Dell’s Channel Transformation: Leveraging Operations Research to Unleash Potential across the Value Chain

Business Overview & Problem
Phil Bryant - Vice President, Sales

Business Strategy & Need for OR
Donna Warton - Vice President, Supply Chain

Innovative OR Solutions & Results
Parag Chitalia - Director, Analytics
Murugan Pugalenthi - Sr. Manager, Analytics
Karl Martin - Director, Sales Operations
Dell achieved market leadership by pioneering the direct sales model

1996
- Dell.com launched
- $1 million/day within 6 months

1997
- 10 millionth PC shipped
- 15 days of inventory levels

1999
- #1 in PCs in the U.S
- #1 in Workstations worldwide

2000
- Dell.com sales reach $40 million/day

2001
- #1 computer systems provider worldwide

2004
- Revenues grew from $3.5B to $49B in 10 years
In 2007, Dell launched a massive channel transformation initiative to address the changing market dynamics:

- **Commoditization**
- **Competition**
- **Emerging markets**
- **Growth**

The chart shows the following unit shares:

- **Configure to order**: 35%
- **Build-to-Stock (Ships Fast)**: 25%
- **Retail channel**: 16%
- **Build-to-Order**: 15%
- **Distributor and VAR network**: 9%
Business Strategy & Need for OR
Donna Warton
Vice President, Supply chain
Dell’s channel transformation was built on three organization-wide strategic programs:

- **BRAND STRATEGY**
  - Global Operations
  - Global Online
  - Services

- **PEOPLE STRATEGY**

- **BUSINESS STRATEGY**
Segmented supply chain, as part of Client Reinvention, addressed the needs of different customer segments.
Operations Research was leveraged to address the business challenges posed by channel transformation.

**Challenges**
- Deliver profitable growth in channels
- DNA of direct model
- Disruption to the ongoing business

**Responses**
- OR based analytics
- Change management
- Pilot implementations

Dell Global Analytics (DGA), a Center of Excellence for OR and advanced analytics helped address key challenges across the value chain.
DGA delivered high-impact OR solutions to solve key business problems across Dell

Develop
- Configuration Optimizer
  - Reduce configuration complexity
    - $40M
- Pricing Intelligence solution
  - Optimize price point for various FHC offerings
    - $6M

Market/Sell
- Online Conversion Rate Accelerator (OCRA)
  - Refine online purchase experience
    - $34M
- Marketing Investment Optimization
  - Optimize marketing spends
    - $20M
- Retail Margin Maximizer (RMM)
  - Estimate demand accurately & match with supply
    - $42M

Fulfill
- Distribution Network Optimization
  - Design a cost efficient supply chain
    - $3M
- Retail Margin Maximizer
  - Match supply
    - $42M

Support
- Dispatch Reduction Program
  - Minimize warranty parts dispatch
    - $8M

Realized margin improvement of over $140 million in the last two years
We will showcase three high impact OR solutions that supported our channel transformation strategy:

- **Configuration Optimizer**
  - Reduce configuration complexity

- **Online Conversion Rate Accelerator (OCRA)**
  - Refine online purchase experience

- **Retail Margin Maximizer (RMM)**
  - Estimate demand accurately & match with supply
Configuration Optimizer

Parag Chitalia
Director, Analytics
Configuration Optimizer was aimed at reducing the configuration complexity while maximizing revenue.

- **Configuration Optimizer**: Reduce configuration complexity
- **Online Conversion Rate Accelerator (OCRA)**: Refine online purchase experience
- **Retail Margin Maximizer (RMM)**: Estimate demand accurately & match with supply
Configuration Optimizer is aimed at simplifying our product offers - to provide what customers value most

**Problem**
- >60 million options in a single product
- <15% configurations driving 72% sales

**Objective**
Design optimal fixed configurations to meet most customer needs
The first step in building the Configuration Optimizer solution was to generate an initial set of potential configurations.

