LINKS Supply Chain Management Simulation

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Chapter 1: Introduction

Chapter 1 Overview

LINKS Supply Chain Management Simulation firms manage procurement, manufacturing, distribution and warehousing, transportation, service, generate demand, forecasting, information technology, and research studies. LINKS encompasses all supply chain elements: suppliers, manufacturers, distributors, retailers, and end-users.

In LINKS, you manage the supply chain of an on-going high-tech manufacturing business. Working with your team, you're in direct competition with other firms in your LINKS industry. Your goal is to improve your firm's overall financial, operating, and market performance.

The learning objectives implicit in LINKS include the following:
- Gaining exposure to all supply chain elements individually and to their associated interactions
- Appreciating the need for balance and managing trade-offs in supply chains
- Experiencing competitive dynamics in an evolving marketplace
- Appreciating information flows and integration of information with decision making
- Enhancing and encouraging fact-based analysis and decision making
- Gaining familiarity with financial statements used routinely in for-profit businesses.

Traditional financial statements, operating reports, and optional research studies provide an information-rich environment for LINKS. Information management is important within supply chain management and LINKS includes various optional information enhancements (information technology and research studies) available for a fee.

In LINKS, a multi-factor quantitative performance evaluation system is used. Financial, operating, and customer performance measures are combined to create an overall measure of performance in the style of a balanced scorecard.

LINKS is a supply chain management simulation encompassing product development, procurement, manufacturing, distribution, transportation, service, generate demand, forecasting, and information technology, plus associated research study resource options. This chapter introduces LINKS, provides a perspective on management simulation learning, and overviews the analysis-planning-implementation-evaluation cycle that you'll experience.
Supply Chain Management

Supply chain management addresses fundamental issues of controlling the planning, sourcing, making, and delivering of manufactured goods. The supply chain encompasses sourcing and procurement, production scheduling, order processing, inventory management, transportation, warehousing, and customer service.

Service is not an incidental part of supply chains for manufactured goods; it is fundamental to the customer experience. The intangibles implicit in service must be combined with the traditional tangibles associated with manufactured goods to account for the whole customer experience that the supply chain tries to deliver.

Supply chains also include information systems (IT) to monitor, control, and manage these activities. Seamless sub-process coordination and integration is the hallmark of successfully managed supply chains. Supply chain management includes consideration of partners: suppliers, carriers, and third-party providers.

In LINKS, you have the opportunity to assume management responsibility for the supply chain of an on-going high-tech manufacturing business. Working with your teammates, you are in direct competition with other firms in your LINKS industry. Your goal is to improve your firm's overall financial, operating, and market performance. Although you and your teammates have ultimate responsibility for your LINKS firm, a coach will be available to assist you throughout this exercise. Thus, you won't be alone, even at the beginning.

Why Use Simulations?

"I hear and I forget; I see and I remember; I do and I understand." – Confucius

Why use simulations in management education? Why not use traditional classroom lectures, perhaps combined with case studies? Adults learn best by doing. "Doing" involves taking responsibility for one’s actions, receiving feedback, and having an opportunity to improve through time. In management education and training settings, management simulations support learning in a non-threatening but competitive environment of the kind that real managers face every day.

Like an airline pilot flight simulator, a management simulator allows more rapid time compression,
quick feedback to the learner, and is a low-risk process (except to one’s ego). A well-designed management simulator can provide the student with a realistic education and training experience in the relative safety of a simulation’s operating environment. And, perhaps more importantly, the lessons learned in the management simulator environment occur within hours or days, not the months, quarters, or years associated with real life.

Here are the classic reasons to favor management simulations in adult-learning environments. Compared to traditional lecture/case/discussion educational events, simulations:

- Reflect active not passive participation, enhancing learning motivation.
- Apply key management concepts, especially coordination and planning.
- Demand analysis and decisions in the context of market-based feedback in the presence of thoughtful, vigilant competitors.
- Provide rapid feedback, encouraging participants to learn from their successes and failures within a relatively low-risk competitive environment.
- Provide learning variety through novel learning environments.

What Will You Learn?

"The ability to learn faster than competitors may be the only true sustainable competitive advantage." – Arie P. De Geus

The learning objectives implicit in LINKS include the following:

- Gaining exposure to all supply chain elements individually and to their associated interactions
- Appreciating the need for balance and managing trade-offs in supply chains
- Experiencing competitive dynamics in an evolving marketplace
- Appreciating information flows and integration of information with decision making
- Enhancing and encouraging fact-based analysis and decision making
- Gaining familiarity with financial statements used routinely in for-profit businesses.

Beyond these learning objectives, other subtle learning goals include improving your ability to recognize and cope with uncertain environmental forces. For example, well-designed strategies, tactics, and plans can be thwarted by outside forces.

Since the management simulation learning environment is built around teams, small group functioning and decision making skills are emphasized in the background throughout this simulation exercise. Since most workplaces include healthy doses of project teams, the management simulation learning environment provides hands-on experience in identifying key principles and practices associated with high-performing teams.

LINKS Overview

"The best way to put distance between you and the crowd is to do an outstanding job with information. How you gather, manage, and use information will determine whether you win or lose." – Bill Gates

LINKS is a supply chain management simulation. LINKS encompasses all major supply chain elements: suppliers, manufacturers, distributors, retailers, and end-users. Firms in LINKS are responsible for managing:
• Procurement (purchasing/sourcing)
• Manufacturing
• Distribution and warehousing
• Transportation
• Customer service
• Generate demand
• Forecasting
• Information technology
• Research studies.

Traditional financial statements, various operating reports, and optional research studies provide an information-rich environment for LINKS. Information management is important within supply chain management and LINKS includes various optional information enhancements (information technology and research studies) available for a fee.

Exhibit 1 contains a schematic representation of the LINKS supply chain. LINKS firms manufacture and distribute products, as well as provide post-sale customer service via regional service centers. The indirect retailer and direct e-commerce channels in LINKS provide a rich and challenging competitive milieu for supply chain management.

Each decision period in LINKS is one calendar month. Within LINKS, each calendar month in the year is assumed to have an equal number of calendar days. There is no known time-of-year seasonality within the product categories of interest in LINKS.

You assume control of your LINKS firm at the end of month 3. Thus, your first decisions will be for month 4. Although your firm has been operating for a number of years, detailed information is only available about the recent past.

All firms in your industry started month 1 identically. This is consistent with an industry that has evolved over time with all competitors now emulating each other exactly. Decisions in months 1-3 were constant throughout these three months. Due to the normal random forces in the various markets in which your firm operates, the financial and market positions of the firms in your industry will vary somewhat at the end of month 3.

You manufacture, distribute, and sell set-top boxes in three regional markets in LINKS. Your manufacturing plant is located in market region 1. Distribution centers in each market region inventory your products, fill orders from the retail and direct channels, stock inventories of sub-assembly components for replacement parts for within-warranty failures, and provide customer service via regional service centers. Your distribution center in region 1 is located adjacent to your manufacturing plant and shares inventory of sub-assembly components with your manufacturing plant.

The "product" in LINKS is a set-top box. A set-top box is a high-tech electronics product purchased by individual consumers for home use and by a wide range of businesses for office and manufacturing/operations environment uses. LINKS set-top boxes are "fourth generation" versions. Fourth-generation set-top boxes include telephony applications (such as internet-based long-distance calling, interactive video conferencing, and interactive TV), local-area wireless networking, control/monitoring of a wide range of within-area electrical appliances and devices, digital media server, basic virtual reality, and teleportation enhancement capabilities.
Exhibit 1: LINKS Supply Chain

Region 1, DC (Distribution Center) Adjacent To Manufacturing Plant

Other Regions With No DC (Distribution Center)

Other Regions With a DC (Distribution Center)

Notes:
(1) In this Exhibit, "DC" refers to distribution center, "RM" refers to raw materials (used for production and the first stage of postponed production), and "SAC" refers to sub-assembly components (used for production, postponed production, and replacement parts).
(2) The shaded area in this exhibit is the direct responsibility of the LINKS manufacturers. The "manufacturing plant" handles product development, procurement, and production. Multiple customer segments (i.e., "end users" or "final customers") are reached via indirect (retail) and direct distribution channels. These customer segments include individuals (consumers) and business-to-business customers.
Within LINKS, there are two set-top box categories: hyperware and metaware. These categories share many elements in common within your supply chain, so the same general procurement, manufacturing, distribution, transportation, and service mechanisms exist. But, these categories are quite different products for end users. **There is no direct competition across the hyperware and metaware set-top box categories.**

Each LINKS firm in your set-top box industry has two products: one hyperware product (product 1) and one metaware product (product 2).

**What Will You Do Within LINKS?**

> “The secret of getting ahead is getting started. The secret of getting started is breaking your overwhelming tasks into small manageable tasks, and then starting on the first one.” – Mark Twain

The analysis-planning-implementation-evaluation cycle in LINKS, shown below in Exhibit 2, is fundamental to management and to management simulations. This analysis-planning-implementation-evaluation cycle repeats itself throughout the LINKS exercise. During each decision round (month), you will have the chance to learn from earlier analyses, decisions, and results. Indeed, extensive financial, operations and market feedback is perhaps the most dramatic component of a sophisticated management simulation like LINKS.

**Exhibit 2: Analysis-Planning-Implementation-Evaluation Cycle**

(1) **Analysis**: Analyze current financial, operating, and market performance, which involves both individual and within-team analysis.

(2) **Planning**: Based on prior analyses and working with your teammates, make decisions for the next round. These decisions represent your plan.

(3) **Implementation**: Submit your decisions for the next round via the LINKS Simulations website.

(4) **Evaluation**: Compare your plan to your results. What were you trying to accomplish? How well did you do? What corrective action is needed?

**Analysis**

After each decision round (month), your LINKS team receives updated financial and operating reports. Financial reports provided include profit-and-loss statements for each product in each market region and channel, an overall balance sheet for your firm, and a cash-flow statement for the firm. Additional operational reporting provides details of inventory flows (raw materials, components and finished goods), emergency procurement and production, and service-related performance elements throughout your supply chain.

LINKS teams may order various research studies for a fee. These research studies are of two general kinds: competitive benchmarking against industry-wide competitors and specific customer/market analyses. Industry-wide benchmarking studies allow both process and performance dimensions to be compared across competitors within your set-top box industry.
These research studies help you understand your relative position (compared to your competitors) in your markets, regions, and channels. In addition, these research studies provide the essential external customer-oriented measures of performance such as customer satisfaction, service quality perception, and product quality perception.

Planning

You and your teammates must develop a specific plan for each month in LINKS. Your plan consists of the decision inputs that you'll ultimately record on the decision forms described in this manual.

Implementation

Ultimately, you record your decisions on decision forms included within this participant's manual. Normally, one member of your team will enter those decisions into the LINKS Simulation Database for processing. There will be a pre-announced deadline for receipt of your team's input for each LINKS round.

At the specified input submission deadline, the simulation will run for the next round. Part of this "running" involves the generation of new financial, operations, and research reports. Your firm's reports will be accessible to you via the LINKS Simulation Database.

Evaluation

After receiving your results from the previous month, you will need to assess how well you did compared to your plans and goals. Criteria for such an evaluation presumably include top-line performance measures such as profitability, but the underlying drivers of profitability must be examined as well.

In LINKS, a multi-factor quantitative performance evaluation system is used. Various financial, operating, and customer performance measures are combined to create an overall measure of performance in the style of a balanced scorecard. This multi-factor quantitative performance evaluation system is described in Chapter 15.

Decisions and Decision Forms

"The twin supply chain management challenge facing retailers, distributors, manufacturers, and suppliers is to maximize customer service while minimizing costs. For most supply chain operations, the service challenge can be expressed in terms of availability: having the right product at the right place when the customer wants it. The cost challenge is to make that happen at low cost." – Yossi Sheffi

Included within Chapters 3-12 and Chapter 14 are copies of the various decision variable input forms that you will use to record your LINKS decisions. With the exception of research studies, all LINKS decisions are standing orders. That is, decisions are permanent until they are explicitly changed. Thus, you only need to enter decision changes each round. If you are satisfied with a current decision, there is no need to change it. This standing-order aspect of LINKS decisions
means that you will be inputting only a few decisions each round, rather than having to reinput all decisions.

You are responsible for your own LINKS input. Here's advice from a past participant:

"Never ask just one person to input the data. The volume of input data is so extensive that even the most dependable individual will make mistakes. Our team president was responsible for data entry, but we always had one additional person verify the inputs. Even with this verification process, we still made input errors."

Excel Spreadsheet Access To This Manual's Exhibits

This participant's manual for the LINKS Supply Chain Management Simulation includes a large number of tabular exhibits. To facilitate convenient access to these exhibits for on-going referencing during your LINKS exercise, these exhibits have been included in an Excel spreadsheet. To access/download this Excel spreadsheet, point your favorite browser to this case-sensitive URL:

http://www.LINKS-simulations.com/SC/ExhibitsSC.xls
Chapter 2: Decision Variables and Perspective

"Project Phases in All Organizations: (1) enthusiasm; (2) disillusionment; (3) panic; (4) search for the guilty; (5) punishment of the innocent; and, (6) praise and honors for the uninvolved." – Unknown

Chapter 2 Overview

Your LINKS firm manages the complete supply chain, from procurement to manufacturing to distribution and transportation to service to generate demand. At the beginning of the LINKS exercise, you and your teammates take over an on-going firm in the set-top box industry. Your goal is to improve the financial, operating, and market performance of this firm during the LINKS exercise.

Your firm has two products, referenced as "f-p" (for firm "f" and product "p"). For example, product 4-1 refers to product 1 of firm 4. For all firms, product 1 is a hyperware product and product 2 is a metaware product.

Your firm has a manufacturing plant and owned distribution center in region 1. You may choose to have third-party or owned distribution centers in regions 2 and 3. Your manufacturing plant in region 1 produces set-top boxes that are shipped to distribution centers in the regions served by your firm. Depending on the firm's manufacturing strategy, postponed production is possible as well.

There are three regional markets in your set-top box industry. Two sales channels, retail and direct, exist to reach end users in these three regional markets. When you receive your initial financial reports for months 1-3, you will see the market region descriptors for the three market regions in your particular set-top box industry.

This chapter overviews the decision variables available to you within LINKS and provides a variety of fundamental definitions of LINKS terminology. The full range of available LINKS decision variables covers a lot of ground: procurement, manufacturing, distribution, transportation, service, generate demand, and forecasting. In addition to these supply chain decision variables, information technology, research studies orders, and other decisions exist. These decision areas and the specific decisions for which you are responsible in LINKS are summarized in Exhibit 3.

Details about each decision area are provided in Chapters 3-12. Financial reports and research studies are detailed in Chapters 13 and 14. Given the detail in Chapters 3-14, you should expect to read and reread these chapters many times throughout your LINKS exercise.

Inherent in this architecture is a general strategic perspective in LINKS. Fine levels of implementation details (e.g., raw materials handling and storage, production scheduling, and hiring/deploying/training service center personnel) are left to others.
**Exhibit 3: LINKS Decisions**

<table>
<thead>
<tr>
<th>Decision Areas</th>
<th>Specific Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement</td>
<td>Raw materials volumes</td>
</tr>
<tr>
<td></td>
<td>Sub-assembly components suppliers and volumes mode</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Production volumes</td>
</tr>
<tr>
<td></td>
<td>Postponed production volumes</td>
</tr>
<tr>
<td></td>
<td>Emergency production limits</td>
</tr>
<tr>
<td></td>
<td>Production volume flexibility</td>
</tr>
<tr>
<td>Distribution</td>
<td>Distribution center presence in regional markets</td>
</tr>
<tr>
<td></td>
<td>RFID-application process for retail-channel sales</td>
</tr>
<tr>
<td></td>
<td>Emergency carrier for plant-DC finished-goods shipments</td>
</tr>
<tr>
<td></td>
<td>Cross-docking</td>
</tr>
<tr>
<td></td>
<td>Surface shipping methods (FGI and SAC)</td>
</tr>
<tr>
<td>Transportation</td>
<td>Volumes and modes for inbound sub-assembly components</td>
</tr>
<tr>
<td></td>
<td>Shipment volumes and modes for plant-to-DC finished goods</td>
</tr>
<tr>
<td>Service</td>
<td>Service outsourcing</td>
</tr>
<tr>
<td>Generate Demand</td>
<td>Introduction/drop in market regions and channels</td>
</tr>
<tr>
<td></td>
<td>Price for each product, channel, and region</td>
</tr>
<tr>
<td></td>
<td>Marketing spending for each product, channel, and region</td>
</tr>
<tr>
<td>Forecasting</td>
<td>Short-term sales volume forecasts</td>
</tr>
<tr>
<td>Information Technology</td>
<td>Information technology options</td>
</tr>
<tr>
<td>Research Studies</td>
<td>Ordering specific research studies</td>
</tr>
<tr>
<td>Other Decisions</td>
<td>Firm name</td>
</tr>
</tbody>
</table>
Perspective and Definitions

"You have exactly the same number of hours per day as Martin Luther King Jr., Marie Curie, Thomas Jefferson, or Bill Gates." – Unknown

Your LINKS firm manages a complete supply chain from procurement to manufacturing to distribution and warehousing to service to generate demand. At the beginning of the LINKS exercise, you and your teammates take over an on-going firm in the set-top box industry. Your goal is to improve the financial, operating, and market performance of this firm during the LINKS exercise.

Your firm has two products, referenced as "f-p" (for firm "f" and product "p"). For example, product 4-1 refers to product 1 of firm 4. For all firms, product 1 is a hyperware product and product 2 is a metaware product. Your firm has a manufacturing plant and owned distribution center in region 1. You may choose to have third-party or owned distribution centers in regions 2 and 3. Your manufacturing plant in region 1 produces set-top boxes that are shipped to distribution centers in the regions served by your firm. Depending on the firm’s manufacturing strategy, postponed production is possible as well.

There are three regional markets in your set-top box industry. Two sales channels, retail and direct, exist to reach end users in these three regional markets. When you receive your initial financial reports for months 1-3, you will see the market region descriptors for the three market regions in your particular set-top box industry.

Currency Conventions in LINKS

The LINKS currency unit is the LCU, the "LINKS Currency Unit." The LCU is abbreviated "$" and pronounced Ldollar ("el-dollar"). The "LINKS Currency Unit" (LCU) is a Euro-like multi-country currency.

In your travels, you might have encountered the "$" symbol associated with currencies in Australia, the Bahamas, Barbados, Belize, Bermuda, Brunei Darussalam, Canada, Cayman Islands, Fiji, Guyana, Hong Kong, Jamaica, Liberia, Namibia, New Zealand, Singapore, Solomon Islands, Suriname, Taiwan, Trinidad/Tobago, the United States, and Zimbabwe. That's merely a coincidence. The "$" currency symbol is widely known to have originated with the Ldollar.
Chapter 3: Product Development Decisions

Chapter 3 Overview

Set-top box products have a six-element configuration:
(1) product category:
(2) raw material Alpha;
(3) raw material Beta;
(4) bandwidth;
(5) warranty;
(6) packaging.
For example, the product H55321 is a hyperware set-top box with 5 kilograms of raw material Alpha, 5 kilograms of raw material Beta, bandwidth of 3 terahertz, warranty of 2 months, and standard packaging.

In addition to one Epsilon sub-assembly component, set-top boxes require a Gamma (hyperware) or a Delta (metaware) sub-assembly component. A variety of suppliers provide sub-assembly components and alternative suppliers' offerings are fully interchangeable in manufacturing. Thus, since their particular "value" (supplier) doesn't impact configuration, sub-assembly components are not a formal part of the set-top box configuration.

Your firm has two products. Product 1 must always be a hyperware product; product 2 must always be a metaware product.

In the LINKS Supply Chain Management Simulation, reconfiguration of your existing products is not permitted.

Set-Top Box Configurations

Each set-top box product is defined by a configuration that is expressed as a six-character code with the following elements and interpretations:
(1) Product category: "H" for hyperware, "M" for metaware
(2) Raw material Alpha: 0-9 (number of kilograms)
(3) Raw material Beta: 0-9 (number of kilograms)
(4) Bandwidth: 1-7 (terahertz)
(5) Warranty: 0, 1, 2, 3, or 4 (length of warranty in months)
(6) Packaging: "1" (standard), "2" (premium), or "3" (environmentally sensitive premium).

For example, the product H55321 is a hyperware set-top box with 5 kilograms of raw material Alpha, 5 kilograms of raw material Beta, bandwidth of 3 terahertz, warranty of 2 months, and standard packaging.

