Forecasting ATE sales at Teradyne, Inc.

May 13, 2004

Kapil Dev Singh, Torben Thurow, and Truman Bradley
Agenda

• Teradyne’s business
• Problem statement
• Process comparison and analysis
  – Teradyne’s forecasting process
  – System Dynamics process
• Conclusions and insights
• Next steps
Teradyne

• Manufactures and sells equipment that automatically tests semiconductors
  – Used in wafer sort operations and
  – Final testing after packaging

• Major customers include Intel, Motorola, Texas Instruments, Analog Devices, TSMC
Problem Statement

- Teradyne sees dramatic cyclicality in its orders and struggles to efficiently adjust production to meet demand.
Teradyne’s forecasting process

• Size of ATE market correlated with total semiconductor market size
• Historically, Constant buy rate
  – ATE market = 2.5% * semi market
  – Size of semiconductor market based on external forecasts
• Recent data departs from historical trends
• Sales team provides input for market share estimates and short term forecasting based on customer input
Reference Mode Breakdown

- Growth in market size
- Oscillation in market size
- Increasing amplitude of oscillation in market size
Momentum Policies

• Internal
  – Temporary employment
  – Expandable and contractable capacity
  – Long customer lead times (order to receipt)
  – Surge capacity
  – Shorten component lead times

• External
  – Talk to customers to forecast better

Even with perfect forecasts, operational improvements will drive performance. However the effects of particular policies may not be obvious
Causal Loops – Process Insights

- Quick way to improve understanding of the industry dynamics
- Great way to capture causal relationships
- Expands viewpoint to big picture
- Valuable by themselves
- Easy to understand and work with
Causal Loops – System Insights

- Growth in market size
  - Due to growth in consumer electronics demand
  - Due to growth in semiconductor content in electronics
- Oscillation in market size
  - Due to forecasting methods and delays in capacity adjustment
- Increasing amplitude of oscillation in market size
  - Due to change in industry structure – increasing use of subcontractors
• Forces deep thought on each link of chain, hence detailed understanding of contributing factors
• Leads to revision of dynamic hypotheses
• Time consuming, hence costly
Conclusions and Insights
When to use small policy models?

- Small system dynamics models are better suited to studying internal systems than forecasting external events.
- A forecasting model is really only useful if better than current forecasting approach.
  - Numerical accuracy is important.
- A small forecasting model may lead to a better understanding of exogenous industry structure, but most firms have few high leverage policies available to influence industry structure.
Forecasting drives oscillations

• Oscillations are largely driven by the individual players in the industry trying to predict demand
  – Production decisions throughout the industry are based on demand forecasts due to long production lead times

• Reducing oscillations in the industry will require more accurate forecasting among all players
  – Decreasing forecast horizon improves accuracy and reduces oscillation
  – Decreasing time of historical trend increases responsiveness, but increases magnification
  – Sharing information between firms may also improve forecasting

• Responding quickly to changes in required capacity does not significantly affect oscillation magnitude unless forecast horizons are changed
Setting Customer Lead Times

• Longer delivery lead times increase volatility in customer orders
  – Requires customers to make longer term forecasts about equipment requirements
  – Results in less accurate ordering - cancelled orders and pushbacks may become more common

• Balance increased risks from volatility against reduced inventory risks from forcing customers to commit early prior to inventory investments
Oscillations Aren’t All Bad

• Industry cyclicality is good for total sales.
• Oscillating demand for ATE results in more ATE sales
• Testing capacity is driven by peak demand
Forecasting Isn’t Everything

• Even a perfect forecast won't solve Teradyne’s problems
• Problems stem from the rapid oscillations of demand relative to speed Teradyne can adjust inventory and capacity
• Competitive pressure makes reduction in production hard despite knowing that current growth is not sustainable
  – Customer lock-in increases the risks associated with limiting capacity
  – Large percentage of total sales are made during booms
Bullwhip effect is severe and worsening

- Disaggregation of industry leads to increased volatility
- Increasing numbers of firms in supply chain increases forecasting errors
  - Less information sharing
  - More steps in the value chain with forecasts at each step
- IDMs and subcontractors respond to different market signals and probably set ATE capacity targets differently
  - Forecasting may improve by considering IDM and subcontractor purchase decisions differently
Next steps

• Integrate insights into forecasting efforts
  – Investigate regression model including growth and size of the semiconductor market
  – Consider time delays in systems – use regression models with time lags

• Choose how to use System Dynamics in the future
  – Continue with current forecasting approach without System Dynamics
  – Continue policy model level efforts internally to improve system level understanding and improve current methodology
  – Consider value of investing in fully calibrated System Dynamics model for forecasting