- **Commodity Selection**: Identify influential commodities
- **Bundles Generation**: Create Performance, Security & Accessibility Bundles (correlated buying preference)
- **Potential Set**: Formulate initial configurations

**Exploratory Analysis**

**Factor Analysis**

**Demand Cluster Analysis**
The objective function was to maximize revenue through the design of optimal configurations by using a quadratic function

$$\text{Maximize Revenue} = \sum_{i \in FHC} \{\text{price}_i - C_i - L_i\} \times X_i$$

Unit coverage ($X_i$) = \[\sum_{j \in \text{commodity}} \sum_{k \in \text{options}} (\text{OptionInfluence}_{ijk} \times \text{IsOptionSelected}_{ijk}) \quad \forall i \in FHC\]

Upgrade Cost ($C_i$) = \[\sum_{j \in \text{commodity}} \sum_{k \in \text{options}} (\text{UpgradeCost}_{ijk} \times \text{IsOptionSelected}_{ijk}) \quad \forall i \in FHC\]

Opportunity Loss ($L_i$) = \[\sum_{j \in \text{commodity}} \sum_{k \in \text{options}} (\text{LossDueToGap}_{ijk} \times \text{IsOptionSelected}_{ijk}) \quad \forall i \in FHC\]

Bounds
- Number of FHCs, Technology Trend, Commodity Upgrades and Cost, SOS
Configuration Optimizer solution reduced the offer complexity & led to $40M in margin improvement.

**Benefits**

- **FHC sales mix**: 30% in 2010, 50% in 2012.
  - *America Large Enterprise*

- **Configuration complexity**: 127 M in 2010, 50 M in 2011, 2.5K in 2012.

- **Commodity complexity**: 35%

- **Margin (Ocean ship & Rationalization)**: $40M
Online Conversion Rate Accelerator (OCRA)

Murugan Pugalenthi
Sr. Manager, Analytics
OCRA aimed to refine the online purchase experience while maximizing conversion rates

- **Configuration Optimizer (CO)**: Reduce configuration complexity
- **Online Conversion Rate Accelerator (OCRA)**: Refine online purchase experience
- **Retail Margin Maximizer (RMM)**: Estimate demand accurately & match with supply
OCRA addressed the changing online customer preferences in Ships Fast channel

**Objective**
- Increase purchase conversion rate and customer experience

**Problems**
- Trillions of possible design combinations
- Lower conversion rates

**Main Menu**
- 10 options

**Color**
- 20 options

**Navigation**
- 5 options

**Images**
- 12 options

**Video**
- 5 options

**Merchandising**
- 10 banners

**SubMenu**
- 5 options

**Buttons**
- 5 options

**Content**
- 5 options

**Objective - Increase purchase conversion rate and customer experience**
OCRA followed a multi-step approach to enhance online customer experience and maximize conversion rates

- **Identify conversion influencers**
  - Driver Analysis
  - Text Mining
  - Pathing Analysis
  - Benchmarking

- **Evaluate alternative designs**
  - A/B test & Multivariate test

- **Identify optimal design**
  - Webpage Optimizer
Online data volume & variety necessitated use of big data tools; a non-linear mixed integer program helped in maximizing conversion.

\[ \text{Maximize Conversion Rate} = \sum_{i \in A} \sum_{j \in B} a_{ij} \times x_{ij} + \sum_{i_1 \in A} \sum_{j_1 \in B} \sum_{i_2 \in A} \sum_{j_2 \in B} b_{i_1 j_1 i_2 j_2} \times x_{i_1 j_1} \times x_{i_2 j_2} \]

\( a_{ij}, b_{ij} \) : Influence factor on conversion rate
A : Set of components
B : Options

Component combination = \( \sum_{\forall i, j \in \text{Permissible Combinations}} \text{IsOptionSelected}_{i_1 j_1} + \text{IsOptionSelected}_{i_2 j_2} + \ldots + \text{IsOptionSelected}_{i_n j_n} = 1 \)

Load Time (T) = \( \sum_{\forall i, j \in \text{Permissible Combinations}} \text{TimeToLoad}_{ij} \times \text{IsOptionSelected}_{ij} \leq \text{AcceptableLoadTime} \)

Bound: Product price mix, Components per page, SOS, Products on promotion
OCRA improved online customer satisfaction & conversion, resulting in a margin improvement of $34M

**Benefits**

**Online Customer Satisfaction**
- 2010: 27%
- 2011: 45%
- 2012: 45%

**Revenue Per visit**
- 2010: 16% points
- 2012: Increase

**Margin (Improved conversion)**
- $34 M

**Recognition**
- 8 out of 17 at whichtest-won.com
Retail Margin Maximizer (RMM) & Overall Impact

Karl Martin
Director, Sales Operations
Retail Margin Maximizer aimed to improve retail profitability through collaborative planning of inventory & promotions.