Product configuration influences manufacturing, handling, and post-sale costs in known fashions. These various costs are in the next section. This six-element product configuration allows for rich interactions between product development, procurement, manufacturing, distribution,
transportation, and post-sale service. In addition to these six configuration elements, two sub-assembly components must be included within set-top boxes. Details about these sub-assembly components are provided in Chapter 4. Exhibit 4 contains a schematic representation of the hyperware and metaware set-top box product configurations.

Exhibit 4: Set-Top Box Configurations

<table>
<thead>
<tr>
<th>Product 1: Hyperware</th>
<th>Product 2: Metaware</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration Elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. &quot;H&quot;</td>
<td>1. &quot;M&quot;</td>
<td>Category [hyperware (&quot;H&quot;) or metaware (&quot;M&quot;)]</td>
</tr>
<tr>
<td>2. Alpha</td>
<td>2. Alpha</td>
<td>0-9 Kg of Raw Material</td>
</tr>
<tr>
<td>3. Beta</td>
<td>3. Beta</td>
<td>0-9 Kg of Raw Material</td>
</tr>
<tr>
<td>5. Warranty</td>
<td>5. Warranty</td>
<td>0-4 Months</td>
</tr>
<tr>
<td>6. Packaging</td>
<td>6. Packaging</td>
<td>Stnd (&quot;1&quot;), Prem (&quot;2&quot;), or ES Prem (&quot;3&quot;)</td>
</tr>
<tr>
<td>Sub-Assembly Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epsilon</td>
<td>Epsilon</td>
<td>Common Sub-Assembly Component</td>
</tr>
<tr>
<td>Gamma</td>
<td>Delta</td>
<td>Unique Sub-Assembly Component</td>
</tr>
</tbody>
</table>

In addition to one Epsilon sub-assembly component, set-top boxes require a Gamma (hyperware) or a Delta (metaware) sub-assembly component. A variety of suppliers provide sub-assembly components and alternative suppliers' offerings are fully interchangeable in manufacturing. Thus, since their particular "value" (supplier) doesn't impact configuration, sub-assembly components are not a formal part of the set-top box configuration.

Product Costs

Costs of raw materials and sub-assembly components are described in Chapter 4. Costs other than those related to raw materials and sub-assembly components are detailed below:

- **Bandwidth**: $10 + 0.5(T*T*T) where T is the terahertz rating of the product. A terahertz level of 1 costs $10.50 while bandwidth of 6 terahertz costs $118. You have the engineering capability to include any level of bandwidth in your set-top box products, within the technology range 1-7. Bandwidth is a "more-is-better" product attribute. Terahertz is just an industry-specific, generally-accepted metric describing the bandwidth performance of a set-top box. Customers will always prefer more bandwidth, but they might or might not prefer it enough to offset the additional bandwidth costs.

- **Warranty**: Set-top boxes may be configured with a warranty or with no warranty. With no warranty, there are no associated warranty costs. If you choose to offer a warranty, then the associated cost is $8 + 3(W*W), where W is the warranty length in months. For example, a one-month warranty costs $11, a two-month warranty costs $20, a three-month warranty costs $35, and a four-month warranty costs $56. Warranty coverage is outsourced to a reputable service provider in each market region. These warranty costs are paid directly to the
outsourced warranty provider at the time the product is manufactured. Warranty costs do not depend on the failure rates of the sub-assembly components. Set-top box manufacturers are responsible for the costs associated with replacing sub-assembly components that fail in the field during the warranty period associated with a set-top box product. **Warranties are honored in the original calendar month of sale plus the additional number of months of the warranty associated with a product's configuration.**

- **Packaging:** "1" (standard) packaging costs $10, "2" (premium) packaging costs $14, and "3" (environmentally sensitive premium) packaging costs $28. More expensive, premium packaging presumably has positive generate demand implications and provides greater physical protection during shipping, resulting in somewhat reduced failure rates in the field (i.e., lower failure rates to customers). "3" packaging denotes premium packaging with environmentally sensitive design, construction, and materials.
Chapter 4: Procurement Decisions

"Buy low, sell higher." – Unknown

Chapter 4 Overview

Your LINKS firm manages procurement by sourcing raw materials and sub-assembly components from suppliers. Raw material and sub-assembly components inventories must be managed within your firm's manufacturing plant, which is located in market region 1. If postponed production is chosen, then similar inventory management decisions are required at regional distribution centers in which postponement occurs. Sub-assembly components must be sourced from specific suppliers and transportation method (surface or air) must be chosen.

Your procurement strategies and tactics will need to balance input costs, supplier delivery performance, sub-assembly component quality, and associated relationship management costs.

The Alpha and Beta raw materials are widely available single-grade commodities purchased at the common world price for these inputs.

Set-top boxes are composed of either one Gamma (for hyperware) or one Delta (for metaware) sub-assembly component. Gamma and Delta sub-assembly components are available on the spot-market for immediate delivery. Epsilon sub-assembly components are delivered one month after ordering, not within the current month. You'll need to take this delivery lag into account in managing your Epsilon sub-assembly component inventories.

Sub-assembly components from alternative suppliers are freely substituted without influencing manufacturing costs.

If your firm practices postponed production, sub-assembly components inventories must be managed at your regional distribution centers. And, if you are currently manufacturing completed products at your manufacturing plant, inventories of sub-assembly components also have to be managed at the manufacturing plant.

Sub-assembly components may fail in the field as customers use their set-top boxes. Within the warranty period associated with each product, replacement parts are provided without cost by set-top box firms. Each regional distribution center services demand for sub-assembly component replacement parts from the "local" region. If a particular regional distribution center does not exist, then replacement part demand from that region is sourced from the distribution center adjacent to the firm's manufacturing plant in market region 1.

If the available inventory of any raw material or sub-assembly component is insufficient to meet the requirements implicit in your production orders, an emergency procurement order is automatically executed by the simulation software.
This chapter provides details about the procurement decisions for which you are responsible within LINKS. Your LINKS firm manages the procurement function in your supply chain by sourcing raw materials and sub-assembly components from various suppliers. Raw material and sub-assembly components inventories must be managed within your firm’s manufacturing plant, which is located in market region 1.

If postponed production is chosen, then similar inventory management decisions are required at regional distribution centers in which postponement occurs. Sub-assembly components must be sourced from specific suppliers and transportation method (surface or air) must be chosen.

Within LINKS, your procurement strategies and tactics will need to balance input costs, supplier delivery performance, sub-assembly component quality, and associated relationship management costs (the explicit Ldollar costs associated with maintaining relationships with alternative suppliers and the implicit time costs associated with managing a supplier portfolio). The input costs of raw materials and sub-assembly components represent a sizeable portion of total product costs. Thus, thoughtful management of the procurement sub-process will be an important aspect of managing your firm in the set-top box industry.

**Raw Materials**

Raw materials Alpha and Beta are widely available single-grade commodities purchased at worldwide spot-market prices. In-bound transportation costs are covered by the raw material suppliers. Due to their ubiquitous nature, surface transportation is the accepted mode of transportation. Raw materials are always delivered for use within the current month’s production activities.

The current prices of raw materials are $3/kg for Alpha and $4/kg for Beta.

Volume discounts exist for all raw materials procurements.
- If your firm’s Alpha or Beta raw materials procurements exceed 250,000 kilograms in a month, your firm receives a 7.6% discount on the current raw materials price for Alpha or Beta procurement volume in excess of 250,000 kilograms.
- An additional 6.2% discount (a total discount of 13.8%) accrues for Alpha or Beta raw materials procurements in excess of 500,000 kilograms in a month.
- A further 5.4% discount (a total discount of 19.2%) is realized for Alpha or Beta raw materials procurements in excess of 1,000,000 kilograms in a month.
- These raw materials procurements volume discounts are not applied to the total of Alpha and Beta procurements, but to each of Alpha and Beta separately.

Raw materials vendors in the set-top box industry provide inbound transportation as part of their bundled prices. Thus, there are no transportation decisions for set-top box manufacturers to make with regard to raw materials. While there are no transportation costs associated with regular purchases of raw materials, emergency (expedited) raw materials orders incur a cost of $1/kg in transportation charges.
Sub-Assembly Components and Supplier Decisions

Hyperware products include sub-assembly component Gamma while metaware products include sub-assembly component Delta. Each set-top box is composed of either one Gamma or one Delta sub-assembly component, depending on whether it is hyperware (Gamma) or metaware (Delta). Sub-assembly component Gamma may be sourced from suppliers "A", "B", "C", or "D" while sub-assembly component Delta may be sourced from suppliers "B", "C", "D", "E", or "F". Each set-top box (i.e., hyperware and metaware set-top boxes) is manufactured with an Epsilon sub-assembly component that may be sourced from suppliers "D", "E", "F", or "G".

Gamma and Delta sub-assembly components are available on the spot-market for immediate delivery. Epsilon sub-assembly components are delivered one month after ordering, not within the current month. You'll need to take this delivery lag into account in managing your Epsilon sub-assembly component inventories.

Sub-assembly components from alternative suppliers are freely substituted without influencing manufacturing costs. While all suppliers' versions sub-assembly components perform approximately the same, there are differences in price, delivery performance, and in-field failure rates of the suppliers. Product failure in the field can result if the Gamma, Delta, or Epsilon components fail. By common practice, the customer (i.e., your firm) arranges and pays for the transportation associated with in-bound sub-assembly components.

Suppliers and manufacturers are jointly responsible for transportation decisions regarding inbound shipments of sub-assembly components. Suppliers quote unbundled sub-assembly component and transportation mode costs (surface and air). Manufacturers choose modes but suppliers arrange specific carriers for each transaction. Suppliers choose specific carriers for sub-assembly components to deal with less-than-truckload orders economically. In addition, suppliers' sub-assembly components are used in many other industries than just set-top boxes, so they must deal effectively and efficiently with cross-industry transportation requirements.

Your LINKS firm must make sourcing decisions for sub-assembly components used in manufacturing involving both supplier selection and transportation modes. Surface and air transportation modes are possible. Costs of air transportation exceed those of surface. However, air transportation ensures timely receipt of sub-assembly components so that they may always be used within the current month's production activities.

Gamma and Delta sub-assembly components cost $3/unit [$4/unit] for surface [air] transportation with the corresponding surface [air] transportation per-unit cost for Epsilon units being $4 [$6]. Emergency (expedited) orders of sub-assembly components incur a cost 50% higher than air transportation. These transportation costs are payable by the customer (i.e., your firm), although carrier-specific decisions are made by the sub-assembly component suppliers. And, of course, these transportation costs are in addition to supplier purchase costs.

Exhibit 5 contains cost, delivery, and failure data for sub-assembly components. "Delivery" refers
to the average rate of receipt of sub-assembly components within the current month via surface transportation. With air transportation, sub-assembly components are always received within the current month and may be used within the current month's manufacturing activities. Recall that Epsilon sub-assembly components are ordered in this month and are delivered in the following month. Surface and air transportation options exist for Epsilon, but these deliveries are in the following month, not in the current month.

- The delivery rates in Exhibit 5 are average delivery rates. The typical range of delivery rates is shown in “±” form (for example, “80% ± 2%” reflects an average surface delivery rate of 80% with a typical range for that average being 78% to 82%. Surface transportation of in-bound sub-assembly components is subject to various possible delays. While the typical ranges are plus or minus 2% to 14% from the published statistics in Exhibit 5, more extreme performance levels are possible. If you want to be certain of current-month delivery, you can always use air rather than surface transportation. But, as you might expect, there are higher costs associated with air compared to surface transportation of sub-assembly components. Variability in surface transportation performance is one of the many elements of supply chain variability that must be managed, in real supply chains and in the LINKS set-top box supply chain.

- "Failure" refers to the per-month failure rate for each sub-assembly component from each supplier. These failure rates refer to in-field failure faced by customers. A 1% failure rate is interpreted as a probability of 0.01 that a specific sub-assembly component fails in any month. These failure rates are especially relevant during your products' warranty periods, when your firm must bear any costs associated with sub-assembly component failure.

- The costs in Exhibit 5 are the spot-market prices for sub-assembly components as of month 1. You will be advised of any changes in these sub-assembly component spot-market prices. Obviously, a range of trade-offs exist in sourcing sub-assembly components. Cost, delivery performance, and failure rates must all be balanced in sourcing sub-assembly components.

Volume discounts exist for all sub-assembly components.

- If your firm's procurements of any sub-assembly component from any sub-assembly component supplier in a region exceed 50,000 units in a month, your firm receives a 10.4% discount on the supplier's current price for procurements volume in excess of 50,000 units.

- An additional 7.1% discount (a total discount of 17.5%) is realized for any individual sub-assembly component procurement in excess of 100,000 units from any supplier in a region.

Some suppliers may not be able to supply sub-assembly components for spot-market purchases in any given month due to capacity limitations and pre-existing contractual obligations with existing customers. Set-top box manufacturers that already have on-going relationships with suppliers (i.e., firms that purchased sub-assembly components last month from a supplier) receive preferential treatment as existing customers and, therefore, are normally unaffected by spot-market unavailability conditions with such suppliers.
Exhibit 5: Sub-Assembly Component Characteristics

<table>
<thead>
<tr>
<th>Sub-Assembly Components</th>
<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Delivery</td>
<td>Failure</td>
<td>Cost</td>
</tr>
<tr>
<td>Supplier A</td>
<td>$12</td>
<td>80% ± 2%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Supplier B</td>
<td>$14</td>
<td>85% ± 4%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Supplier C</td>
<td>$13</td>
<td>85% ± 6%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Supplier D</td>
<td>$22</td>
<td>90% ± 8%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Supplier E</td>
<td></td>
<td>$14</td>
<td>70% ± 10%</td>
</tr>
<tr>
<td>Supplier F</td>
<td></td>
<td>$13</td>
<td>70% ± 12%</td>
</tr>
<tr>
<td>Supplier G</td>
<td></td>
<td></td>
<td>$21</td>
</tr>
</tbody>
</table>

Inventory Management For Postponed Production

LINKS firms produce complete set-top boxes at their manufacturing plant and ship them through their regional distribution centers to customers. Alternatively, postponement is possible by producing semi-finished set-top boxes. Postponed production involves creating a semi-completed product at the manufacturing plant. That semi-completed product, referenced as product "f-0" (for firm "f"), may be subsequently converted into either hyperware or metaware at the distribution center.

If your firm practices postponed production, sub-assembly components inventories must be managed at your regional distribution centers. And, if you are currently manufacturing completed products at your manufacturing plant, inventories of sub-assembly components also have to be managed at the manufacturing plant. Recall that your manufacturing plant shares inventories with your distribution center in market region 1.

Raw materials are included within the initial production activities conducted at your firm's manufacturing plant. Thus, you only inventory raw materials at your manufacturing plant, not at any regional distribution centers outside of market region 1.

Negative shipments of raw materials and sub-assembly components (i.e., returns to vendors) are not possible. The LINKS software automatically disposes of any residual inventory of sub-assembly components and finished goods when a DC is closed. The inventory is converted to cash at the current balance-sheet values and a corresponding disposal cost of 20% of the
inventory's value accrues. This disposal cost is recorded under Consulting Fees on the firm's P&L statement. An appropriate disposal-sale message appears at the end of the firm's financial statements.

**Replacement Parts**

Sub-assembly components may fail in the field as customers use their set-top boxes. Within the warranty period associated with each product, replacement parts are provided without cost by set-top box firms.

Each regional distribution center services demand for sub-assembly component replacement parts from the "local" region. If a particular regional distribution center does not exist, then replacement part demand from that region is sourced from the distribution center adjacent to the firm's manufacturing plant in market region 1. Obviously, your LINKS firm must maintain a suitable inventory of sub-assembly components to service replacement parts demand.

**Emergency Procurement**

Your firm has a policy of never running out of inventories of raw materials or sub-assembly components. If the available inventory of any raw material or sub-assembly component is insufficient to meet the requirements implicit in your production orders, an emergency procurement order is automatically executed by the simulation software.

Emergency procurement orders of sub-assembly components are made from supplier D, the only full-service supplier offering all sub-assembly components. Emergency procurement orders of raw materials and sub-assembly components involve extra charges of $1/kg and $3/unit, respectively ($6/unit for Epsilon sub-assembly components). Emergency procurement costs are recorded as "Emergency Procurement" costs on the "Corporate P&L Statement."

Emergency orders are always shipped by air so that they arrive in time to be used within the current month’s production activities. Emergency orders of sub-assembly components involve transportation costs that are 50% higher than the usual costs associated with sourcing via air transportation. Emergency procurement of raw materials incurs a cost of $1/kg.

**Relationship Management Costs**

Each relationship with a sub-assembly supplier incurs one-time start-up costs of $20,000, plus ongoing costs of $10,000 in the initial month of procurement and $5,000 in subsequent months as long as your firm continues to source sub-assembly components from a supplier. If you cease
ordering sub-assembly components from a supplier and then start ordering again in a later month, these start-up costs are incurred again.

“Relationship” means one or more purchase orders processed with a sub-assembly component provider. Relationship management costs are recorded under "Procurement FC" on your financial statements.

Fixed order costs of $1,250 accrue for every sub-assembly component procurement (via surface or air) from every supplier used in a month. These costs are also recorded under “Procurement FC” on your financial statements.

On-going relationships with sub-assembly component suppliers have the positive benefit of reducing the risk associated with spot-market unavailability in any given month. As mentioned above, as an existing customer of a sub-assembly component supplier, your firm would receive preferential treatment with regard to any supply constraints. Thus, your firm would normally not face spot-market unavailability from your existing sub-assembly component suppliers.

**SAC Surface Shipping**

SAC surface shipping, a distribution decision variable in LINKS, references in-bound surface shipments of sub-assembly components to each DC.

- **Expedited Surface Shipping (level 3):** With expedited surface shipping (i.e., the proverbial “rush job”), carriers typically bypass consolidation hubs to ship directly to final destinations. Shipments of any size, even small lots, are possible via expedited shipping. In LINKS, expedited surface shipping of in-bound sub-assembly components to a DC increases surface shipping delivery reliability by 10%-20%. For example, expedited surface shipping from supplier D for Delta increases surface shipping delivery reliability from 80% to 88%-96%. The cost of expedited surface shipping for sub-assembly components is 25% above the standard surface shipping cost.

- **Standard Surface Shipping (level 2):** Standard surface shipping is the normal form of surface shipping for in-bound sub-assembly components to each DC. Standard surface delivery reliability parameters are specified in Exhibit 5.

- **Economy Surface Shipping (level 1):** With economy shipping, shippers save costs (passed on to their clients) by consolidating shipments into large shipping units such as full truck-loads or full container-loads. Economy shipments typically involve spot-market bidding for low-cost shipping and consequent delays due to the consolidation process. Longer shipping times and greater use of interlining (i.e., transferring across shippers each of which serve a limited geographical area) combine to decrease shipping costs and delivery reliability. Relative to standard performance in Exhibit 5 for sub-assembly components, economy surface shipping reduces shipping costs by 30% and reduces surface delivery reliability by 35%-40%. For example, economy surface shipping for supplier D for Delta decreases surface shipping delivery reliability from 80% to 48%-52%.

Transportation costs are reported in the LINKS financial reports for standard surface shipping. Incremental adjustments in transportation costs for expedited surface shipping and economy surface shipping accrue as Transportation Rebates on the LINKS financial reports. Expedited surface shipments are reflected as negative Transportation Rebates while economy surface shipments are reflected as positive Transportation Rebates.
Procurement Decisions Form

Blank "Procurement Decisions" forms may be found on the next two pages. Complete these decision forms during your team deliberations.
# Procurement Decisions (1)

## Raw Materials

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Beta</th>
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</table>

## Sub-Assembly Components, Plant&DC1

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<th>Supplier E</th>
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<tbody>
<tr>
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</table>

## Reminders

- Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.
- **Don't forget to zero-out prior procurement decisions if you don't wish them to continue on into the next month.**
- All decision inputs change the existing values to the values that you specify. Do not enter "+" or "+" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
## Procurement Decisions (2)

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<tr>
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<th>Supplier C</th>
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<th>Supplier D</th>
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</table>

### Reminders

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

Don't forget to zero-out prior procurement decisions if you don't wish them to continue on into the next month.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "+" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 5: Manufacturing Decisions

Chapter 5 Overview

Your LINKS firm makes production decisions for each of your products each month. The LINKS production sub-process is build-to-plan (build-to-stock). You must plan ahead to create your production volume orders in light of downstream demand forecasts that you craft as part of your supply chain decision making. With build-to-plan, the consequences of poor production planning are either too much inventory of unsold products or emergency production.

Postponed production involves creating a partially completed product, referenced as product "0" (zero), at your firm's manufacturing plant. Inventories of product "0" are tracked, like all other finished goods inventories of your other products, from your manufacturing plant to your distribution centers. Postponed production occurs at your regional distribution centers and involves converting product "0" into specific finished goods. With postponed production, final product identity is assigned at the distribution center (DC), not at the manufacturing plant. Postponed production has the potential to reduce demand-supply imbalances at distribution centers since not all product shipped to the distribution centers has to be completely finished. Product "0" postponed units may be converted into either hyperware or metaware to meet local demand variations across your set-top box product line. Postponed production is only possible with an owned DC, not with a third-party DC.

