample

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>SE X</th>
<th>SE Y</th>
<th>R²</th>
<th>F</th>
<th>df Residual</th>
<th>SS Reg</th>
<th>SS Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.716448119</td>
<td>0.015630716</td>
<td>0.989636968</td>
<td>2100.930716</td>
<td>1.2827E+13</td>
<td>22</td>
<td>1.34319E+11</td>
<td></td>
</tr>
</tbody>
</table>

- **Bias**
  - ME: -1%

- **MAPE**
  - 4%

**Consumption Forecast**

![Graph showing consumption forecast](chart.png)

*Note: The chart shows the consumption forecast for two different periods, with blue and red lines representing historical and forecasted data, respectively.*
3. Development of Shipment Forecast Based on Consumption Forecast

Detection of lag/lead relationship of factory shipments and consumption.

**Consumption vs. Shipments**

**Correlation of Consumption with Lagged Shipments**

**Consumption vs. Lag 5 Shipments**

**Shipment Forecast based on Consumption Forecast (incl. Markup)**

Shipment forecast based on consumption.
4. Linking Consumption Forecast to Supply Chain and Internal Marketing/Sales Programs

Adding supply events and TV advertising (dummy variables) plus marketing promotions (past history and forecast) as final variables to the consumption based factory shipment forecast.

<table>
<thead>
<tr>
<th>Factory Shipment $</th>
<th>All Outlet Consumption ($)</th>
<th>Supply Event +</th>
<th>Supply Event -</th>
<th>TV ADV +</th>
<th>TV ADV -</th>
<th>PPK / Flip</th>
</tr>
</thead>
<tbody>
<tr>
<td>734,463</td>
<td>1,754,735</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>661,829</td>
<td>1,886,659</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1,114,722</td>
<td>2,077,878</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2,923,619</td>
<td>3,774,419</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,168,757</td>
</tr>
<tr>
<td>1,964,437</td>
<td>1,899,503</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>189,091</td>
</tr>
<tr>
<td>1,489,604</td>
<td>1,434,915</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>518,577</td>
</tr>
</tbody>
</table>

Final forecast (green) based on consumption, supply chain constraints, marketing and sales activity.
Comparison of traditional forecasting approach (blue) versus MTCA (red).

What would it mean to supply chain if only statistical shipment forecast was used?
### Why Haven’t Companies Embraced the Concept of Demand-Driven?

<table>
<thead>
<tr>
<th>Incentives</th>
<th>Leadership</th>
<th>Traditional view of supply chain excellence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical rewards versus horizontal processes</td>
<td>Focus: Inside out, not outside in</td>
<td>Focus on transactions not relationships</td>
</tr>
</tbody>
</table>

Source: Charles Chase, SAS
Why Haven’t Companies Embraced the Concept of Demand-Driven?

- **Incentives:**
  - As long as sales is incented only for volume sold and marketing only for market share, companies will never become demand driven. To make the transition to demand-driven, companies must focus on profitable sales growth through the channel.

- **Traditional view of supply chain excellence.**
  - For demand-driven initiatives to succeed, they must extend from the customer’s customer to supplier’s supplier. Customer and supplier initiatives usually are managed in separate initiatives largely driven by cost.

- **Leadership.**
  - The concepts of demand latency, demand sensing, demand shaping, demand translation, and demand orchestration are not widely understood. As a result, they are not included in the definition of corporate strategy.

- **Focus: Inside out, not outside in.**
  - Process focus is (today) from the inside of the organization out, as opposed to from the outside (market driven) back. In demand-driven processes, the design of the processes is from the market back, based on sensing and shaping demand.

- **Vertical rewards versus horizontal processes.**
  - In supply-based organizations, the supply chain is incented based on cost reduction, procurement is incented based on the lowest purchased cost, distribution/logistics is rewarded for on-time shipments with the lowest costs, sales is rewarded for sell-in volume into the channel, and marketing is rewarded for market share. These incentives cannot be aligned to maximize true value.

- **Focus on transactions not relationships.**
  - Today, the connecting processes of the enterprise – selling and purchasing – are focused on transactional efficiency. As a result, the greater value that can happen through relationships – acceleration of time to market through innovation, breakthrough thinking in sustainability, and sharing of demand data – never materializes.

Source: Charles Chase, SAS
Recommendations

- Understand Demand
  - By better understanding demand, companies can plan production capacity and inventory level in a more accurate fashion, minimizing the risk of lost sales opportunities.

- Collaboration and Integration
  - The ability to share information between departments within the business is essential to improving supply chain.
  - Without internal communication processes in place (Demand Planning, S&OP), the company as a whole cannot effectively collaborate with the outside entities, whether they are supplier or customers.

- Supply Chain Management
  - Increased visibility into supply decisions and constraints by providing input in the demand shaping and shifting activity will help ensure the product is available at the right place at the right time.
Thank You ☺

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