- Configuration Optimizer (CO): Reduce configuration complexity
- Online Conversion Rate Accelerator (OCRA): Refine online purchase experience
- Retail Margin Maximizer (RMM): Estimate demand accurately & match with supply
Retail channel posed a variety of inventory management and promotion planning challenges resulting in lower profitability.

**Problem**
- Inflated forecasts
- High season-end inventory
- Delayed season transition
- Low margins due to high discounting

**Objective**
Improve retail margin using
- Proactive inventory risk management
- Effective promotions

Retail business operates through 3 annual seasons:
- Spring
- Back to School
- Holiday
The first module, Demand Sensing, drove collaborative planning using advanced time series techniques.

Demand Sensing

Like-wise FHC analysis

Demand Forecasting

Weekly Governance

Time Series

Other Factors

• Inventory
• Price
• Competitor actions
• Special events

ARIMAX

Scenario analysis

Replenishment planning
The second module, Demand Shaping, helped systematically plan & execute promotions to improve margins

**Demand Shaping**

- **Demand forecast**
- **Product lifecycle stage**
- **Demand & supply variability**
- **Competitor promotions**

**Inventory Optimization**
*Identifies FHCs with high inventory risk*

**Promotion Uplift Model**
*Identifies FHCs with high potential uplift*

**Optimization Engine**
- Which FHC to promote?
- What promotion to run?
- When to promote?
The objective function was to minimize the cost of excess and deficient inventory across the season

Minimize \(( Ce_i + Cd_i ) = C_m \alpha_p I_{eT} + C_p X + C_d \left( \frac{\alpha_d I_{eT}}{R} \right) + C_o \alpha_w I_{eT} + C_e \alpha_f I_{dT} + C_l \alpha_u I_{dT} \)

\( = \text{MarkdownCost} + \text{PromotionCost} + \text{DelayedLaunchCost} + \text{ObsolescenceCost} + \text{ExpediteOrderCost} + \text{LostOpportunityCost} \)

Constraints

- **Inventory Balance Equation with Supply Mode and Lead Times**
- **Demand elasticity (ARIMAX)**
- **Markdown + PromotionCost \leq \text{Marcom budget}**
- **ExpediteOrderCost \leq \text{Budget}**
- **ExcessInventory as % of opportunity**
RMM delivered $42M margin uplift in the retail channel & is portable across fixed configuration channels

**Benefits**

**ROI on Promotions**
- 2010: 39%
- 2012: [Star]

**Inventory**
- 2010: [Bar]
- 2012: Reduced by 52%

**Margin (Markdown reduction)**
- $42M

**Recognition**
- Best supplier award by top retailers
Change management played a key role in the successful rollout of the OR solutions.

Challenges in:

- Global Rollout
  - Regional focus groups / Collaboration

- Information Diversity
  - In-house BI - web crawler & partner insight, big data tools

- Stakeholder Buy-in
  - Embedding in strategy / Proof of concepts
These multi-channel OR initiatives delivered a margin improvement of over $140 million between 2010-12

- NPS (Customer Loyalty) score more than doubled
- Growth in services upsell
Solution Architecture

Data Sources
- Teradata DW
- Demand Manager (JDA)
- Zyme
- Omniture DW
- Merkle
- IFR, NPD & Gartner
- iPerceptions/ Verbatim

Data Preparation
- SQL/ SSIS Packages
- SAS ETL
- Business Objects
- Advanced VBA

Analytical Data Marts
- Analytical Data Mart 1
- Analytical Data Mart 2
- Analytical Data Mart 3

OR Modeling
- SAS Enterprise Miner
- Open source (R)
- SAS OR
- Rapid Miner
- SAS QC
- SAS Enterprise Guide
- SAS Forecast Studio
- JMP
- SAS IRP