In addition to production decisions, you also control product-specific emergency production limits. If finished goods inventory is insufficient to meet end-user demand, an emergency production order is executed automatically up to the product's specified emergency production limit:

Production volume flexibility decisions permit you to exceed month-over-month production order change limits (maximum change of 10,000 units from the previous month's production level).

Unfilled orders can exist in your set-top box industry. If demand for any product exceeds the product’s emergency production limit, customer sales and scheduled product shipments to other DCs must be reduced (proportionately) by the amount that orders exceed the product’s emergency production limit. The difference between potential customer sales (orders) and actual customer sales due to inadequate on-hand finished goods inventory (after accounting for a product’s emergency production limit) is "unfilled orders" in LINKS. Unfilled orders are not backlogged orders. Unfilled orders are not guaranteed (i.e., contracted, pre-paid) future sales.

Past experience in the set-top box industry suggests that 8%-12% of sales result in returns, but this can be higher if unfilled orders exist (some customers return such orders when they are ultimately shipped).
In the manufacturing sub-process, your LINKS firm makes production decisions for each of your products each month. These production volume decisions include both completed products and postponed production. In addition, you must decide on emergency production limits for each completed product each month.

The LINKS production sub-process is build-to-plan (build-to-stock), not a build-to-order customized production style popularized by Dell Computer, for example. You will have to plan ahead to create your production volume orders in light of downstream demand forecasts that you craft as part of your supply chain decision making. With build-to-plan, the consequences of poor production planning are either too much inventory of unsold products or emergency production.

**Perspective on Manufacturing and Postponed Production**

"Nobody wants to have inventory, but everybody wants a product there when they want it." – Joe Chernay, Vice-President of Manufacturing and Technology Bayer Corporation, http://www.industry.net/discussions/supplychain.htm

Production decisions for unrelated products are simple: produce sufficient quantities to meet end-user demand at your plant and then ship market-specific quantities to regional distribution centers to meet forecasted end-user demand. With unrelated products that don’t share manufacturing and parts components, supply-demand imbalances inevitably arise at regional distribution centers due to end-user demand variability. Some distribution centers will have too much finished goods inventories to meet local end-user demand, while other distribution centers will have too little finished goods inventories to meet local end-user demand. With unrelated products, there is little that can be done to alleviate these imbalances, given fallible forecasts and unpredictable end-user demand levels.

The theoretical basis for postponed production is potential underlying production/engineering similarities across multiple related products and/or product lines. For example, a diversified manufacturer of TVs, automobiles, and footwear has no apparent production/engineering similarities among these disparate products. These are "unrelated" products. On the other hand, a manufacturer of TVs and personal computer CRTs has "related" products with many similarities in production/engineering. As described in the paragraphs that follow, postponement is one strategy for taking advantage of "relatedness" in products and product lines.

Customer preference variations predispose manufacturers to offer extensive product lines to appeal to a range of customer segments, notwithstanding the customization costs accruing with specialized product offerings (e.g., shorter production runs with more products in a line). Perhaps less obviously, demand-supply matching is more challenging for each item in an
extensive product line, since forecasting errors are inevitably larger as more disaggregate forecasts are required. The theory of postponed production is to mass produce a core product and then finish, customize, or refine it relatively close to the final customer, when customer preferences and demand for particular product variations are known.

With related products as in LINKS, some further supply chain management possibilities arise. The supply-demand imbalance issue still exists, of course, with the painful aspect that some products will have too much finished goods inventory at the regional distribution centers while other products will have too little finished goods inventory. If only there was a way to use the related products to meet these local supply-demand imbalances. Postponed production is one such strategy.

Retrofitting hyperware to become metaware and vice-versa would be another hypothetical strategy, but that's not possible in the set-top box for a variety of engineering and design reasons.

Paint is an ideal example where postponed production is crucial. Suppose that paint had to be manufactured in all possible colors and shades at the manufacturing plant. This would involve hundreds or thousands of paint SKUs. Each paint SKU would have to be inventoried individually throughout the paint supply chain. Efficient inventory management of paint SKUs would be impossible. Too much paint of one color would accumulate at some DCs or retail outlets while there would be shortages of that paint color at other DCs or retail outlets. But, consider an alternative manufacturing process: base paint ingredients (prime colors) are produced at the manufacturing paint and these base paint ingredients are suitably mixed at the DCs, retail outlets, or at the customer's site to form the final paint color. In such a postponed production system, customization of paint color occurs close to or at the point of sale and inventories of paint SKUs do not accrue throughout the paint supply chain. With postponement, production of paint ingredients (base colors) occurs at the manufacturing plant with final customization into a finished product (paint color) occurring later in the supply chain, at the DC, retail outlet, or customer's site.

Hyperware and metaware share a variety of engineering and production characteristics. Except

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It's easier to forecast aggregate sales for a product class than to forecast disaggregate sales for each item in that product class. Similarly, it's easier to forecast aggregate monthly sales for a product than to forecast that product's daily sales levels. Disaggregate forecasting errors tend to “average out” as one moves to more aggregate forecasts.
for a few product configuration elements (Gamma or Delta), hyperware and metaware products share a common production/engineering platform. To take advantage of this common production platform, postponed production is possible.

Postponed production involves creating a partially completed product, referenced as product "0" (zero), at your firm's manufacturing plant. Inventories of product "0" are tracked, like all other finished goods inventories of your other products, from your manufacturing plant to your distribution centers. **Postponed production occurs at your regional distribution centers and involves converting product "0" into specific finished goods. With postponed production, final product identity is assigned at the distribution center (DC), not at the manufacturing plant.** Postponed production has the potential to reduce demand-supply imbalances at distribution centers since not all product shipped to the distribution centers has to be completely finished. Product "0" postponed units may be converted into either hyperware or metaware to meet local demand variations across your set-top box product line.

**Postponed production is only possible with an owned DC, not with a third-party DC.**

**Production and Postponed Production**

The costs associated with manufacturing and postponed production are described in Exhibit 6. DC-specific costs refer to the incremental production costs associated with converting postponed-production units into either hyperware or metaware completed products. There is a fixed cost per order associated with setting up each production run, whether at the manufacturing plant or for postponed production at any distribution center. In addition to these production-related costs, the implied costs associated with the configurations of the products are also added into the costs of the products.

Production volumes for each product (including postponed production [product 0]) can change by a maximum of 10,000 units from the previous month's value. You may, however, change a product's production volume to 0 units at any time, but you'd then be limited to a maximum production volume of 10,000 units in the following month. This constraint on successive month's production volumes is necessitated by load balancing requirements associated with available plant capacity and labor force overtime scheduling requirements.

In addition to the order-related fixed costs and the unit-related variable costs described in Exhibit 6, your firm absorbs costs associated with depreciation and maintenance of your dedicated plant capacity to manufacture set-top boxes. These costs are $100,000 per month for each production

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**FYI: Why Hold Inventory?**

While low inventory levels are attractive from a cost perspective, there are a variety of reasons for holding inventory:

- *To create buffers against the uncertainties of supply and demand.*
- *To take advantage of lower purchasing and transportation costs associated with high volumes.*
- *To take advantage of economies of scale associated with manufacturing products in batches.*
- *To build up reserves for seasonal demands or promotional sales.*
- *To accommodate products flowing from one location to another (work in progress or in transit).*
- *To exploit speculative opportunities for buying and selling commodities.*

"shift," and they are recorded as "Plant Capacity FC" (plant capacity fixed costs) on your "Corporate Current P&L Statement." These costs are allocated equally among your products.

### Exhibit 6: Manufacturing Costs (Per Unit)

<table>
<thead>
<tr>
<th>Postponed Production</th>
<th>Manufacturing Plant</th>
<th>DC1</th>
<th>DC2</th>
<th>DC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postponed Production Fixed Costs (per order)</td>
<td>$20,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor Costs (per unit)</td>
<td>$22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Costs (per unit)</td>
<td>$11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperware Fixed Costs (per order)</td>
<td>$22,500</td>
<td>$5,000</td>
<td>$5,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>Labor Costs (per unit)</td>
<td>$30</td>
<td>$14</td>
<td>$15</td>
<td>$12</td>
</tr>
<tr>
<td>Production Costs (per unit)</td>
<td>$20</td>
<td>$12</td>
<td>$14</td>
<td>$11</td>
</tr>
<tr>
<td>Metaware Fixed Costs (per order)</td>
<td>$24,500</td>
<td>$6,000</td>
<td>$8,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>Labor Costs (per unit)</td>
<td>$36</td>
<td>$16</td>
<td>$20</td>
<td>$15</td>
</tr>
<tr>
<td>Production Costs (per unit)</td>
<td>$16</td>
<td>$10</td>
<td>$12</td>
<td>$10</td>
</tr>
</tbody>
</table>

**Note:** DC-specific "Postponed Production" costs are incremental, above and beyond "Postponed Production" costs recorded in the "Manufacturing Plant" column. For example, the total fixed costs (per order) associated with postponed production for hyperware completed at DC1 are $20,000+$5,000=$25,000.

With postponed production, the semi-completed set-top box (product 0) must be initially configured at the manufacturing plant to facilitate ultimate conversion to a specific hyperware or metaware product at the second-stage of postponed production which occurs at the regional distribution center. To do this, some elements of set-top boxes must initially be overbuilt to ensure downstream conversion flexibility. **Postponed production of product 0 requires raw materials values of Alpha and Beta equal to 9.** At postponement completion at a regional distribution center, excess raw materials are retooled out of semi-completed production as product 0 is transformed into a complete finished product (product 1 or product 2). These excess raw materials are waste and have no recovery value.

- **Raw materials (Alpha and Beta) are only procured and inventoried at your manufacturing plant, not at your distribution centers.** The first-stage production process in postponed production occurs only at your manufacturing plant. That's where raw materials are embedded into your products, both postponed production and completed/finished goods. Raw materials are never needed at your distribution centers.
- **With postponed production, all sub-assembly components (Gamma, Delta, and Epsilon) are applied to the final-form product at the distribution center.** Thus,
inventories of all sub-assembly components must be maintained at DCs where postponement is executed.

- With postponed production, the bandwidth associated with a product is engineered in at the final production stage at your distribution center, not during initial production at your plant.
- **Postponed production qualifies as "local" manufacturing at the owned DC in which product "0" is converted into finished goods. No duties and tariffs are payable for such "local" manufacturing at owned DCs.** Of course, by definition, all finished goods sold in market region 1 are "local," since your firm's manufacturing plant is located in market region 1 and you own your DC in market region 1. "Duties & Tariffs" are levied on sales in a market region (orders from customers) with appropriate credit being provided for "local" production (i.e., for the second-stage of postponed production when the final identity is assigned to the finished product at the within-region owned distribution center).

Postponement and reconfiguration are two different concepts. With postponement, you're not actually establishing the identity of the postponed product (product 0) until the second-stage of the production process, at the distribution center when postponed production (product 0) is converted into a final finished good. Reconfiguration, on the other hand, involves changing the configuration of a fully complete/finished set-top box product.

A production "shift" can accommodate up to 50,000 units of production per month. If your total production volume across all products (including regular, emergency, and postponed production at your manufacturing plant) is less than 50,000 units per month, then you only need one production shift that month, and the associated costs are $100,000. If your total production volume across all products (including regular, emergency, and postponed production at your manufacturing plant) is 50,001 to 100,000 units per month, then you need two production "shifts" in that month, with associated costs of $200,000. The LINKS software automatically schedules the appropriate number of production "shifts" based on your total production volume. Note that you must always have at least one production "shift" capability at all times, even if your total production volume in a month is zero units.

**Emergency Production**

In addition to production decisions, you also control product-specific emergency production limits, which are a maximum of 10,000 units per product. (Emergency production limits do not exist for product 0 which, by definition, can never be produced on an emergency basis.) Of course, you may choose emergency production limits of less than 10,000 units for any product.

If end-user demand exceeds available inventory plus postponed production inventory (product 0) plus your emergency production limit, additional end-user demand becomes unfilled orders. There is a $2/unit [$3/unit] cost for standby charges associated with all emergency production limits for hyperware [metaware] products. These standby charges are levied regardless of whether you actually use the specified emergency production limits during a month. Emergency production costs are recorded under "Emergency Production" on the "Corporate P&L Statement."

If finished goods inventory is insufficient to meet end-user demand, an emergency production order is executed automatically up to the product's specified emergency production limit:

1. If you have available postponed production inventory at a regional distribution center, then it is automatically accessed to cover emergency production requirements, if possible. Postponed production inventory accessed for emergency production purposes has no additional labor
and production costs associated with it, other than those costs described in Exhibit 6.

(2) If you have no inventory of postponed production at your distribution center, then your finished goods inventory at your manufacturing plant (distribution center in market region 1) is accessed. Air shipment is always used for such emergency inventory situations. There is a 50% premium above normal air shipment rates for such emergency finished goods shipments from your manufacturing plant (i.e., your regional distribution center in market region 1) to any regional distribution center.

(3) If your distribution center in market region 1 has no available finished goods inventory, an emergency production order is executed at your manufacturing plant. Emergency production orders have an associated 50% cost premium (i.e., labor and production costs are 50% higher than standard) for emergency production volumes up to the product's specified emergency production limit. For emergency production for any product in excess of 5,000 units, the production and labor costs premiums are 100% above standard rates. Emergency production finished goods inventory is shipped via air at a 50% premium above normal air shipment rates.

You have complete control over whether you wish to use emergency production for any product. If you set a product's emergency production limit to 0, then either postponed production would be invoked (if product 0 inventory is available) or else unfilled orders would result. You'll need to assess the relevant trade-offs between emergency production and unfilled orders.

Emergency production orders might also necessitate emergency raw materials or emergency sub-assembly component orders if there is not sufficient available on-hand inventory at your manufacturing plant. Thus, the overall cost impact of emergency production orders can extend beyond just the emergency production order costs highlighted above.

**Production Volume Flexibility**

As described above, each product's production order volume may not change by more than 10,000 units from the previous month's production order volume for that product. "Change" includes both increases and decreases in production order volume. Larger production order volume changes than 10,000 units must be phased in over successive months. However, a change to 0 units of production order volume for a product is always possible, but then the following month's production for that product would be limited to a maximum of 10,000 units.

You may enhance your firm's set-top box manufacturing technology to provide greater production volume flexibility in changing a product's production order volume from month to month. As might be expected, this incremental production volume flexibility has associated costs, as detailed below. You may increase the standard allotment of a product's production order volume change limit (of 10,000 units) between 1 and 12,500 incremental units with the following associated cost implications:
### Incremental Production Order Volume Flexibility

<table>
<thead>
<tr>
<th>Order Volume Flexibility</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2,500 Units</td>
<td>$2/unit</td>
</tr>
<tr>
<td>2,501 to 5,000 Units</td>
<td>$5,000 plus $4/unit over 2,500 units</td>
</tr>
<tr>
<td>5,001 to 7,500 Units</td>
<td>$15,000 plus $6/unit over 5,000 units</td>
</tr>
<tr>
<td>7,501 to 10,000 Units</td>
<td>$30,000 plus $8/unit over 7,500 units</td>
</tr>
<tr>
<td>10,001 to 12,500 Units</td>
<td>$50,000 plus $10/unit over 10,000 units</td>
</tr>
</tbody>
</table>

In addition to these costs, any change in a product’s production volume flexibility costs $10,000 in one-time (fixed) costs. These production order volume flexibility costs are recorded as “Production FC” on your Corporate P&L Statement.

“Incremental production order volume flexibility” refers to the extra flexibility in a product’s production volume change limit from month to month, beyond the standard allotment of 10,000 units for each product. For example, suppose that you select 4,200 units of incremental production order volume flexibility for a product. Then, that product’s production volume could change by a maximum of 14,200 units (10,000 units from the standard allotment plus 4,200 in [optional] incremental production volume flexibility) from the previous month’s production volume for that product.

Production volume flexibility is specific to each product. Thus, you may provide for some incremental production volume flexibility (over the standard allotment of 10,000 units) for one product but not for others. Incremental production volume flexibility is possible for product 0, like all other products.

To engage production volume flexibility, two steps are required.
1. First, change production volume flexibility for a product to the desired additional production volume (i.e., number of units) above and beyond the standard production volume change limit of 10,000 units for a product.
2. Second, change production for a product to the desired level, which includes any extra flexibility provided by the current input-value for production volume flexibility.

### FYI: Volume Flexibility Possibilities

- **Labor**
  - Using overtime and temps
  - Cross-training workers

- **Equipment**
  - Deploying flexible equipment
  - Sharing equipment with strategic partners

- **Management Planning/Control Systems**
  - Improving sales forecasting accuracy
  - Better coordination of manufacturing and sales
  - Reducing manufacturing lead times
  - Optimizing inventory holdings

- **Suppliers and Vendors**
  - Synchronizing procurement and manufacturing
  - Risk-pooling with multiple suppliers and vendors
  - Contract manufacturing and outsourcing
  - Subcontracting work during peak demand

Setting production volume flexibility to a non-zero value doesn’t automatically order extra production volume. Production volume flexibility just permits you to exceed the standard production volume change limit by the current input-value in production volume flexibility.

**Unfilled Orders**

Unfilled orders can exist in your set-top box industry. If demand for any product exceeds the product’s emergency production limit, customer sales and scheduled product shipments to other DCs must be reduced (proportionately) by the amount that orders exceed the product’s emergency production limit. The difference between potential customer sales (orders) and actual customer sales due to inadequate on-hand finished goods inventory (after accounting for a product’s emergency production limit) is "unfilled orders" in LINKS.

*Unfilled orders are not backlogged orders. Unfilled orders are not guaranteed (i.e., contracted, pre-paid) future sales.* Unfilled orders occur at a particular time due to inventory shortages relative to potential customer demand (orders), given competitive conditions at that particular time. **Unfilled orders incur processing and handling costs of $25/unit.**

Past experience suggests that current unfilled orders reflect three types of set-top box customers. Some customers immediately defect to another competitor’s (available) product. Other customers decide not to buy any set-top product now or in the near-term future. A third segment of customers are inclined to wait and attempt to repurchase the preferred product having these unfilled orders again in the future when supply (i.e., inventory availability) is more favorable. The size of these three types of unfilled-orders customers is unknown. In all cases, however, it should be expected that unfilled orders negatively impacting downstream demand to some extent.

If competitive conditions change (e.g., if you raise your unfilled-orders product’s price dramatically or competitors substantially improve their own product offerings and marketing programs), then the share of customers with unfilled orders who would have been inclined to attempt to repurchase your unfilled-orders product in the future can decrease. Additionally:

- If you drop a product with unfilled orders from active distribution in a particular channel and region, the unfilled orders associated with that product in that particular channel and region are completely lost. They will not shift to another product, even your own dropped product still actively distributed in another channel in that region.
- If you reconfigure a product with outstanding unfilled orders, those unfilled orders are lost.

Unfilled orders represent additional potential demand that might have been realized beyond "filled orders" (i.e., sales) if sufficient product supply had been available to meet all purchase requests. A high level of unfilled orders could also reflect industry-wide double-counting if multiple firms' products simultaneously have unfilled orders. If two products simultaneously have unfilled orders, then some customers might have wished to purchase first one of the products and then the other product when the stockout situation for the first product was encountered. In such a situation, a single customer would have been counted as an unfilled order by both stocked-out products.

The definition of unfilled orders varies by channel. For a direct channel (like channel #2), an unfilled order to an end-user customer is the same as an unfilled order to the manufacturer. However, for an indirect channel (like channel #1), inventory buffer stock routinely maintained by retailers complicates the interpretation of unfilled orders. If retailers order 1,000 units from a manufacturer but that manufacturer is only able to fill 600 units of that order, this represents 400
units of unfilled orders to the manufacturer. However, this doesn't necessarily mean that retailers have unfilled orders from end-user customers. If the 600 units of the retailers' manufacturer-order yield sufficient on-hand retailer inventory to permit all end-user customer orders to be filled, then there are no unfilled orders as far as retailers are concerned. (In this case, retailers' ending inventory level would be below the desired level, which presumably would lead to increased orders in the following month to meet expected end-user customer demand plus inventory restocking targets.) With the buffering nature of retailer inventory, there could be no industry-wide unfilled orders but individual manufacturers could still have unfilled orders in channel #1.

If dealers stockout, they will reorder in anticipation of future (continuing) rising demand above current sales levels, as well as accounting for their (i.e., dealers') desired future inventory levels. These are the total unfilled orders that manufacturers see arising from channel #1. Industry-wide unfilled orders, as reported in Research Study #12, reference actual final end-user customer stockouts now (not in the future). Note, too, that since industry-wide unfilled orders are customer-based, industry-wide unfilled order estimates presumably are based on customer surveys. Such survey-based estimates contain some statistical noise as well as reflecting the potential for biases in customer surveys, especially if there are lots of customers who encountered stockout situations. Thus, even a thoughtful/rational survey respondent might claim to have wanted to buy and encountered a stockout situation, to encourage manufacturers to have more plentiful inventory, especially when no contractual purchase commitment is required within the survey.

**Manufacturing Decisions Form**

A blank "Manufacturing Decisions" form may be found on the next page. Complete this decision form during your team deliberations.
Manufacturing Decisions

<table>
<thead>
<tr>
<th>Manufacturing Decisions</th>
<th>Product 0</th>
<th>Product 1</th>
<th>Product 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Production Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Volume Flexibility</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
(1) "Product 0" refers to postponed-production units.
(2) Each production volume may change by a maximum of 10,000 units from the preceding month's value. You may, however, change production to 0 at any time. However, note that with a production value of 0 units, the following month's production volume would be limited to a maximum of 10,000 units.

Reminders

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

Don't forget to zero-out prior production decisions if you don't wish them to continue on into the next month.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 6: Distribution Decisions

Distribution decisions in LINKS include whether you have distribution centers (DCs) in regions other than your home-base (i.e., region 1) and, if so, the form of those DCs (outsourced vs. owned). For each region-specific DC, you also face decisions related to how RFID-application occurs for products distributed through the retail channel (channel #1), whether to enable cross-docking with one or more carriers, and surface shipping methods for finished goods inventory shipped from DC1 to other DCs and for in-bound surface shipments of sub-assembly components to each DC.

While you must always have an owned DC in region 1, you may or may not wish to have DCs in other regions. Even if you choose not to have a distribution center in a market region other than market region 1, you can still have sales in that market region if you choose to have products in active distribution in any channel in that market region. Such sales would be serviced directly from your region 1 DC.

Retailers require that set-top boxes be equipped with RFID (radio-frequency identification). RFID is applied to your outbound set-top box products at your distribution centers. Only products distributed to the retail channel (i.e., channel #1) require RFID-application. At each distribution center, you may use outsourced or insourced RFID-application.

With cross-docking enabled at a DC, inventory holding costs and DC operating costs are reduced because inbound shipments are directly transferred to outbound (local) carriers with reduced regional-DC handling, warehousing, and administration. Cross-docking is possible at all regional DCs (i.e., at third-party and owned regional DCs) other than DC1. Cross-docking decisions involve balancing the trade-offs between cross-docking costs and DC operating cost reductions associated with cross-docking enablement.

Surface shipping methods provide three levels of surface shipping for finished goods shipments from DC1 to other DCs and for in-bound surface shipping of sub-assembly components to each DC. Surface shipping methods include expedited, standard, and economy surface shipping with associated consequences for surface shipping delivery reliability and cost.
Distribution Center Decisions

While you must always have an owned DC in region 1, you may or may not wish to have DCs in other regions. Even if you choose not to have a distribution center in a market region other than market region 1, you can still have sales in that market region if you choose to have products in active distribution in any channel in that market region. Such sales would be serviced directly from your region 1 DC.

With a distribution center in a market region:
- Replacement parts demand is fulfilled from that regional DC, rather than from DC1, thus requiring inventories of sub-assembly components to be maintained at such regional DCs.
- Postponed production is possible with owned “local”-region distribution centers. Postponed production at an owned DC has further implications for inventories of sub-assembly components at that regional DC.
- When a regional distribution center opens, you’ll have no inventory of sub-assembly component Epsilon available at that DC for the first month. All first-month usage of Epsilon will be on an emergency basis, with consequent first-month emergency ordering costs.
- Transportation of finished goods to customers from a regional DC is via surface transportation. Otherwise, air transportation is required to ship finished goods from the distribution center in region 1 to customers in other regions without a local distribution center.

Three distribution center decision options exist in regions other than region 1. In region 1, your firm always owns your distribution center (located adjacent to your manufacturing plant in region 1). The distribution center decision options, along with their cost consequences, are as follows:
- Decision Option "0" (no distribution center): No distribution center costs exist.
- Decision Option "1" (outsourced third-party distribution center): With third-party logistics, your firm outsources your regional distribution center to a reputable partner in a region. Outsourced distribution centers involve one-time costs of $100,000 to open an outsourced distribution center, $50,000 in one-time costs to close an outsourced distribution center.

Case Study: When the Storm Hits: Home Depot’s Preparations

Here’s how Home Depot uses its supply chain to prepare for the before, during, and after of hurricane season — and to ensure that customers and employees get their needs met.

- Pre-Season: Supply chain managers place orders in November, based on past storm data, so products like gas cans, generators, and plywood are stocked in three hurricane-specific distribution centers by June. Before Hurricane Gustav in 2008, 500 trucks full of supplies went to distribution centers.
- Storm Detected: The command center opens gradually except in the case of category 2 to category 5 storms heading for a populated area, or a category 1 storm in a very populated area. Planners track the weather and handle everything from store needs to placing products near impact zones to finding employees shelter.
- Landfall: Home Depot tries to be the last retailer to close and the first to reopen. Employees secure stores. When winds hit 45 mph, stores close. The command center operates from 7am to midnight, arranging for additional needs. During Gustav, 300 trucks reached the 35 affected stores.
- Post-Storm: Stores reopen as soon as field teams assess the area, selling high-demand products like flashlights, tarps, and lumber. Batteries come in containers that can be opened directly on the floor; lumber can be loaded straight from a truck into a car. Temporary stores may open in parking lots and elsewhere.

center, $50,000 in monthly costs as long as your firm has an outsourced distribution center in any region, and inventory charges of 5% based on the inventory value at any outsourced distribution center. One-time $100,000 costs are incurred to open any outsourced distribution center or to convert an owned distribution center to outsourced status.

- Decision Option "2" (operate owned distribution center): In operating owned distribution centers, your firm incurs one-time costs of $250,000 to open an owned distribution center in any market region, $150,000 in one-time costs to close any owned distribution center, $25,000 in monthly costs as long as your firm owns a regional distribution center, and inventory charges of 3% based on the inventory value at owned regional distribution centers. These one-time costs of $250,000 are incurred to open any owned distribution center or to convert any outsourced distribution center to owned status.

Inventory costs are recorded under "Inventory Charges" and other distribution costs are recorded under "Distribution FC" on the "Corporate P&L Statement."

Your firm either has no DC in a region or your firm has one DC in a region. Your firm never has more than one DC in a region. The DC status code “2” denotes an owned DC in a region, not two DCs in that region.

DC-openings and DC-conversions (from outsourced to owned or from owned to outsourced) occur immediately (i.e., at the start of the next month). In DC-conversions, existing inventory is automatically transferred to the new DC-form.

The LINKS software automatically disposes of residual inventory of sub-assembly components and finished goods when a DC is closed. The inventory is converted to cash at the current balance-sheet values and a corresponding disposal cost of 20% of the inventory's value accrues. This disposal cost is recorded under Consulting Fees on the firm's P&L statement. An appropriate disposal-sale message appears at the end of the firm's financial statements.

Postponed production is only possible with an owned DC in a region, not with a third-party DC or with no DC.

**RFID-Application For Retail-Channel Sales**

A recent development in the set-top box industry has increased your costs associated with selling through the indirect channel (i.e., channel #1). Retailers of set-top box products now require that your products be equipped with RFID (radio-frequency identification). Compared to bar codes, radio tags can carry more information about products, can be scanned more rapidly, and can be located easily even if they are hidden in cartons or behind other products. RFID is seen as the long-term successor to bar codes throughout the retail industry.

RFID is applied to your outbound set-top box products at your distribution centers. Only products being distributed to the retail channel (i.e., channel #1) require RFID-application.

At each distribution center, you have two choices with regard to how RFID is included on your set-top box products sold through the indirect (retail) channel.

- **Decision Option 0 (outsourced RFID-application):** Your current practice is to outsource RFID application to a reputable vendor in each market region in which you have a distribution center. Outsourcing adds $11 in variable costs to all of your set-top box products sold through the retail channel (i.e., channel #1).
• Decision Option 1 (insourced RFID-application): You can insource the provision of RFID for products sold through the retail channel. Insourcing incurs a one-time investment of $350,000 (for capital equipment purchases, process reorganization, and staff retraining) and reduces the variable costs to $1 for all set-top box products sold through the retail channel (i.e., channel #1). The one-time investment of $350,000 is recorded under "Consulting Fees" on your corporate profit-and-loss statement.

Note that there is no re-sale market for used RFID equipment. Therefore, you would not be able to recapture any part of the one-time $350,000 investment in RFID insourcing at any distribution center if you subsequently choose to close that distribution center.

Your RFID decision is specific to each distribution center. Thus, you may choose to insource at some DCs and outsource at other DCs, as you wish.

RFID insourcing is only possible if you already have (or simultaneously open) a DC in a region. With no DC in a region, your set-top box products must be sourced from DC1 and your RFID status at DC1 will be in effect for your retail-channel sales in other regions without a local DC.

Emergency Carriers For Plant-To-DC Shipments

You must also choose an emergency carrier for each of your DCs (other than DC1). This emergency carrier for each DC (other than DC1) is used for plant-to-DC transportation shipments required on an emergency basis. Your emergency carrier choices are recorded on the Distribution Decisions form, since these decisions are specific to each DC.

Cross-Docking

With cross-docking enabled at a DC, inventory holding costs and DC operating costs are reduced because inbound shipments are directly transferred to outbound (local) carriers with reduced regional-DC handling, warehousing, and administration. In LINKS, cross-docking is possible at all regional DCs (i.e., at third-party and owned regional DCs) other than DC1. Due to technology infrastructure considerations, cross-docking is only possible with carriers K, L, M, and N.

Cross-docking decisions involve balancing the trade-offs between cross-docking costs and DC operating cost reductions associated with cross-docking enablement.

• Cross-Docking Costs
  • One-time fixed costs to enable cross-docking with a specific carrier are $7,500/carrier.
  • On-going (monthly) maintenance costs with each shipper where cross-docking is enabled are $2,500/carrier.

Case Study: Cross-Docking at Wal-Mart

Wal-Mart developed cross-docking processes in which goods come from the suppliers to Wal-Mart’s distribution centers (DCs) and are moved immediately to the stores. This process reduced DC warehousing costs and, more important, eliminated an echelon in the distribution chain. Rather than ordering from the store to the DC and from the DC to the suppliers, the stores were, in fact, ordering directly from the suppliers.

• **DC Operating Cost Reductions Associated With Cross-Docking**
  - Reduced inventory charges associated with cross-docked shipments (reduced by 0.5%, from 5% to 4.5% for third-party DCs and from 3% to 2.5% for owned DCs), based on the relative proportion of shipments received by a regional DC via carriers with cross-docking enabled in a month. Due to special processing and handling requirements, cross-docking is not possible for emergency shipments of finished goods inventory from DC1 to other DCs. In calculating cross-docking cost reductions in inventory charges, the maximum applicable finished goods inventory valuation at a DC with cross-docking enabled is $5,000,000.²
  - Reduced monthly DC operating costs for each cross-docking enablement (monthly DC operating costs are reduced by $1,000/carrier for each existing carrier-specific cross-docking capability enabled at a regional DC other than DC1).

Cross-docking costs on the "Corporate P&L Statement" reflect the net costs (positive or negative) associated with cross-docking, including the reduction in finished goods inventory charges associated with cross-docked shipments. Thus, regular inventory charges accrue under "Inventory Charges" and off-setting cross-docking cost reductions are included in the "Cross-Docking" line-item.

Cross-docking operates identically for surface and air shipments. The presence or absence of cross-docking enablement with a specific carrier has no impact on that carrier’s surface or air delivery reliability.

At each distribution center (other than DC1), you have two choices with regard to cross-docking for each of carriers K, L, M, and N:

- **Decision Option 0:** No cross-docking exists with a specific carrier. Existing cross-docking enablement with a specific carrier is terminated if you change your cross-docking decision from "1" to "0" for that carrier. No special costs accrue with the termination of cross-docking enablement with a specific carrier.

- **Decision Option 1:** Cross-docking is enabled with a specific carrier (or cross-docking continues to be enabled, if cross-docking was already in effect in

---

**FYI: About Cross-Docking**

Cross-docking is the practice of receiving goods at one door of a facility and shipping out through another door almost immediately without putting the goods in storage.

Why is cross-docking of interest to supply chain managers? Generally, cross-docking involves cost control, acceleration of inventory velocity, just-in-time service, and responsiveness to customer demand.

- Improved customer service can follow from cross-docking, especially for perishable goods, and perishable goods reach customers faster, preserving quality and freshness.
- Cross-docking gets the right product mix to the right customers. Some cross-docks break pallets into individual orders via layer picking or even case picking to get stores what they need. Store-ready orders can be prepared by suppliers for shipment to the cross-dock, and then routed for store delivery.
- Since product doesn’t need to be handled multiple times, labor is reduced. Product isn’t put into storage to be picked later. The product waits for shipment on the trailer it will ship on, so extra handling is by-passed.
- By consolidating LTL (less-than-truckload) shipments into full loads via cross-docking, freight savings accrue.


---

² Finished goods inventory valuation in excess of $5,000,000 yields no additional inventory cost savings due to cross-docking.
the previous month).

Cross-docking involves in-bound shipments from DC1 to another DC. If there are no in-bound shipments to a DC via a carrier with cross-docking enabled in a particular month, then there are no cross-docking cost-savings associated with that carrier in that month at that DC.

**Surface Shipping Methods**

Surface shipping methods provide three levels of surface shipping for finished goods shipments from DC1 to other DCs and for in-bound surface shipping of sub-assembly components to each DC. Surface shipping methods include expedited, standard, and economy surface shipping with associated consequences for surface shipping delivery reliability and cost.

FGI surface shipping is specific to each DC (other than DC1) and applies to all carriers’ surface shipments of finished goods from DC1 to that DC. The full details about FGI Surface Shipping are provided in Chapter 7 (Transportation Decisions).

SAC surface shipping provides three levels of surface shipping for in-bound sub-assembly components to each DC. The full details associated with surface shipping method are provided in Chapter 4 (Procurement Decisions).

**Distribution Decisions Form**

A blank "Distribution Decisions" form may be found on the following page. Complete this decision form during your team deliberations.
## Distribution Decisions

<table>
<thead>
<tr>
<th>Distribution Decisions</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution Center? {0=none</td>
<td>1=outsourced</td>
<td>2=owned}</td>
<td></td>
</tr>
<tr>
<td>RFID-Application? {0=outsourced</td>
<td>1=insourced}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Carrier? {I</td>
<td>J</td>
<td>K</td>
<td>L</td>
</tr>
<tr>
<td>Cross-Docking, Carrier K {0=no</td>
<td>1=yes}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-Docking, Carrier L {0=no</td>
<td>1=yes}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-Docking, Carrier M {0=no</td>
<td>1=yes}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-Docking, Carrier N {0=no</td>
<td>1=yes}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FGI Surface Shipping {1=Economy</td>
<td>2=Standard</td>
<td>3=Expedited}</td>
<td></td>
</tr>
<tr>
<td>SAC Surface Shipping {1=Economy</td>
<td>2=Standard</td>
<td>3=Expedited}</td>
<td></td>
</tr>
</tbody>
</table>

### Reminders

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 7: Transportation Decisions

Chapter 7 Overview

The LINKS transportation decisions include transportation mode choice (surface and air) for in-bound sub-assembly components and transportation mode choice (surface and air) and carrier selection for finished goods shipments from your plant to your distribution centers (DCs).

Surface transportation is less expensive and less reliable than air transportation. Mode choice (surface and air) and carrier selection involves explicit trade-offs between cost and performance. The regional distribution center in region 1 is located adjacent to your manufacturing plant, so there are no transportation costs associated with shipments of products to your distribution center in market region 1. For all other market regions, transportation decisions are required to ship your products to regional distribution centers. You make shipment volume decisions across two possible transportation modes (surface and air) and six possible carriers (I, J, K, L, M, and N).

Based on past experience, 100% of all postponed production and finished goods shipped by air arrives at regional DCs to meet current-month orders. This 100% reliability of delivery is a major advantage of air transportation: guaranteed delivery performance. Of course, air transportation does have a cost premium over surface transportation.

All carriers offer a 20% rebate on the current month's transportation charges if they are used exclusively in a given month. Your shipments from your manufacturing plant to all of your DCs may be divided between surface and air, but the 20% rebate only accrues if 100% of your shipped plant-to-DC volume is made via a single carrier.

You must also choose an emergency carrier for each of your DCs (other than DC1). This emergency carrier for each DC (other than DC1) is used for plant-to-DC transportation shipments required on an emergency basis.

FGI surface shipping, a distribution decision variable in LINKS, is specific to each DC (other than DC1) and applies to all carriers' surface shipments of finished goods from DC1 to that DC. FGI surface shipping options include expedited, standard, and economy possibilities, with corresponding performance (surface delivery reliability) and cost trade-offs.

This chapter details the transportation decisions for which you are responsible in LINKS:
- transportation mode choice (surface and air) for in-bound sub-assembly components
- transportation mode choice (surface and air) and carrier selection for finished goods shipments from your plant to your distribution centers (DCs).

Surface transportation is less expensive and less reliable than air transportation. Mode choice (surface and air) and carrier selection involves explicit trade-offs between cost and performance.

Damage rates are comparable and relatively low across set-top box industry carriers. Carriers are
contractually responsible for damages arising in goods under their care. If carriers accept a shipment from a manufacturer, then they are responsible for it throughout the shipment journey. Thus, damage is not a major consideration in your LINKS transportation decisions.

**Transportation Responsibilities**

Different kinds of transportation decisions are required in different parts of your supply chain.

- **Inbound Raw Materials**: Vendors of raw materials in the set-top box industry provide inbound transportation as part of their bundled prices. Thus, there are no transportation decisions for set-top box manufacturers to make with regard to raw materials.

- **Inbound Sub-Assembly Components**: Suppliers and manufacturers are jointly responsible for transportation decisions regarding inbound shipments of sub-assembly components. Suppliers quote unbundled sub-assembly component and transportation mode costs (surface and air). Manufacturers choose modes but suppliers arrange specific carriers for each transaction. Cost and operating details for these transportation modes are provided in Chapter 4. Suppliers choose specific carriers for sub-assembly components to deal with less-than-truckload orders economically and to efficiently manage cross-industry transportation requirements for sub-assembly components.

- **Plant-To-DC Shipments**: Manufacturers are responsible for all transportation decisions related to within-firm shipments of postponed production and finished goods from manufacturing plants to DCs. Transportation decisions include mode choice (surface and air) for carriers I, J, K, L, M, and N. Cost and operating details are provided in this chapter.

- **DC Shipments To Customers**: Set-top box manufacturers ship by surface from within-region DCs and ship by air for customer shipments where a local DC doesn't exist (and direct shipment from DC1 is required). Since corporate policy and set-top box industry custom dictates the transportation modes and the carriers used, there are no active decisions required within LINKS at this supply chain linkage. Since the standard costs associated with DC shipments to customers are borne by manufacturers, these transportation activities impact the financial performance of manufacturers. If customers prefer expedited transportation above and beyond the standard transportation modes used, customers absorb any incremental costs associated with expedited transportation.

Exhibit 8 summarizes the roles of transportation throughout the set-top box industry supply chain. Some transportation decisions are the responsibility of suppliers, others are shared between suppliers and manufacturers, and still others are the manufacturer's responsibility.

**Plant Shipments To Distribution Centers**

The regional distribution center in region 1 is located adjacent to your manufacturing plant, so there are no transportation costs associated with shipments of products to your distribution center in market region 1. For all other market regions, transportation decisions are required to ship your products to regional distribution centers. You make shipment volume decisions across two possible transportation modes (surface and air) and six possible carriers (I, J, K, L, M, and N).
Exhibit 8: Transportation Responsibilities

**Notes:** Transportation responsibilities in the set-top box industry are indicated by the bolded and italicized text at each supply chain linkage point where transportation activity occurs. The set-top box manufacturer's supply chain management responsibility domain is shaded. Recall that set-top box manufacturers both manufacture and manage distribution centers in the set-top box industry.
Based on past experience, 100% of all postponed production and finished goods shipped by air arrives at regional DCs to meet current-month orders. This 100% reliability of delivery is a major advantage of air transportation: guaranteed delivery performance. Of course, air transportation does have a cost premium over surface transportation.