Solutions
- Configuration Optimizer
  - Cut-off time: 1Hr
  - # of variables: 3000
- OCRA
  - Cut-off time: 30mins
  - # of variables: 5000
- RMM
  - Cut-off time: 40mins
  - # of variables: 7000

The cut-off time includes a feasible initial solution.
Application of OR solutions in the business processes across functions

**Configuration Optimizer**
- Over 100 product categories
- 20 quarters of order data
- 150+ countries

**Online Conversion Rate Accelerator**
- 1.5 million unique daily visitors
- Thousands of web pages
- Websites in 15 languages

**Retail Margin Maximizer**
- 40 Retailers globally
- 1200 SKUs planned annually
- 5000 promotions planned annually

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**FHC Launch Cycle**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>FHC creation</th>
<th>Approval process</th>
<th>FHC Build</th>
<th>Product Launch</th>
<th>Product Refresh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td>T-6</td>
<td>T-4</td>
<td>T-2</td>
<td>T</td>
<td>T+6</td>
</tr>
</tbody>
</table>

**Owners**
- Marketing, Product Group, DGA
- Global, regional marketing
- Manufacturing
- Sales, Global Operations
- Marketing, Product Group, DGA

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**Webpage development Cycle**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Webpage design</th>
<th>Webpage testing</th>
<th>Business approval</th>
<th>Webpage going live</th>
<th>Refine webpage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td>T-5</td>
<td>T-3</td>
<td>T-2</td>
<td>T</td>
<td>T+2</td>
</tr>
</tbody>
</table>

**Owners**
- Online team, DGA
- Webpage testing team, DGA
- Online Business Team
- Online team, OBM
- Online team, DGA

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**Retail business cycle**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Finalize product assortment</th>
<th>Life cycle volume planning</th>
<th>Promotion Planning</th>
<th>Season Launch</th>
<th>Weekly inventory Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td>T-3</td>
<td>T-2</td>
<td>T-1</td>
<td>T</td>
<td>T+1</td>
</tr>
</tbody>
</table>

**Owners**
- Marketing, Product Group, DGA
- DGA
- Marketing, DGA
- Retail Team
- Demand/Supply, DGA
The benefits were calculated by monitoring the key metrics before and after solution implementation.

<table>
<thead>
<tr>
<th>Implemented</th>
<th>Measure</th>
<th>Before</th>
<th>After</th>
<th>Margin Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Config Optimizer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• US LE</td>
<td># Commodities</td>
<td>625</td>
<td>327</td>
<td></td>
</tr>
<tr>
<td>• US Public</td>
<td># Platforms</td>
<td>68</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>• EMEA LE</td>
<td>Ocean Shipment</td>
<td>0.5M units</td>
<td>8M units</td>
<td></td>
</tr>
<tr>
<td><strong>Online Conversion Rate</strong></td>
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<tr>
<td><strong>Accelerator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• USA &amp; Canada</td>
<td>Shipsfast RPP</td>
<td>$4.30</td>
<td>$5.14</td>
<td></td>
</tr>
<tr>
<td>• UK</td>
<td>Masthead RPP</td>
<td>$3.30</td>
<td>$3.65</td>
<td></td>
</tr>
<tr>
<td>• France</td>
<td>Deals RPP</td>
<td>$3.70</td>
<td>$3.85</td>
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<tr>
<td><strong>Retail Margin</strong></td>
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<tr>
<td><strong>Maximizer</strong></td>
<td>Markdown %</td>
<td>12%</td>
<td>6%</td>
<td></td>
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<tr>
<td>• Best Buy</td>
<td>Season end</td>
<td>42 days</td>
<td>17 days</td>
<td></td>
</tr>
<tr>
<td>• Wal-Mart</td>
<td>Inventory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sam's Club</td>
<td>Promo uplift %</td>
<td>5.5%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>• France</td>
<td>RPP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• China</td>
<td>RPP- Revenue Per</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>• Japan</td>
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<tr>
<td>• USA &amp; Canada</td>
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<td>• Canada</td>
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<td>• UK</td>
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</tbody>
</table>

2011  | 2012  | Total
$25M  | $15M  | $40M
$20M  | $13.5M | $33.5M
$24M  | $18M  | $42M

RPP – Revenue Per Page