Based on past experience, an average of about 70% of surface transported volume arrives at regional DCs in time to meet current-month orders. However, average surface delivery performance varies across carriers and regions. The range of surface transported production volumes received within the current month varies from about 40% to 100%. Surface transported finished goods volume that does not arrive within the current month always arrives by the end of the current month and it is, therefore, available for meeting orders in the following month.

Current transportation costs per unit between your manufacturing plant and your regional distribution centers for all carriers are shown in Exhibit 9. Note that these transportation costs are identical for all set-top box products (i.e., for hyperware and metaware products). Since postponed production can be shipped in bulk form to regional distribution centers, the cost of postponed production is 50% of the costs associated with transporting finished goods to a DC.

The surface delivery rates ("Delivery") in Exhibit 9 are averages. The typical range of delivery rates is shown in "±" form (for example, "70% ± 8%" reflects an average surface delivery rate of 70% with a typical range for that average being 62% to 78%. The "100%" delivery reliability for air transportation reflects the certainty of delivery within the current month when air transportation is chosen for plant-to-DC shipments.

Occasionally, carriers have limited space and are unable to offer shipping services in a particular month due to prior contractual obligations, seasonal forces, or environmental developments (e.g.,

FYI: Transportation Strategy

“When contracting for transportation, it is common for U.S. companies to bid for capacity on certain origin-destination movements ("lanes") and then bid separately for ‘surge capacity.’ Surges occur when a company’s business grows unexpectedly in certain regions of the country (as a result of weather, for example or because of an unanticipated large order). Transportation carriers cannot be expected to have trucks or rail cars in reserve everywhere ‘just in case.’ They can, however, put in place certain operational procedures to identify available resources and move them around, helping them to respond to surges. Such surge capacity is typically priced higher, in acknowledgement of the extra equipment repositioning required by the carriers to respond to the increased demand.”


FYI: Surface Transportation Delays

“In many parts of the world, the transportation infrastructure is relatively undeveloped or congested. Imagine, for example, sourcing product from a factory in Wuhan, China for retail sale within the US. After manufacture, the product may travel by truck, then by rail, by truck again, and then be loaded at a busy port; and it may repeat the sequence of steps (in reverse order) within the US. At each stage the schedule may be delayed by congestion, bureaucracy, weather, and road conditions.”

Source: John J. Bartholdi and Steven T. Hackman, Warehouse & Distribution Science (Atlanta: Georgia Institute of Technology, 2010), p. 5.
strikes, equipment limitations, etc.). Set-top box manufacturers that already have an on-going relationship with a carrier (i.e., firms using a carrier last month) receive preferential treatment as existing customers and, therefore, are normally unaffected by such spot-market unavailability. If your firm's carriers are unavailable in any month, carrier N is used. Carrier N has an unblemished record of availability and is the recognized carrier-of-last-resort in the set-top box industry.

All carriers offer a 20% rebate on the current month's transportation charges if they are used exclusively in a given month. Your shipments from your manufacturing plant to all of your DCs may be divided between surface and air, but the 20% rebate only accrues if 100% of your shipped plant-to-DC volume (including emergency shipments, if any) is via a single carrier. This rebate is recorded as "Transportation Rebates" on your "Corporate P&L Statement."

You must also choose an emergency carrier for each of your DCs (other than DC1). This emergency carrier for each DC (other than DC1) is used for plant-to-DC transportation shipments required on an emergency basis. Your emergency carrier choices are recorded on the Distribution Decisions form, since these decisions are specific to each DC.

### Exhibit 9: Plant-To-DC Transportation Shipments

<table>
<thead>
<tr>
<th>Market Region 1</th>
<th>Market Region 2</th>
<th>Market Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrier I, Surface</td>
<td>Cost</td>
<td>Delivery</td>
</tr>
<tr>
<td>Carrier I, Air</td>
<td>$6</td>
<td>70% ± 4%</td>
</tr>
<tr>
<td></td>
<td>$8</td>
<td>100%</td>
</tr>
<tr>
<td>Carrier J, Surface</td>
<td>$4</td>
<td>40% ± 8%</td>
</tr>
<tr>
<td>Carrier J, Air</td>
<td>$10</td>
<td>100%</td>
</tr>
<tr>
<td>Carrier K, Surface</td>
<td>$6</td>
<td>70% ± 12%</td>
</tr>
<tr>
<td>Carrier K, Air</td>
<td>$8</td>
<td>100%</td>
</tr>
<tr>
<td>Carrier L, Surface</td>
<td>$8</td>
<td>75% ± 4%</td>
</tr>
<tr>
<td>Carrier L, Air</td>
<td>$10</td>
<td>100%</td>
</tr>
<tr>
<td>Carrier M, Surface</td>
<td>$6</td>
<td>65% ± 8%</td>
</tr>
<tr>
<td>Carrier M, Air</td>
<td>$8</td>
<td>100%</td>
</tr>
<tr>
<td>Carrier N, Surface</td>
<td>$10</td>
<td>82% ± 12%</td>
</tr>
<tr>
<td>Carrier N, Air</td>
<td>$12</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Note:** Since your manufacturing plant is located adjacent to your DC in market region 1, there are no transportation shipments from your manufacturing plant to DC1.
Distribution Center Shipments To Customers

Your firm is responsible for covering all costs associated with shipping your products from your DCs to your customers, to retailers in the retail channel (channel 1) and to end-users in the direct channel (channel 2).

- If your firm has a distribution center in a market region, then that distribution center is used to service all orders for set-top boxes. Your firm's policy is to ship by surface transportation when you have a within-region distribution center. Occasionally, customers may request expedited shipment, but the custom in the set-top box industry is for customers to pay any incremental shipping charges above surface transportation rates.

- If your firm does not have a distribution center in a market region, then the distribution center in market region 1 (i.e., the distribution center associated with your manufacturing plant) must service such an order. Your firm's transportation policy is to ship via air in such situations, to ensure prompt delivery to customers within the current month.

The transportation costs associated with customer shipments are shown in Exhibit 10. Since direct-channel customers order in smaller quantities, shipping costs to customers in the direct channel (channel 2) are higher than the retail channel (channel 1). The cost of shipping replacement parts to end-users is 50% of the cost of shipping finished products to customers.

Exhibit 10: Customer Shipment Transportation Costs (Per Unit)

<table>
<thead>
<tr>
<th></th>
<th>Within-Region Surface Transportation Costs</th>
<th>Sourcing From Plant/DC1 With No Within-Region DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel 1</td>
<td>Channel 2</td>
</tr>
<tr>
<td>Market Region 1</td>
<td>$4</td>
<td>$8</td>
</tr>
<tr>
<td>Market Region 2</td>
<td>$6</td>
<td>$12</td>
</tr>
<tr>
<td>Market Region 3</td>
<td>$8</td>
<td>$16</td>
</tr>
</tbody>
</table>
Outbound Shipments

If the Exhibit 9 and Exhibit 10 data are combined, the total transportation costs for outbound shipments may be determined for any choice of plant-to-DC carrier. The total transportation costs for "outbound shipments" refers to finished goods transportation costs from the manufacturing plant to the customer, either through the "local" DC if one exists or directly from the plant/DC1 to regions where no "local" DC exists. Exhibit 11 contains the relevant calculations for a sample carrier, carrier I. Alternative calculations would follow for other plant-to-DC carriers.

- Total transportation costs for "air to DC" shipping exceed "surface to DC" shipping.
- In all cases, total transportation costs are less when a "local" DC exists than when air sourcing is required from the plant/DC1 because no "local" DC exists. Of course, this variable cost advantage for having a "local" DC does not take into account the fixed costs of operating DCs and the incremental management effort required to manage a more complicated supply chain.
- In all cases, channel 1 total transportation costs are less than channel 2 total transportation costs, reflecting the relative costliness of shipping to individual (direct) customers purchasing single units of set-top boxes.

### Exhibit 11: Sample Plant-DC-Customer Total Transportation Costs

<table>
<thead>
<tr>
<th></th>
<th>Channel 1</th>
<th>Channel 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Local&quot; DC</td>
<td>Air Sourced From Plant/DC1</td>
</tr>
<tr>
<td></td>
<td>Surface To DC</td>
<td>Air To DC</td>
</tr>
<tr>
<td>Region 1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Region 2</td>
<td>6+6=12</td>
<td>8+6=14</td>
</tr>
<tr>
<td>Region 3</td>
<td>10+8=18</td>
<td>14+8=22</td>
</tr>
</tbody>
</table>

**Notes:** These total transportation costs refer to finished goods, not to postponed production. They reflect the sum of the cost of shipping finished goods from the plant/DC1 to the regional DC plus the cost of shipping finished goods to the final customer from the regional DC. With sourcing from plant/DC1 (when there is no "local" DC), the former cost is, of course, zero. These sample total transportation cost calculations reference carrier I for plant-to-DC shipments.

Emergency Transportation Shipments

LINKS calculates inventory requirements at DCs in the first instance assuming that all potential demand can be met. This can lead to "tentative" emergency shipments being created from DC1 to other regions. After making adjustments for possible conversion of available postponed
production and the availability of emergency production capability, remaining excess demand over available inventory results in unfilled orders. Then, for example, if total worldwide unfilled orders represent 28.35% of total potential demand, all shipments including "tentative" emergency shipments are reduced by 28.35% to reflect the unfilled orders situation.

Intuitively, this situation is interpreted as follows. The regular (planned) surface and air transportation system is overwhelmed by unfilled orders. Surface and air transportation is planned ahead of time, presumably on a more-or-less regular basis throughout a month (e.g., weekly shipments). With unfilled orders occurring, (unplanned) emergency shipments have to occur immediately to meet on-going unfilled orders. This can result in regular surface and air transportation shipments being converted to emergency shipments, with a corresponding reduction in the original amounts of the regular surface and air transportation shipments.

Emergency transportation shipments to a regional DC cost 50% more than the current air transportation costs of your designated regional emergency carrier.

**FGI Surface Shipping**

FGI surface shipping, a distribution decision variable in LINKS, is specific to each DC (other than DC1) and applies to all carriers’ surface shipments of finished goods from DC1 to that DC.

- **Expedited Surface Shipping (level 3):** With expedited surface shipping (i.e., the proverbial “rush job”), carriers typically bypass consolidation hubs to ship directly to final destinations. Shipments of any size, even small lots, are possible via expedited shipping. In LINKS, expedited surface shipping of finished goods from DC1 to other DCs increases surface shipping delivery reliability by 10%-20%. For example, expedited surface shipping for carrier I in region 2 increases surface shipping delivery reliability from 70% to 77%-84%. The cost of expedited surface shipping is 25% above a carrier’s standard surface shipping cost as specified in Exhibits 8 and 9.

- **Standard Surface Shipping (level 2):** Standard surface shipping is the normal form of surface shipping for finished goods inventory from DC1 to other DCs in LINKS. Standard surface shipping costs and delivery reliability parameters are specified in Exhibits 8 and 9.

- **Economy Surface Shipping (level 1):** With economy shipping, shippers save costs (passed on to their clients) by consolidating shipments into large shipping units such as full truck-loads or full container-loads. Economy shipments typically involve spot-market bidding for low-cost shipping and consequent delays due to the consolidation process. Longer shipping times and greater use of interlining (i.e., transferring across shippers each of whom serve a limited geographical area) combine to decrease shipping costs and delivery reliability. Relative to standard performance and costs in Exhibits 8 and 9, economy surface shipping reduces shipping costs by 30% and reduces surface delivery reliability by 35%-40%. For example, economy surface shipping for carrier I in region 2 decreases surface shipping delivery reliability from 70% to 42%-45%.

Transportation costs are reported in the LINKS financial reports for Standard Surface Shipping. Incremental adjustments in transportation costs for Expedited Surface Shipment and Economy Surface shipping accrue as Transportation Rebates on the LINKS financial reports. Expedited Surface Shipments would be reflected as negative Transportation Rebates while Economy Surface Shipments would be reflected as positive Transportation Rebates.
FGI surface shipping decisions are recorded as distribution decisions in LINKS, since they refer to decisions regarding distribution center management. DC1 shares common inventory (raw materials, sub-assembly components, and finished goods inventory) with your manufacturing plant.

**Transportation Decisions Form**

A blank "Transportation Decisions" form may be found on the following page. Complete this decision form during your team deliberations.
## Transportation Decisions

### Plant Shipments To DC2

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Carrier I</th>
<th>Carrier J</th>
<th>Carrier K</th>
<th>Carrier L</th>
<th>Carrier M</th>
<th>Carrier N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product 0, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 0, Air</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 1, Surface</td>
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<tr>
<td>Product 1, Air</td>
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<td>Product 2, Surface</td>
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<td>Product 2, Air</td>
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</tbody>
</table>

### Plant Shipments To DC3

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Carrier I</th>
<th>Carrier J</th>
<th>Carrier K</th>
<th>Carrier L</th>
<th>Carrier M</th>
<th>Carrier N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product 0, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 0, Air</td>
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<td></td>
</tr>
<tr>
<td>Product 1, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 1, Air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 2, Surface</td>
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<tr>
<td>Product 2, Air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

1. "Product 0" refers to postponed-production units.
2. Residual inventory (inventory not explicitly shipped to another DC) is automatically "shipped" from your plant to your adjacent DC in region 1, with no associated shipment costs.

### Reminders

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

Don't forget to zero-out prior transportation decisions if you don't wish them to continue on into the next month.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 8: Service Decisions

Rather than actively managing service, service is outsourced in the LINKS Supply Chain Management Simulation. Service outsourcing is provided by reputable call-center service providers in each region and is region-specific. You may freely choose from among the four available service outsourcing options/levels in each region, in addition to level "0" ("None" which implies no service is provided). Their per-call costs and associated guaranteed service quality performance levels ("SQ Guarantee") are detailed below:

<table>
<thead>
<tr>
<th>Service Outsourcing Level</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Minimum&quot; [1]</td>
<td>Cost/Call</td>
<td>$6</td>
<td>$7</td>
</tr>
<tr>
<td>SQ Guarantee</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>SQ Guarantee</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>&quot;Enhanced&quot; [3]</td>
<td>Cost/Call</td>
<td>$16</td>
<td>$18</td>
</tr>
<tr>
<td>SQ Guarantee</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>SQ Guarantee</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
</tr>
</tbody>
</table>

These "SQ Guarantees" are long-run averages. Service-center outsourcers guarantee that perceived service quality won't vary by more than 3% from these averages in any month. Costs for call-center service outsourcing are reported as "Service Outsourcing" on your financial and operating reports.

With service outsourcing, you automatically receive a summary "Service Center Operations Report" as part of your regular financial and operating reports.

A blank "Service Decisions" form may be found on the next page. Complete this decision form during your team deliberations.

FYI: Customer Interaction Costs

Estimates of representative customer interaction costs (in $US) are listed below:

- Self-Service Web Interaction: $0.1-$0.4
- Direct-Mail Contact: $0.25-$5
- Telephone Interaction: $2-$5
- Fax/Mail Interaction: $3-$6
- Telemarketing Interaction: $8-$24
- Telephone Support Interaction: $4-$75
- Field Sales Interaction: $40-$400

Source: Adapted from Figure 2 in Jonathan Wright and Jerry Quinn, "Enterprise Service Management: The Key To Service Excellence," Achieving Supply Chain Excellence Through Technology, Volume 4 (Montgomery Research, 2002), p. 190.
## Service Decisions

<table>
<thead>
<tr>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Outsourcing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reminders**

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 9: Generate Demand Decisions

Chapter 9 Overview

Your LINKS firm is responsible for channel selection, pricing, and marketing spending decisions. Aspects of your supply chain management decisions influence end-user demand (e.g., product configuration, sub-assembly component in-field failure rate, and service center performance). Supply chain management efforts must be closely coordinated with generate demand decisions.

There are two sales channels within LINKS market regions: retail and direct. You may choose to distribute your set-top box products in either, both, or neither channels in each market region. ("Neither" is the same as dropping a product from active distribution in a channel and region.)

- **Channel 1 is a retail channel.** The retail channel serves individual consumers who purchase set-top boxes for home use and businesses with set-top box needs. Retailers stock set-top boxes, along with an array of other similar and complementary electronic products. Retailers provide point-of-purchase support for in-person shoppers.

- **Channel 2 is a direct channel.** In the direct channel, firms sell set-top boxes directly to final customers via an e-commerce channel. Since your firm sells to final end-users in the direct channel, the price in the direct channel is the final price paid by customers.

You set prices for each product in each region and channel every month. The retail channel price is the bulk-rate price for units purchased for resale by retailers. In the direct channel, you set the final price paid by end-users.

A marketing spending budget is required for each product in each region and channel. This budget, managed by your firm’s region and channel managers, is used for advertising, promotion, and sales force efforts associated with your products. You’re free to allocate funds to marketing spending as you see fit and spending doesn’t have to be equal in all regions and channels.

Your LINKS firm is responsible for channel selection, pricing, and marketing spending decisions. Aspects of your supply chain management decisions influence end-user demand (e.g., product configuration, sub-assembly component in-field failure rate, and service center performance). Supply chain management efforts must be closely coordinated with generate demand decisions.

**Channel Decisions**

There are two sales channels within LINKS market regions: retail and direct. You may choose to distribute your set-top box products in either, both, or neither channels in each market region. ("Neither" is the same as dropping a product from active distribution in a channel and region.)
• **Channel 1 is a retail channel.** The retail channel serves individual consumers who purchase set-top boxes for home use and businesses with set-top box needs. Retailers stock set-top boxes, along with an array of other similar and complementary electronic products. Retailers provide point-of-purchase support for in-person shoppers.

• **Channel 2 is a direct channel.** In the direct channel, firms sell set-top boxes directly to final customers via an e-commerce channel. Since your firm sells to final end-users in the direct channel, the price in the direct channel is the final price paid by customers.

Alternative distribution channels tap into common and distinct customers, so the channels partially compete with each other. Some customers only purchase a set-top box product if it's available in their preferred distribution channel. Other customers purchase set-top box products from any of the available channels, to the extent that multiple channel options are available. These latter customers will, of course, shift some of their purchases away from existing channels and toward new channels, as new channels become available.

Another source of sales for new channels is channel-captive customers. Channel-captive customers have not purchased in the past due to the absence of products being sold via their strongly preferred channel, the channel to which they are captive. Markets can grow (i.e., total category sales volume can increase) as firms open new channels, since captive customers in non-available channels do not purchase unless products are available in the preferred channel.

Differential order processing costs accrue for sales in these two channels in all regions: $4/unit and $24/unit in channels 1 ("Retail") and 2 ("Direct"), respectively.

**Price Decisions**

"Price is what you pay. Value is what you get." – Warren Buffett

You set prices for each of your products that are actively distributed in each market region and channel each month. The retail channel price is the bulk-rate price for all units purchased for resale by retailers. The custom in the set-top box industry is to quote a single price regardless of order volume. In the direct channel, you set the final price paid by end-users.

You don't control final selling prices in the retail channel. Rather, your manufacturer price is marked up by a percentage by retailers in the various regions. You'll need to consult current research studies to determine average retailer prices for your products in the various regions. In the direct channel, you control final selling prices, since you're selling direct to final end-users.

You must take potential cross-channel competition into account in your price setting. If
you sell a product in multiple channels in a market region, some customers will inevitably seek out the lower-priced channel to purchase preferred brands.

Prices affect customer demand in the usual fashion for set-top boxes. Higher prices are normally associated with lower demand levels in all markets, categories, and channels. The specific price sensitivities in the markets, categories, and channels that you face in LINKS are unknown. You will need to learn about the markets’ price responsiveness through your experience in LINKS and by exploiting available LINKS research studies. It’s very easy to drop price to attempt to increase demand. However, it’s always an interesting question whether that increased demand actually increases profits. The price drop that generates increased demand also reduces margin on each unit sold. More importantly, it’s easy for competitors to see and feel threatened by price drops.

In addition to the physical costs of producing and distributing updated price sheets, lists, and databases that accrue when a manufacturer changes price (so-called “menu costs”), a range of indirect and non-obvious costs arise with price adjustments.  

- Managerial Costs: A manufacturer must gather information, analyze, assess, and ultimately communicate the logic associated with price changes throughout their firm. Managerial costs presumably increase with larger price changes, since there is more to assess/analyze and more organizational members become involved with larger price changes.
- Customer-Facing Costs: When implementing price changes, a communications program must be created and executed to portray a price change in the most favorable light to customers. In a B2B environment, price adjustments potentially involve (re)negotiation with those customers who are resistant to new (higher) prices.

In LINKS, each price change by your manufacturing firm for a product in a channel in a market region costs $10,000 plus $200 in costs per-dollar change in price (increase or decrease in price) plus costs of 0.25% of current-month revenues. For example, a $75 change in price on a product with revenues of $4,500,000 in a particular channel and region incurs price change costs of $10,000 + ($200)(75) + (0.0025)($4,500,000) = $10,000 + $15,000 + $11,250 = $36,250. These price change costs are recorded as “Price Changes” in your firm’s profit-and-loss statements in the month in which the price change occurs.

It’s very easy to drop price to attempt to increase demand. However, it’s always an interesting question whether that increased demand actually increases profits. Remember, the price decrease that generates increased demand also reduces your margin on each unit sold. More importantly, it’s easy for competitors to see and feel threatened by a price change.

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3 Recent published research documents the range of direct and indirect costs associated with price adjustments for a large U.S. industrial manufacturer (more than one billion USD$ revenues selling 8,000 products [used to maintain machinery] through OEMs and distributors). The authors found that managerial costs are more than 6 times, and customer-facing costs are more than 20 times, the so-called “menu costs” (physical costs) associated with price adjustments. In total, price adjustment costs comprise 1.22% of the company’s revenue and 20.03% of the company’s net margin. {Source: Mark J. Zbaracki, Mark Ritson, Daniel Levy, Shantanu Dutta, and Mark Bergen, “Managerial and Customer Costs of Price Adjustment: Direct Evidence From Industrial Markets,” *The Review of Economics and Statistics*, Volume 86, Number 2 (May 2004), pp. 514-533.}

4 Price change costs only accrue for products that are already actively being sold in a channel and region. No price change costs accrue for price changes for a product as it is being introduced into a channel and region (i.e., it was inactive in that channel and region in the last month).
Price wars are often initiated by thoughtless price manipulations by naive managers who assume that competitors won't notice, won't respond, or respond ineptly. To provide a fact-based approach for making pricing decisions, please refer to the "Pricing Worksheet" on the following page. Complete this "Pricing Worksheet" anytime you're planning to reduce prices. Review the worksheet details with your teammates. After this review, go ahead with the price decrease if you really think that it's appropriate. Review this "Pricing Worksheet" again after you receive next month's financial results to verify whether your assumptions and predictions were reasonable.

**Marketing Spending Decisions**

A marketing spending budget is required for each product in each region and channel. This budget, managed by your firm's region and channel managers, is used for advertising, promotion, and sales force efforts associated with your products. You're free to allocate funds to marketing spending as you see fit and spending doesn't have to be equal in all regions and channels.

Marketing spending budgets are at your discretion within the limits of corporate policy. **Corporate policy is that marketing spending budgets may not vary by more than $100,000 from their initial values for any product in any channel in any region.** That is, if the original marketing spending budget is $100,000 when you take over management of your firm in LINKS, then the maximum marketing budget spending discretion that you have is in the range of $0-$200,000. Values that exceed these discretionary limits will be automatically adjusted by the LINKS software.

Marketing spending is thought to increase customer demand for set-top boxes in all regions and channels. Past industry practice has been to budget at least $50,000 per month in marketing spending in all regions and channels in which a product is actively distributed. It is thought that the impact of marketing spending on customer demand declines at higher spending levels, but the precise form of the relationship between spending and sales is unknown. You'll have to learn about marketing's influence on sales through your experience within the set-top box industry.

Since the channels overlap to an extent, marketing spending in one channel of a region will have some spillover in influencing customers in the other channel. Advertising, for example, targeted at individual consumers will have some spillover to businesses that purchase in the direct channel. Marketing efforts are not normally targeted to reach only those customers in a particular channel.

If you drop a product from active distribution in a region or channel, you must also reduce the marketing spending to $0. Otherwise, marketing spending will continue to occur, perhaps in anticipation of a future relaunch.
# Pricing Worksheet

This pricing worksheet is designed to provide an analysis framework anytime you are contemplating decreasing prices within LINKS.

Complete the "Before" columns and review the "Before" columns with your team members. Complete the "After" column with actual data from the next month, after the results are available. Review the before-after comparison with your team members.

<table>
<thead>
<tr>
<th>Firm</th>
<th>Product</th>
<th>Region</th>
<th>Channel</th>
<th>Month</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>* Volume Market Share [%s]</td>
<td>Last Month, Actual</td>
<td>Next Month, Predicted</td>
</tr>
<tr>
<td>= Sales Volume [units]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Manufacturer Price [$]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>= Revenue [$]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Variable Costs [$]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>= Gross Margin [$]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Fixed Costs [$]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>= Operating Income [$]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Introduction/Drop Decisions

You may introduce products into regions or channels not currently active or drop products from regions or channels as you see fit. Introduction incurs a one-time cost of $300,000 in channel #1 in any region and $100,000 in channel #2 in any region. Dropping a product from active distribution in a region or channel incurs no special costs. Introduction costs are recorded under "Introductions" on your financial statements.

To "activate" a product in a channel/region, change the "Active Product?" status to "Yes" to introduce a product into a specific channel and/or region. To drop a product from active status in a channel or region, change its "Active Product?" status to "No." You only have to introduce a product into a channel/region once. Once a product is active in a channel/region, it remains active until you make an explicit drop ("No") decision.

You must explicitly introduce or drop a product from a channel and/or region, regardless of your marketing spending and your sales volume forecasts. Setting marketing spending to zero does not result in the associated product being dropped from that market region and channel.

If you drop a product from active distribution in a region or channel, you must also reduce the marketing spending to $0. Otherwise, marketing spending will continue to occur, perhaps in anticipation of a future relaunch.

Given the capacity constraints associated with your manufacturing plant, your firm has a policy of limiting simultaneous new product-region-channel launches to a maximum of three in any month. For example, if you choose to launch a product in two channels of a region in the same month, that action represents a total of two new launches and only one other launch would be possible in that month in any other combinations of channels and regions.

Generate Demand Decisions Form

A blank "Generate Demand Decisions" form may be found on the next page. Complete this decision form during your team deliberations.

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5 The higher per-channel introduction costs in channel #1 reflect slotting fees and allowances in the retail channel. Slotting fees and allowances are the up-front, one-time, lump-sum payments from set-top box manufacturers to retailers to obtain new product distribution in the retail channel. For a discussion and analysis of retail-channel slotting fees, see Paula Fitzgerald Bond, Karen Russo France, and Richard Riley, "A Multi-Firm Analysis of Slotting fees," Journal of Public Policy & Marketing, Volume 25, Number 2 (Fall 2006), pp. 224-237.
## Generate Demand Decisions

### Product 1, Channel 1

<table>
<thead>
<tr>
<th>Region</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Product?</strong></td>
<td>{Yes</td>
<td>No}</td>
<td></td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marketing Spending</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Product 1, Channel 2

<table>
<thead>
<tr>
<th>Region</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Product?</strong></td>
<td>{Yes</td>
<td>No}</td>
<td></td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marketing Spending</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Product 2, Channel 1

<table>
<thead>
<tr>
<th>Region</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Product?</strong></td>
<td>{Yes</td>
<td>No}</td>
<td></td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marketing Spending</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Product 2, Channel 2

<table>
<thead>
<tr>
<th>Region</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Product?</strong></td>
<td>{Yes</td>
<td>No}</td>
<td></td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marketing Spending</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** You only have to introduce a product into a channel once. Once a product is active in a channel, it will continue to be active until you make an explicit drop ("No") decision.

### Reminders

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 10: Forecasting Decisions

"Forecasting is like looking into a Kaleidoscope. The patterns are beautiful, but with a wrist flick, they change dramatically. The patterns all look clear today, but just a flick of fate, a competitor’s action, or a shift in customer preferences and everything changes.” – Claire Verweij, University of Michigan MBA (1995)

Chapter 10 Overview

Your firm is responsible for short-term sales volume forecasts for all products/channels/regions for the next month.

Administrative overhead costs increase by 1% for every 1% inaccuracy in your sales volume forecasts. For example, a forecast error of 10% (whether positive or negative) increases the associated administrative costs for that product in that region/channel by 10%. The maximum administrative overhead penalty associated with sales forecasting inaccuracy is a doubling of current administrative overhead. These administrative overhead penalties are recorded as “Forecast Inaccuracy” costs on your firm’s profit-and-loss statements.

Sales volume forecasting decisions are independent of your procurement and production decisions. Sales volume forecasting decisions are your best estimates of customer demand. Of course, your actual procurement and production decisions will be based on additional factors, such as fixed order costs and target inventory levels.

Good forecasts are the cornerstone of any supply chain management process. Forecasting prowess reflects understanding of the demand drivers of any business. In LINKS, monthly sales volume forecasts are required for retail and direct channel sales in each region for each of your products. While explicit recorded replacement parts forecasts are not required, you will need to forecast replacement parts demand to manage your inventories of sub-assemblies.

Administrative overhead costs increase by 1% for every 1% inaccuracy in your sales volume forecasts. For example, a forecast error of 10% (whether positive or negative) for a product in a region increases the administrative overhead costs for that product in that region by 10%.

- The maximum administrative overhead penalty associated with sales forecasting inaccuracy for each product in each region is a doubling of administrative overhead.
- Forecast error costs are recorded as “Forecast Inaccuracy” costs on your firm’s profit-and-loss statements, so the reported base administrative overhead costs are always $80,000/month and $120,000/month per product in channels 1 and 2, respectively, in all market regions.

Sales volume forecasting decisions are independent of your procurement and production decisions. Sales volume forecasting decisions are your best estimates of customer demand. Of course, your actual procurement and production decisions will be based on additional factors, such as fixed order costs and target inventory levels.
A Judgmental Sales Forecasting Template

"No amount of sophistication is going to allay the fact that all your knowledge is about the past and all your decisions are about the future." - Ian E. Wilson

The following page contains a judgmental sales forecasting worksheet that provides a template for systematically approaching the sales forecasting process. Judgmental adjustments are challenging, but at least you're explicitly taking into account that your generate demand program changes, and those of your competitors, influence your sales.

Forecasting Accuracy

"Life can only be understood backwards, but it must be lived forwards." – Soren Kierkegaard

Forecasting accuracy is one of the components of the multi-factor LINKS performance evaluation scorecard described in Chapter 15. Forecasting accuracy influences operating performance both directly (via adjustments in base administrative overhead for forecasting inaccuracies) and indirectly (via inventory pipeline inefficiencies [too much or too little inventory]).

Forecasting accuracy is equal to 100*(1-(abs(Forecast-Actual)/Actual)) expressed in percentage terms, where "abs" is the absolute value function. Thus, a forecast value of 11,000 and an actual value of 8,000 results in a forecast accuracy of 100*(1-abs(11,000-8,000)/8,000) = 100*(1-(3,000/8,000)) = 100*(1-0.375) = 62.5%. The minimum possible value of forecasting accuracy is 0.0%. For example, with an Actual sales volume of 8,000, a Forecast above 16,000 results in a forecasting accuracy score of 0.0%.

About Forecasting and Forecasting Accuracy

Given the importance of forecasting in running your LINKS business, you might find that reading the following article has a positive return on your reading-time investment:

  http://www.forecastingprinciples.com/paperpdf/The_Forecasting_Canon.pdf

Forecasting Decisions Form

"Predicting rain doesn't count; building arks does." – Warren Buffett

A blank "Forecasting Decisions" form may be found on the page following the next page. Complete this decision form during your team deliberations.
Judgmental Sales Forecasting Worksheet

Sales forecasting drives everything in the supply chain. Unfortunately, sales forecasting is extraordinarily challenging due to the many factors influencing your sales (your current and recent generate demand programs, current and recent competitors' generate demand programs, and exogenous market forces).

Here's a judgmental sales forecasting process that, at a minimum, provides an organizational template to systematically approach the sales forecasting process. Judgmental adjustments are challenging, but at least you're explicitly taking into account that your generate demand program changes, and those of your competitors, influence your sales.

- **Step 1** (the "easy" part): Construct a trend-line extrapolation of past sales realizations based on a crucial assumption: future market and environmental forces will continue as they have existed in the recent past. Be watchful for structural considerations like channel loading (forward buying), unfilled orders, and backlogged orders.

- **Step 2** (the "hard" part): Make adjustments for planned changes in your generate demand programs. The potential impacts of changes in product, price, distribution, communications, and service on your sales must be quantified.

- **Step 3** (the "subtle" part): Account for foreseeable competitors' changes in their generate demand programs. It's easy to overlook competitors in forecasting. Assume that competitors are vigilant and thoughtful and present.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trend-Line Extrapolation of Past Sales Realizations (Base-Line Forecast)</td>
</tr>
<tr>
<td>2</td>
<td>Adjustments For Planned Changes In Generate Demand Program (list specifics, with judgmental estimates of sales impacts expressed in +/- %s)</td>
</tr>
<tr>
<td></td>
<td>Product Changes</td>
</tr>
<tr>
<td></td>
<td>Price Changes</td>
</tr>
<tr>
<td></td>
<td>Distribution Changes</td>
</tr>
<tr>
<td></td>
<td>Communications Changes</td>
</tr>
<tr>
<td></td>
<td>Service Changes</td>
</tr>
<tr>
<td>3</td>
<td>Adjustments For Foreseeable Changes In Competitors' Generate Demand Programs (list specifics, with judgmental estimates of sales impacts expressed in +/- %s)</td>
</tr>
<tr>
<td></td>
<td>Product Changes</td>
</tr>
<tr>
<td></td>
<td>Price Changes</td>
</tr>
<tr>
<td></td>
<td>Distribution Changes</td>
</tr>
<tr>
<td></td>
<td>Communications Changes</td>
</tr>
<tr>
<td></td>
<td>Service Changes</td>
</tr>
</tbody>
</table>

Adjusted Sales Forecast
## Forecasting Decisions

<table>
<thead>
<tr>
<th>Short-Term (i.e., Next Month) Sales Volume Forecast, Product 1</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product 1, Channel 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 1, Channel 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Short-Term (i.e., Next Month) Sales Volume Forecasts, Product 2</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product 2, Channel 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product 2, Channel 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reminders**

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 11: Information Technology Decisions

Chapter 11 Overview

LINKS information technology (IT) options provide elaborations/extensions of traditional within-firm information technology systems or additional operating reports. The costs and benefits of these synchronization opportunities must be assessed. Other LINKS information technology options provide additional operational and financial reports:
- Procurement Transactions Report
- Product Cost Report
- Replacement Parts Demand Report
- Retail Pipeline Report
- Transportation Cost Report
- Transportation Report

LINKS information technology (IT) options provide elaborations/extensions of traditional within-firm information technology systems or additional operating reports. The costs associated with your IT decisions are recorded on your "Corporate P&L Statement" under the heading "Information Technology."

IT Synchronization With Plant-To-DC Carriers

You coordinate your transportation needs with specific plant-to-DC carriers via IT synchronization efforts. By linking your IT system with the IT systems of one or more of your plant-to-DC carriers, an enhanced degree of supply chain synchronization is achieved in transportation with corresponding improvements in surface transportation delivery performance.

The specifics of plant-to-DC carrier IT synchronization within LINKS are as follows:
(1) IT synchronization involves a one-time cost per carrier to implement initially and a carrier-specific on-going per-month IT-synchronization maintenance cost. You may terminate IT synchronization with a plant-to-DC carrier at any time at no cost. If you subsequently decide to reestablish IT synchronization, the one-time setup cost would again accrue in the initial month of IT synchronization with any plant-to-DC carrier.
(2) IT-synchronization linkages improve surface transportation delivery performance for plant-to-DC carriers. With greater delivery reliability, the relative attractiveness of surface transport compared to air transport obviously improves.
Exhibit 12 details these specifics for each plant-to-DC carrier. Your firm may establish and
maintain IT synchronization with one or more plant-to-DC carriers with these costs and benefits.

**Exhibit 12: IT Synchronization With Carriers, Costs and Benefits**

<table>
<thead>
<tr>
<th>Plant-To-DC Carriers</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Time Setup Cost</td>
<td>$9K</td>
<td>$8K</td>
<td>$9K</td>
<td>$9K</td>
<td>$6K</td>
<td>$5K</td>
</tr>
<tr>
<td>Monthly Maintenance Cost</td>
<td>$7K</td>
<td>$7K</td>
<td>$9K</td>
<td>$8K</td>
<td>$6K</td>
<td>$3K</td>
</tr>
<tr>
<td>Surface Transportation Change</td>
<td>+5%</td>
<td>+10%</td>
<td>+6%</td>
<td>+3%</td>
<td>+4%</td>
<td>+2%</td>
</tr>
</tbody>
</table>

**Note:** See Exhibit 9 for base surface transportation delivery performance statistics. These IT-synchronization adjustments are additive changes. For example, carrier I's surface transportation delivery performance for plant-to-DC shipments is estimated to change (improve) +5%, from 80% to 85%, with an IT-synchronization program in effect.

Decision options associated with each plant-to-DC carrier are as follows:
- Decision Option "0": Do not have IT synchronization.
- Decision Option "1": Establish and maintain IT synchronization with costs and other ramifications as described above.

Note that these options are carrier-specific. A separate IT-synchronization decision is required for each of the six available plant-to-DC carriers, carriers I to N.

**IT Synchronization With Sub-Assembly Component Suppliers**

You may establish vendor-managed inventory system with your sub-assembly component suppliers. By linking your IT system with the IT systems of one or more of your suppliers, an enhanced degree of supply chain synchronization is achieved in procurement, with corresponding improvements in surface transportation delivery performance and component quality (i.e., a reduction in sub-assembly component failure rates).

The specifics of supplier IT synchronization within LINKS are as follows:
1. IT synchronization involves a one-time cost per supplier to implement initially and a supplier-specific on-going per-month maintenance cost. You may terminate IT synchronization with a sub-assembly component supplier at any time at no cost. If you subsequently decide to reestablish IT synchronization, the one-time setup cost would again accrue in the initial month of IT synchronization with any sub-assembly component supplier.
2. IT-synchronization linkages improve surface transportation delivery performance for sub-assembly component suppliers. With greater delivery reliability, the relative attractiveness of surface transport compared to air transport obviously improves.
3. An IT-synchronization linkage improves the failure rate of a supplier's sub-assembly
components. Failure rates decrease based on closer synchronization between buyer (your firm) and the sub-assembly component supplier.

Exhibit 13 details these specifics for each sub-assembly component supplier. Your firm may establish and maintain IT synchronization with one or more sub-assembly component suppliers with these costs and benefits.

Decision options associated with each sub-assembly component supplier are as follows:
- Decision Option "0": Do not have IT synchronization.
- Decision Option "1": Establish and maintain IT synchronization with costs and other ramifications as described above.

Note that these options are supplier specific. A separate IT-synchronization decision is required for each of the seven available sub-assembly component suppliers, suppliers A to G.

**Exhibit 13: IT Synchronization With Suppliers, Costs and Benefits**

<table>
<thead>
<tr>
<th>Sub-Assembly Component Supplier</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Time Setup Cost</td>
<td>$9K</td>
<td>$8K</td>
<td>$9K</td>
<td>$9K</td>
<td>$6K</td>
<td>$7K</td>
<td>$7K</td>
</tr>
<tr>
<td>Monthly Maintenance Cost</td>
<td>$7K</td>
<td>$7K</td>
<td>$9K</td>
<td>$8K</td>
<td>$6K</td>
<td>$5K</td>
<td>$5K</td>
</tr>
<tr>
<td>Surface Transportation Change</td>
<td>+5%</td>
<td>+4%</td>
<td>+6%</td>
<td>+3%</td>
<td>+4%</td>
<td>+5%</td>
<td>+6%</td>
</tr>
<tr>
<td>Failure Rate Change</td>
<td>-0.2%</td>
<td>-0.1%</td>
<td>-0.4%</td>
<td>-0.5%</td>
<td>-0.4%</td>
<td>-0.3%</td>
<td>-0.3%</td>
</tr>
</tbody>
</table>

Note: See Exhibit 5 for the base surface transportation delivery performance and base failure rate statistics to which these IT-synchronization adjustments accrue. These are additive changes. For example, supplier A's surface transportation delivery performance for Gamma is estimated to change (improve) +5%, from 80% to 85%, with an IT-synchronization program in effect.

**Procurement Transactions Report**

The "Procurement Transactions Report" information technology option provides a report documenting procurement volumes and costs associated with your firm’s procurement decisions. Breakdowns by each raw material and sub-assembly component for all DCs are provided.

Decision options and costs for the "Procurement Transactions Report" are as follows:
- Decision Option "0": Do not provide a "Procurement Transactions Report."
- Decision Option "1": Provide a "Procurement Transactions Report" for $500.
**Product Cost Report**

The "Product Cost Report" information technology option provides a report documenting all costs associated with production and postponed production for all products and distribution centers. Decision options and costs for the "Product Cost Report" are as follows:

- Decision Option "0": Do not provide a "Product Cost Report."
- Decision Option "1": Provide a "Product Cost Report" at a cost of $750.

**Replacement Parts Demand Report**

The details of replacement parts demand by region, product, and channel are provided in the "Replacement Parts Demand Report." This report shows the current-month replacement parts demand levels to provide a fact-oriented basis for preparing replacement parts forecasts for future month. Of course, you may wish to reference past months’ replacement parts demand to establish a longer-term view of trend lines for replacement parts demand.

Decision options and costs for the "Replacement Parts Demand Report" are as follows:

- Decision Option "0": Do not provide a "Replacement Parts Demand Cost Report."
- Decision Option "1": Provide a "Replacement Parts Demand Cost Report" at a cost of $1,250.

**Retail Pipeline Report**

Your routine financial and operations reports provide details about orders received from all channels in all market regions. However, for the retail channel (channel 1), orders do not correspond to actual sales to final customers. Rather, retail channel orders reflect both final customer orders and inventory holding decisions of retailers. Retailers must hold some inventory, to provide a buffer between customer purchases and receipts of orders from manufacturers.

You may wish to receive more detailed retail pipeline data about the inventory holdings of the retail channel, as well as actual customers’ purchases from retailers. A "Retail Pipeline Report" provides information on the inventories and sales of retailers. There is no corresponding inventory report for the direct channel, since direct-channel customers don't stock their own inventories.

Decision options and costs for the "Retail Pipeline Report" are as follows:

- Decision Option "0": Do not provide a "Retail Pipeline Report."
- Decision Option "1": Provide a "Retail Pipeline Report" for the previous month with associated costs of $10,000 per month plus a one-time initiation charge of $15,000 in the first month in which this option is selected.
- Decision Option "2": Provide a "Retail Pipeline Report" for the current month with associated costs of $20,000 per month plus a one-time initiation charge of $30,000 in the first month in which this option is selected.

The higher costs for current-month data are based on development and maintenance costs associated with a much more elaborate and time-sensitive EDI system. There are no charges associated with terminating the ordering of a "Retail Pipeline Report." To terminate ordering the "Retail Pipeline Report," you would change your decision variable to 0 (zero). If you choose to order a "Retail Pipeline Report," it will be included among your financial and operations reports.
Transportation Cost Report

Given the complexity of transportation cost accounting in LINKS, a "Transportation Cost Report" is provided as an IT option. The report provides the details of all transportation costs which are summarized on your "Corporate P&L Statement." These details include per/unit costs, volumes, and total costs in the sub-categories of raw materials, sub-assembly components, plant/DC1 shipments to other DCs, customer shipments (from DCs to customers), and replacement parts shipments (from DCs to customers). Decision options and costs for the "Transportation Cost Report" are as follows:

- Decision Option "0": Do not provide a "Transportation Cost Report."
- Decision Option "1": Provide a "Transportation Cost Report" at a cost of $1,250.

Transportation Report

The "Transportation Report" provides information on transportation cost details, sub-assembly component supplier surface transportation performance (percentage of surface transportation orders by supplier received within the current month), and plant-to-DC carrier surface transportation performance (percentage of surface transportation orders by carrier received within the current month). IT synchronization status is noted where it exists with sub-assembly component suppliers or with plant-to-DC carriers.

Breakdowns of transportation costs into five components are provided in the "Transportation Summary": raw materials, sub-assembly components, plant-to-DC shipments, DC-to-customer shipments, and replacement parts shipments from DCs. For the complete details which underlie these breakdowns, you'll need to order the "Transportation Cost Report" which is available as another information technology option. Decision options and costs for the "Transportation Report" are as follows:

- Decision Option "0": Do not provide a "Transportation Report."
- Decision Option "1": Provide a "Transportation Report" at a cost of $1,000.

Information Technology Decisions Form

A blank "Information Technology Decisions" form may be found on the next page. Complete this decision form during your team deliberations.
## Information Technology Decisions

<table>
<thead>
<tr>
<th>Carriers</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
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</table>

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<th>F</th>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Carriers</th>
<th>Suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement Transactions Report? {0</td>
<td>1}</td>
<td></td>
</tr>
<tr>
<td>Product Cost Report? {0</td>
<td>1}</td>
<td></td>
</tr>
<tr>
<td>Replacement Parts Demand Report? {0</td>
<td>1}</td>
<td></td>
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<tr>
<td>Retail Pipeline Report? {0</td>
<td>1</td>
<td>2}</td>
</tr>
<tr>
<td>Transportation Cost Report? {0</td>
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<td></td>
</tr>
<tr>
<td>Transportation Report? {0</td>
<td>1}</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** See the descriptions of these information technology options for the interpretation of each possible decision option.

### Reminders

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 12: Other Decisions

This chapter details other decisions not described elsewhere in Chapters 3-11 of the LINKS participant's manual. "Other decisions" include establishing a firm name and research ordering decisions.

Your firm may choose a firm name. Any firm name with up to 40 characters is acceptable. This firm name is printed on the top of all financial, operating, and research reports. Firm names have no cost or known demand-side implications, so you are free to choose (or change) your firm's name as you wish.

Chapter 14 describes the available research studies within LINKS. Research studies decisions must be made every month, like all other LINKS decisions. Your research studies requests will be executed and the associated results will be reported to you with your regular financial and operating reports after each LINKS month.

A blank "Other Corporate Decisions" form may be found on the next page. Complete this decision form during your team deliberations.
Other Corporate Decisions

<table>
<thead>
<tr>
<th>Firm Name (max of 40 characters)</th>
</tr>
</thead>
</table>

**Reminders**

Only input changes. If you're happy with the current values of these decisions, leave the appropriate decision entries blank.

All decision inputs change the existing values to the values that you specify. Do not enter "+" or "-" values. Rather, enter new values only (new values replace the existing value of the decision variable with your designated value).
Chapter 13: Financial and Operating Reports

Chapter 13 Overview

The LINKS financial and operating reports are described in this chapter.

Three particularly useful exhibits are provided:

- Exhibit 14: Net Income Drivers in LINKS
- Exhibit 15: Volume Drivers in LINKS
- Exhibit 16: Variable Cost Drivers in LINKS

Sample standard LINKS financial and operating reports are provided in this chapter. In addition to these financial and operating reports, you’ll receive the results of any research studies that you order on additional pages after the last page of your financial and operating reports.

These samples are provided to familiarize you with the style and format of the reports that are provided to your firm after each LINKS round. The data reported in these sample reports are only illustrative of reports formatting. These data aren’t specific to your particular LINKS industry.

The LINKS financial and operating reports are described in this chapter. These are the standard reports that you receive after each month of the LINKS exercise. Recall, too, that several of the information technology options described in Chapter 11 yield additional financial and operating reports.

Profitability Drivers

“"A company can outperform rivals only if it can establish a difference that it can preserve. Competitive strategy is about being different, deliberately choosing a different set of activities to deliver a unique value mix." – Michael Porter

The financial and operating reports described in this chapter are lengthy (13 pages) and detailed. To provide an overall roadmap for thinking about the drivers of profitability, the three charts in Exhibits 14-16 decompose net income into its underlying components.

In Exhibit 14, the principal drivers of net income are revenues and costs. Taxes and non-operating income play lesser roles. Exhibit 15 provides a breakdown of the drivers of volume, one of the two key drivers of revenues. Exhibit 16 provides a roadmap to the drivers of variable costs. Collectively, these exhibits provide a sense of the DNA of net income in LINKS.
Exhibit 14: Net Income Drivers in LINKS

- Volume
- Price

Revenues

Costs

- Variable Costs
- Fixed Costs

Net Income

- Non-Operating Income

Taxes

- Interest Rates
- Loans
- Marketable Securities
- Patent Royalties
Exhibit 15: Volume Drivers in LINKS

- Manufacturer Price
  - Price Volatility (Over Time)
  - Channel Markup
- Product Configuration
  - Failure Rate
- Service Outsourcing Program
- Channels
  - Marketing Program
  - Unfilled Orders
- Competitors’ Generate Demand Programs
- Exogenous Factors (Customers, Economy, Regulatory Environment, Technology, Etc.)

**Perceived Price**

- "Product Quality" Perception
- "Service Quality" Perception
- "Availability" Perception

**Volume**

**Uncontrollables**
Exhibit 16: Variable Cost Drivers in LINKS

Product Configuration
- Raw Materials Costs
- Components Costs
- Labor Costs
- Production Costs

Past Sales Volume
- Warranty
- Failure Rate

Transportation Modes
- Distribution Centers

Product Costs

Replacement Parts Demand

Order Processing

Transportation

Duties and Tariffs

Variable Costs
Performance Evaluation Report

Please consult Chapter 15 for a detailed discussion of the "Performance Evaluation Report" that forms the first page of your financial and operating reports.

Corporate P&L Statement

The "Corporate P&L Statement" aggregates all of the product-specific profit-and-loss statements into an overall corporate profit-and-loss statement. A variety of line items appear on the "Corporate P&L Statement" only, because it is not possible to unambiguously allocate those costs to specific products in specific regions for specific channels.

Definitions of non-obvious line items on the "Corporate Current P&L Statement" follow:

- Administrative overhead ("Administrative O/H") is $80,000/month and $120,000/month per product in channels 1 and 2, respectively, in all market regions.
- "Consulting Fees" may be positive or negative. "Consulting Fees" are adjustments to income or expenses. Conversations with your coach/instructor are normally without charge, so don't worry about "Consulting Fees" associated with these consultations. In LINKS, the "Consulting Fees" line item represents a convenient mechanism for making adjustments to income or expenses. For example, a research billing problem can be corrected via an appropriate negative "Consulting Fee."
- Corporate overhead ("Corporate O/H") is $250,000 per product per month. This per-product charge is incurred if a product is actively distributed in one or more market regions.
- "Distribution FC" reflects the fixed costs associated with operating distribution centers.
- "Duties & Tariffs" are a percentage of the average selling price for finished goods (across all channels) imported into any market region. If a firm is based in a market region (i.e., if a firm has a manufacturing plant in a region), there are no duties and tariffs payable. **Postponed production qualifies as "local" manufacturing, for which no duties and tariffs are payable.** The current duties and tariffs rates are 0% for market region 1, 8% for market region 2, and 12% for market region 3. By definition, all finished goods sold in market region 1 are "local" since your firm's manufacturing plant is located in market region 1. "Duties & Tariffs" are levied on sales in a market region (orders from customers), with appropriate credit being provided for "local" production (i.e., for the second-stage of postponed production when the final identity is assigned to the finished product at the within-region distribution center).
- "Emergency Procurement" reflects all emergency procurement costs.
- "Emergency Production" reflects all emergency production costs, including standby emergency production charges plus any actual emergency-related excess costs (above regular production) associated with actual realized emergency production.
- "Forecast Inaccuracy" records the costs associated with forecasting errors.
- "Information Technology" records all IT charges. Your IT charges include a $1,000/page charge for all financial and operating reports. This charge is per-firm and is not related to the number of members of your firm's management team. Each month's charge is based on the previous month's actual page counts (e.g., the month-32 charge is based on the month-31 page count).
- "Introductions" reflects costs when products are introduced into market regions or channels.
- Inventory charges arise for raw materials, sub-assembly components, in-process production (postponed production), and finished goods. These costs are recorded under the heading "Inventory Charges" on the "Corporate P&L Statement." This inventory charge is equal to 3%
per month for owned distribution centers and 5% per month for outsourced distribution centers based on the value of inventory as recorded on your firm's balance sheet. Inventory charges are levied on the average of beginning-of-month and end-of-month inventory values, and include all costs related to storage, handling, waste, and insurance.

- "Marketing" equals total marketing spending.
- "Non-Operating Income" derives either from interest earned on "Marketable Securities" (from the previous month's "Balance Sheet") or from interest paid on "Loans" (from the previous month's "Balance Sheet").
- "Operating Income" equals "Gross Margin" minus "Total Fixed Costs."
- "Patent Royalties" include patent royalties that your firm pays to other firms, as well as patent royalties received from other firms.
- "Plant Capacity FC" represents the costs associated with production "shifts" in your manufacturing plant. These costs cover all depreciation and maintenance associated with your plant capacity. These costs are allocated equally among your products.
- "Procurement FC" includes the fixed costs associated with procurement.
- "Production FC" includes the fixed costs associated with production orders. Fixed costs for regular and for postponed production are included in the "Production FC" line item. Production volume flexibility charges are also included within "Production FC."
- "Research Studies" reflects the total costs associated with last month's research study requests. Note that the current month's research studies are executed after the current month's financial reports are prepared. Thus, research study billings are lagged a month.
- "Service Salaries" is the total salary cost associated with service centers.
- "Service O/H" is the service center overhead cost levied on service center compensation.
- "Service Hire&Fire" costs are the service center hiring and firing costs.
- "Unfilled Handling" costs are the unfilled orders handling costs.
- "Taxes" represents the corporate taxes payable in the market region in which your firm has its manufacturing plant. Your manufacturing plant is located in market region 1, which has a corporate tax rate of 50%.
- "Total Fixed & Other" is the sum of all fixed costs. Note that "Total Fixed & Other" does not sum correctly down and across since some fixed costs are not allocated to specific products.
- "Transportation Rebates" is the sum of rebates on plant-to-DC shipments if a single carrier is used exclusively for all shipments in any month and incremental transportation costs (compared to Standard Surface Shipping) for Expedited Surface Shipping and Economy Surface Shipping of finished goods from DC1 to other DCs.

**Historical Corporate P&L Statement**

The "Historical Corporate P&L Statement" reports the previous and current month's corporate-level profit-and-loss data. In addition, all elements in the "Historical Corporate P&L Statement" are expressed in percentage-of-revenue terms.
Product P&L Statement

Each product has a current profit-and-loss statement each month. The product "P&L Statement" includes the relevant data for all channels.

Balance Sheet

Your balance sheet records the usual assets and liabilities associated with your firm at the end of each month. Among other things, current levels of procurement and finished goods inventories are reported on the balance sheet.

On the "Balance Sheet":

- "Cash" represents your cash balance. Cash in excess of 10% of revenues is automatically invested in short-term "Marketable Securities" which earn 0.5% per month in "Non-Operating Income" on the "Corporate P&L Statement" in the following month. If cash falls below 5% of revenues, a loan is automatically arranged to increase cash to 5% of revenues. You pay interest of 1% per month on "Loans" and this interest payment is recorded as "Non-Operating Income" (a negative value of "Non-Operating Income") in the following month's "Corporate P&L Statement."
- "Corporate Capitalization" is the dollar-value of the original capital invested by your shareholders to start your firm.
- "Dividends" are cash payments to shareholders. In any month in which "Net Income" is positive, 30% of the "Net Income" is allocated to "Dividends."
- "Plant Investment" represents the dollar-value of your firm's investment in a manufacturing plant to produce set-top box products. The normal per-unit production charges that you pay for producing set-top boxes includes a component to cover the maintenance and depreciation of your plant. Thus, your "Plant Investment" value will also be the same through time.

On-order Epsilon sub-assembly components for delivery next month are reported at the bottom of your balance sheet. While you don't pay for Epsilon sub-assembly components until delivery, this contract is notable since it represents a future procurement purchasing commitment. Each region's Epsilon orders are noted. For example, a reported value of "12,000Fa" refers to a sub-assembly component order of 12,000 units from supplier F via air.

Cash Flow Analysis Report

"Profit is an illusion; cash flow is fact." – Anonymous

Sources and uses of cash are reported in your firm's "Cash Flow Analysis Report." The most important source of cash within any on-going business is revenues derived from sales, but you have lots of costs to pay to earn those revenues. Recent experience with "dot.com" businesses notwithstanding, margin management (revenues less costs) is still the fundamental management challenge for all for-profit businesses.

Cash sources include profits from operations and reductions in inventory holdings. Uses of cash include funding operating losses, increases in inventory holdings, and payment of dividends.
Obviously, you require cash to run your set-top box business. You can't run out of cash within LINKS. As necessary, loans are automatically issued to bring your cash requirement up to minimum acceptable. Of course, you do have to pay interest on loans. Each month in which your firm is profitable, corporate policy is to allocate 30% of net income to dividends.

Other Reports

Additional reports included in the standard LINKS financial and operating reports are as follows:

- **Finished Goods Inventory Report:** The details of your finished goods inventories (including postponed production) are reported on the "Finished Goods Inventory Report." Finished goods inventories are tracked separately for each of your distribution centers. Recall that your manufacturing plant and the distribution center in market region 1 hold common finished goods inventory.

- **Procurement Inventory Report:** Procurement inventories are reported on the "Procurement Inventory Report." Procurement inventories are tracked separately for each distribution center. Recall that your manufacturing plant and the market region 1 distribution center hold common procurement inventory.

- **Forecasting Accuracy Report:** The "Forecasting Accuracy Report" provides details of the forecasting accuracy associated with each of your sales volume forecasts. Forecasting accuracy is equal to $100 \times (1 - \frac{\text{abs}(\text{Forecast} - \text{Actual})}{\text{Actual}})$ expressed in percentage terms, where "abs" is the absolute value function. Thus, a forecast value of 11,000 and an actual value of 8,000 result in a forecast accuracy of $100 \times (1 - \frac{\text{abs}(11,000 - 8,000)}{8,000}) = 100 \times (1 - \frac{3,000}{8,000}) = 100 \times (1 - 0.375) = 62.5\%$. The minimum possible value of forecasting accuracy is 0.0%. For example, with an Actual sales volume of 8,000, a Forecast above 16,000 results in a forecasting accuracy score of 0.0%.

- **Service Center Operations Reports:** The "Service Center Operations Report" provides details about the call-volumes at your regional service centers.

- **Other Decision Variables Report:** The "Product P&L Statement" provides an easy-to-read listing of the current values of the product development, distribution, service, generate demand, and forecasting decision variables. However, the procurement, manufacturing, transportation, and information technology decision variables are either sprinkled around in the financial and operating reports or not directly reported. To provide an easy-to-access listing of the current values of these decision variables, an "Other Decision Variables Report" is provided as part of your financial and operating reports.

- **Set-Top Box Industry Bulletin:** The "Set-Top Box Industry Bulletin" provides current-month industry-related information. Information reported in the "Bulletin" includes things that an actual manager in the set-top box industry could easily observe without additional cost or with nominal effort during the course of events that comprise a normal month's work. To drill down below these headlines, you'll need appropriate research studies.
Sample Reports

"The meaning of life is to do the best you can with what you've got." – Anonymous

The following pages provide samples of the standard LINKS financial and operating reports. In addition to these reports, you'll receive the results of any research studies that you order on additional pages after the last page of your financial and operating reports.

These samples are provided to familiarize you with the style and format of the reports that are provided to your firm after each LINKS round. The data reported in these sample reports are only illustrative of reports formatting. These data aren’t specific to your particular LINKS industry. Please do not interpret these samples as suggested guidelines or benchmarks for good decisions and performance within LINKS.

If you'd like some further background on interpreting LINKS financial statements, please access Tutorial #1 (“P&L Statements”) on the LINKS website and spend 45 minutes or so working through it prior to (or close to) the beginning of your LINKS event.
For Your Information

You receive the LINKS scorecard (shown above) automatically each month as the first page of your financial and operating reports. This scorecard provides comparatives to assess how your firm’s data compares to the industry averages and industry bests on every Key Performance Indicator (KPI).

Historical plots of all KPIs are provided in your firm’s supplementary results Excel spreadsheet (“KPIcharts” worksheet), accessible within the LINKS Simulation Database on the LINKS website. Data from the past six months are displayed, to the extent available in your industry's historical archives, to create month-by-months plots for each of the LINKS performance evaluation metrics (KPIs) compared to the relevant month-specific industry best, industry average, and industry worst in your LINKS industry.

<table>
<thead>
<tr>
<th></th>
<th>Firm 3</th>
<th>Worst</th>
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<td>4.5%</td>
<td>5.4%</td>
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<td>-1.7%</td>
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<td>Inventory Turnover</td>
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<td>15.4%</td>
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<td>Controllable Procure&amp;Mfg to Revenues</td>
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<td>81.8%</td>
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<td>(Marketing + Service) to Revenues</td>
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<td>9.0%</td>
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<td>Current (Month 11)</td>
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<td>Distribution FC</td>
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<td>167,447</td>
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<td>Information Technology</td>
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<td>Introductions</td>
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<tr>
<td>Procurement FC</td>
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</tr>
<tr>
<td>Production FC</td>
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<tr>
<td>Unfilled Handling</td>
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<tr>
<td>Total Fixed &amp; Other</td>
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<td>4,732,633</td>
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**FIRM 5: BOXsRus**

**PRODUCT 5-1 P&L STATEMENT, MONTH 51**

<table>
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<tr>
<th></th>
<th>All Regions (TOTAL)</th>
<th>Region 1 (U.S.A.)</th>
<th>Region 2 (Europe)</th>
<th>Region 3 (Pacific)</th>
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<td>Yes Yes</td>
<td>Yes Yes</td>
<td>Yes Yes</td>
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<td>5,638</td>
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<td>0</td>
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<td>300 450</td>
<td>300 450</td>
<td>300 450</td>
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<td>3,694,650</td>
<td>3,611,850</td>
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**For Your Information**

The standard LINKS monthly reports include separate product P&L statements for each of your products. In this sample display, only the report for product 1 is included.
FIRM 1: United International Set-Top Boxes  INDUSTRY FFF
BALANCE SHEET, MONTH 12  PAGE 9

ASSETS
------
Cash 925,590
Marketable Securities 0
Finished Goods and Postponed Production Inventory:
   Plant & DC1:  Product 1-0 (0 units @ 0.00/unit) 0
                  Product 1-1 (5,107 units @ 148.23/unit) 757,033
                  Product 1-2 (1,855 units @ 180.60/unit) 335,017
   DC2:  Product 1-0 (0 units @ 0.00/unit) 0
                  Product 1-1 (6,599 units @ 147.50/unit) 973,356
                  Product 1-2 (5,726 units @ 179.00/unit) 1,024,954
Plant Investment 100,000,000
Procurement Inventory:
   Plant & DC1:  Alpha (0 units @ 0.00/unit) 0
                  Beta (0 units @ 0.00/unit) 0
                  Gamma (5,370 units @ 17.90/unit) 96,143
                  Delta (2,350 units @ 20.81/unit) 48,899
                  Epsilon (7,850 units @ 23.87/unit) 187,358
   DC2:  Gamma (1,380 units @ 17.45/unit) 24,079
                  Delta (377 units @ 20.47/unit) 7,718
                  Epsilon (2,383 units @ 23.97/unit) 57,109
Total Assets 104,437,256

LIABILITIES AND EQUITIES  
------------------------
Corporate Capitalization 100,000,000
Dividends, Current Month -304,625
Dividends, Cumulative Prior To This Month -865,720
Loans 1,706,447
Retained Earnings, Current Month 1,015,419
Retained Earnings, Cumulative Prior To This Month 2,885,735
Total Liabilities and Equities 104,437,256

Note: These Epsilon components are on-order, for delivery next month:
   Region 1: 12,000Ds 41,000Da
   Region 2: 750Ds 750Da
FIRM 3: International Global
CASH FLOW ANALYSIS REPORT, MONTH 61

Starting "Cash" Balance (Final "Cash" Balance, Month 60) 1,019,505
+ Marketable Securities ( Converted To "Cash" In Month 60) 0
- "Loans" (Liquidated During Month 60) -781,504
+ "Finished Goods Inventory" Changes:
  Product 3-0 (From 0 To 0) 0
  Product 3-1 (From 860,960 To 1,730,389) -869,429
  Product 3-2 (From 659,615 To 1,359,971) -700,356
+ "Plant Investment" Changes 0
+ "Procurement Inventory" Changes:
  Alpha (From 0 To 0) 0
  Beta (From 0 To 0) 0
  Gamma (From 78,251 To 120,222) -41,971
  Delta (From 41,420 To 56,617) -15,197
  Epsilon (From 141,768 To 244,467) -102,699
+ "Net Income" 1,015,419
= Preliminary "Cash" Balance -476,232
- "Dividends" (Paid at End of Month 61) -304,625
= Actual "Cash" Balance (End of Month 61) -780,857
- Operating "Cash" Excess (To "Marketable Securities") 0
+ Operating "Cash" Deficit (From "Loans") 1,706,447
= Final "Cash" Balance (End of Month 61) 925,590

Notes:
(1) "Marketable Securities" and "Loans" refer to the values on last month's balance sheet.
(2) Investment changes can be positive, negative, or zero. A positive (negative) (zero). Investment change corresponds to an increase (a decrease) (no change) in the dollar value of the investment from last month to this month which leads to a decrease (an increase) (no change) in current-month "Cash" balance.
(3) At most, one of Operating "Cash" Excess and Operating "Cash" Deficit will be non-zero; it is possible for both to be zero. Recall that "Cash" must be between 5.0% and 10.0% of current-month sales revenues. Excess "Cash" (above 10.0% of revenues) is invested in "Marketable Securities"; shortfalls in "Cash" (below 5.0% of revenues) result in "Loans."
<table>
<thead>
<tr>
<th></th>
<th>Product 1-0</th>
<th>Product 1-1</th>
<th>Product 1-2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLANT/DC1 FG INVENTORY</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Beginning Inventory</td>
<td>0</td>
<td>1,830</td>
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<tr>
<td>+ Regular Production</td>
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<td>37,500</td>
<td>22,500</td>
</tr>
<tr>
<td>+ Emergency Production</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Postponed Production</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>= Available Inventory</td>
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<td>- Shipments To DC2:</td>
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<tr>
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<td>Air</td>
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<tr>
<td>Emergency</td>
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<tr>
<td>- Sales, Region 1</td>
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<tr>
<td>- Sales, Other Regions</td>
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<tr>
<td>= Ending Inventory</td>
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<td>5,107</td>
<td>1,855</td>
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</table>

|                      |             |             |             |
| **DC2 FG INVENTORY** |             |             |             |
| Beginning Inventory  | 0           | 4,007       | 2,865       |
| + Shipments From DC1:|             |             |             |
| Surface              | 0           | 10,700      | 7,400       |
| Air                  | 0           | 0           | 0           |
| Emergency            | 0           | 0           | 0           |
| Postponed Production | 0           | 0           | 0           |
| = Available Inventory| 0           | 14,707      | 10,265      |
| - Sales, Region 2    | -9,408      | -5,139      |             |
| + Delayed Shipments  | 0           | 1,300       | 600         |
| = Ending Inventory   | 0           | 6,599       | 5,726       |
### FIRM 2: BOX.COM

**INDUSTRY III**

**PROCUREMENT INVENTORY REPORT, MONTH 23**

**PAGE 12**

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
<th>Delta</th>
<th>Epsilon</th>
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<td>------</td>
<td>-------</td>
<td>-------</td>
<td>---------</td>
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<tr>
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<td>3,681</td>
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<td>+ Purchases, Surface</td>
<td>250,000</td>
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<td>16,850</td>
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<td>+ Purchases, Air</td>
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<td>- Production:</td>
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<td>- Emergency Production:</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>- Postponed Production</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Replacement Parts</td>
<td>-811</td>
<td>-1,275</td>
<td>-1,625</td>
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<tr>
<td>+ Purchases, Delayed</td>
<td>3,150</td>
<td>2,350</td>
<td>7,850</td>
<td></td>
<td></td>
</tr>
<tr>
<td>= Ending Inventory</td>
<td>0</td>
<td>0</td>
<td>5,370</td>
<td>2,350</td>
<td>7,850</td>
</tr>
</tbody>
</table>

|                |       |      |       |       |         |
| DC2            |       |      |       |       |         |
| Beginning Inventory | 922   | 230  | 1,578 |       |         |
| + Purchases, Surface | 350   | 300  | 650   |       |         |
| + Purchases, Air    | 400   | 350  | 750   |       |         |
| + Purchases, Emergency | 0     | 0    | 0     |       |         |
| = Available Inventory | 1,672 | 880  | 2,978 |       |         |
| - Postponed Production |      |      |       |       |         |
| - Replacement Parts | -342  | -553 | -695  |       |         |
| + Purchases, Delayed | 50    | 50   | 100   |       |         |
| = Ending Inventory  | 1,380 | 377  | 2,383 |       |         |

### FIRM 4: eTop.com

**INDUSTRY JJJ**

**SERVICE CENTER OPERATIONS REPORT, MONTH 48**

**PAGE 13**

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Region 3</th>
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<td>ACTIVITY REPORT</td>
<td></td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
</tbody>
</table>

===

**PRODUCT 4-1**

Calls          | 38,161 | 12,052  | 11,128   | 14,981   |
CSR Cost/Call  | 11.76  | 10.00   | 12.00    | 13.00    |

**PRODUCT 4-2**

Calls          | 25,020 | 7,727   | 7,740    | 9,553    |
CSR Cost/Call  | 11.76  | 10.00   | 12.00    | 13.00    |
<table>
<thead>
<tr>
<th>Supplier</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC1: Gamma, Surface</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20,000</td>
<td>0</td>
<td>0</td>
<td>20,000</td>
</tr>
<tr>
<td>DC1: Delta, Surface</td>
<td>0</td>
<td>0</td>
<td>10,000</td>
<td>0</td>
<td>0</td>
<td>10,000</td>
<td>0</td>
</tr>
<tr>
<td>DC1: Delta, Air</td>
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<td>0</td>
<td>10,000</td>
<td>0</td>
<td>0</td>
<td>10,000</td>
<td>0</td>
</tr>
<tr>
<td>DC1: Epsilon, Surface</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>30,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>DC1: Epsilon, Air</td>
<td>30,000</td>
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<td>0</td>
<td>0</td>
<td>30,000</td>
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<td>0</td>
</tr>
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<td>DC2: Gamma, Surface</td>
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<td>400</td>
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<td>350</td>
<td>0</td>
<td>0</td>
<td>350</td>
<td>0</td>
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<td>DC2: Delta, Air</td>
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<td>350</td>
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<td>350</td>
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<td>DC2: Epsilon, Surface</td>
<td>750</td>
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<td>0</td>
<td>0</td>
<td>750</td>
<td>0</td>
<td>0</td>
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<tr>
<td>DC2: Epsilon, Air</td>
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<td>0</td>
<td>0</td>
<td>750</td>
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<th>Carrier</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
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<td>0</td>
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<td>IT Synchronization With Carriers?</td>
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<tr>
<td>IT Synchronization With Suppliers?</td>
</tr>
<tr>
<td>Procurement Transactions Report?</td>
</tr>
<tr>
<td>Product Cost Report?</td>
</tr>
<tr>
<td>Replacement Parts Demand Report?</td>
</tr>
<tr>
<td>Retail Pipeline Report?</td>
</tr>
<tr>
<td>Transportation Cost Report?</td>
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<td>Product 6-1, Ch#2</td>
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<td>Product 6-2, Ch#1</td>
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<tr>
<td>Product 6-2, Ch#2</td>
</tr>
</tbody>
</table>

**SUMMARY:** For 12 forecasts, average forecasting accuracy is 83.7%

Note: Forecasts count within the calculation of forecasting accuracy only if the "actual" value being forecast is greater than 100 for sales volumes (to not penalize you for "small" forecasts). Otherwise, the relevant values of "forecast" and "actual" are only reported for reference purposes, but such forecasts are not counted for forecasting accuracy scoring. This is the reason why the number of forecasts referenced in "SUMMARY" may be less than the detailed line-by-line reporting of forecasts.

<table>
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<tr>
<th>SALES HISTORY</th>
<th>Month 11</th>
<th>Month 12</th>
<th>Month 13</th>
<th>Month 14</th>
<th>Month 15</th>
<th>Month 16</th>
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<td>REGION 1</td>
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<td>3,736</td>
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<td>3,886</td>
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<td>5,052</td>
<td>5,246</td>
</tr>
</tbody>
</table>

INDUSTRY NEWS HEADLINES

- Total set-top box industry M&M profits were 3,786,555 this month.
- Firm 3 leads industry M&M in market share (34.9%).
- Firm 2 has the second-highest market share in industry M&M (33.5%).
- Industry M&M inventory investments increased from 5,873,137 to 9,494,327 this month.
- Total industry M&M Research study spending was 0 this month.

DISTRIBUTION CENTER ACTIVITY

- No distribution centers were opened this month.
- No distribution centers were closed this month.

PRODUCT LAUNCHES AND "UNLAUNCHES"

- No products were introduced this month.
- No products were "unlaunched" (dropped) this month.

RECONFIGURATIONS

- No products were reconfigured this month.
Chapter 14: Research Studies

"Research is the process of going up alleys to see if they are blind." - Marston Bates

Chapter 14 Overview

This chapter describes the available LINKS research studies. These research studies provide further information about competitors and about the set-top box markets. These studies are typical of the kinds of research resources that exist in manufacturing-based industries, and the associated costs are typical of the approximate magnitude of the costs associated with such research studies in real industries. However, there's no reason to believe that every one of these research studies is appropriate and useful at all times or worth the associated costs. You'll have to decide whether these research studies are worth their stated costs.

Research studies requests are submitted along with your other decision variable changes. Although LINKS research studies are ordered prior to the beginning of the next month, research studies are executed during and after the next month, as appropriate. Thus, research studies reports always reflect the just-completed month's experience.

The 13 available research studies in the LINKS Supply Chain Management Simulation include:

- Research Study #1: Benchmarking - Earnings
- Research Study #2: Benchmarking - Balance Sheets
- Research Study #4: Benchmarking - Procurement
- Research Study #5: Benchmarking - Manufacturing
- Research Study #6: Benchmarking - Distribution
- Research Study #7: Benchmarking - Transportation
- Research Study #9: Benchmarking - Generate Demand
- Research Study #10: Benchmarking - Info Tech & Research Studies
- Research Study #11: Benchmarking - Operating Statistics
- Research Study #12: Market Statistics
- Research Study #14: Regional Summary Analysis
- Research Study #20: Customer Satisfaction
- Research Study #24: Price Sensitivity Analysis

The research study descriptions include sample output to illustrate the style and formatting of LINKS research study output. These samples are only for illustrative purposes. The output should not be viewed as providing any specific insight into your particular set-top box industry.
to decide whether these research studies are worth their stated costs.

Research studies requests are submitted along with your other decision variable changes. Although LINKS research studies are ordered prior to the beginning of the next month, research studies are executed during and after the next month, as appropriate. Thus, research studies reports always reflect the just-completed month's experience.

An overview of the available LINKS research study resources is provided in Exhibit 17. Exhibit 18 provides a catalog of these research studies organized by application area.

In the following research study descriptions, sample output illustrates the style and formatting of research study output. These samples are only for illustrative purposes. The output should not be viewed as providing any specific insight into your particular set-top box industry.

Research Studies Strategy

"Time spent in reconnaissance is seldom wasted." – Sun Tzu, 4BC

Which research studies should you purchase? When should you purchase these research studies? Two snappy but uninformative responses would be "purchase exactly the research studies that you need and no others" and "it depends." Unfortunately, these responses are not very constructive counsel. Heavy-duty anticipatory thinking is needed before deciding on research study purchases. Bruce Henderson, noted strategist, author, and management consultant, offers the following insightful process-based suggestion for conducting research: "Define the problem and hypothesize the approach to a solution intuitively before wasting time on data collection and analysis. Do the first analysis lightly. Then, and only then, redefine the problem more rigorously and reanalyze in depth. Don't go to the library and read all the books before you know what you want to learn." The problem "reanalysis" stage is particularly relevant since that is where research studies may play a role, once you have determined that the information provided in the research studies may provide useful insight into the problem at hand.

There are no universal answers about appropriate, needed, and desirable research studies, other than the broad principle that research is about uncertainty reduction. What don't you know? How important is it to "know" these things? Is there any research that might be conducted in a timely fashion to reduce this uncertainty?
## Exhibit 17: Overview of LINKS Research Studies

<table>
<thead>
<tr>
<th>#</th>
<th>Research Study</th>
<th>Cost</th>
<th>Limit</th>
</tr>
</thead>
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</tr>
<tr>
<td>2</td>
<td>Benchmarking - Balance Sheets</td>
<td>$1,000 per firm</td>
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</tr>
<tr>
<td>4</td>
<td>Benchmarking - Procurement</td>
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</tr>
<tr>
<td>5</td>
<td>Benchmarking - Manufacturing</td>
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<td>6</td>
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<td>7</td>
<td>Benchmarking - Transportation</td>
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</tr>
<tr>
<td>9</td>
<td>Benchmarking - Generate Demand</td>
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<td></td>
</tr>
<tr>
<td>10</td>
<td>Benchmarking - Info Tech &amp; Research Studies</td>
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<tr>
<td>11</td>
<td>Benchmarking - Operating Statistics</td>
<td>$2,500</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Market Statistics</td>
<td>$2,500</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Regional Summary Analysis</td>
<td>$5,000 per region</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Customer Satisfaction</td>
<td>$10,000</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Price Sensitivity Analysis</td>
<td>$20,000 per product per region per channel</td>
<td>4</td>
</tr>
</tbody>
</table>
Exhibit 18: Research Studies Catalog

<table>
<thead>
<tr>
<th>Supply Chain</th>
<th>1</th>
<th>Benchmarking - Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive Benchmarking</td>
<td>2</td>
<td>Benchmarking - Balance Sheets</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Benchmarking - Procurement</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Benchmarking - Manufacturing</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Benchmarking - Distribution</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Benchmarking - Transportation</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Benchmarking - Generate Demand</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Benchmarking - Info Tech &amp; Research Studies</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Benchmarking - Operating Statistics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competitive and Market Monitoring</th>
<th>12</th>
<th>Market Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>Regional Summary Analysis</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Customer Satisfaction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Generate Demand Program Evaluation</th>
<th>9</th>
<th>Benchmarking - Generate Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>Regional Summary Analysis</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Price Sensitivity Analysis</td>
</tr>
</tbody>
</table>

In thinking about research studies strategy and tactics, some broad generalizations are possible:

- Since research provides the raw data to perform excellent analysis, research should be an important component of your LINKS decision-making process. Do not relegate your research studies ordering decisions to the last five minutes of team meetings. Rather, treat research studies ordering decisions as a fundamental part of your whole decision-making process.

- Plan ahead. To identify patterns and trends, you will probably need to order some research studies on a more-or-less regular basis. A formal research studies plan should be a part of your management planning process.

- Systematize the post-analysis of research studies. This might involve, for example, the continual updating of databases, charts, or graphs to reformat the raw LINKS research studies results into more meaningful and useful forms.

- Share insights derived from research studies with all of your LINKS team members. These may require research studies’ “experts” to assume coaching roles with research studies “novices.” Given the complexity of LINKS, it is not possible to be an “expert” on everything.
Research Study #1: Benchmarking - Earnings

Purpose: This research study provides earnings benchmarks for your industry. The current-month earnings, cumulative-to-date earnings, and current-month dividends of each firm in your industry are reported. In addition, a variety of financial market statistics are reported.

Information Source: These data are based on public information.

Cost: $500.

<table>
<thead>
<tr>
<th>Firm 1</th>
<th>Firm 2</th>
<th>Firm 3</th>
<th>Firm 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Net Income</td>
<td>2,974,292</td>
<td>3,472,461</td>
<td></td>
</tr>
<tr>
<td>Cumulative Net Income</td>
<td>5,788,265</td>
<td>6,334,171</td>
<td></td>
</tr>
<tr>
<td>Current Dividends</td>
<td>892,287</td>
<td>1,041,738</td>
<td></td>
</tr>
</tbody>
</table>

Financial Market Statistics [stock price, shares outstanding (millions), earnings per share, dividends per share, market capitalization ($millions)]

<table>
<thead>
<tr>
<th>Firm 1</th>
<th>Firm 2</th>
<th>Firm 3</th>
<th>Firm 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>StockPrice</td>
<td>120.00</td>
<td>131.80</td>
<td>117.63</td>
</tr>
<tr>
<td>Shares</td>
<td>2.0M</td>
<td>2.0M</td>
<td>2.0M</td>
</tr>
<tr>
<td>EPS</td>
<td>1.49</td>
<td>1.74</td>
<td>1.44</td>
</tr>
<tr>
<td>DPS</td>
<td>.45</td>
<td>.52</td>
<td>.43</td>
</tr>
<tr>
<td>MarketCap</td>
<td>240M</td>
<td>264M</td>
<td>235M</td>
</tr>
</tbody>
</table>

Research Study #2: Benchmarking - Balance Sheets

Purpose: This research study provides summary balance sheet benchmarks for your industry. These balance sheets must be requested for specific firms in your industry.

Information Source: These summary balance sheets are provided by your research supplier based on public information.

Cost: $1,000 per firm.

FIRM 2 BALANCE SHEET

ASSETS:
Cash 1,686,016
Marketable Securities 24,186,533
Finished Goods and Postponed Production Inventory 2,55,661,228
Plant Investment 50,000,000
Procurement Inventories 1,398,909
Total Assets 102,932,686

Research Study #4: Benchmarking - Procurement

Purpose: This research study provides procurement benchmarks for your industry. Each firm’s current sub-assembly component suppliers are listed in the output of this research study. In addition, estimated market shares are reported for each sub-assembly component (SAC) supplier for each SAC.

Information Source: This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top
Box Industry Trade Association.

**Cost:** $3,000.

---

**Research Study #5: Benchmarking - Manufacturing**

**Purpose:** This research study provides manufacturing benchmarks for your industry. This research study reports the distribution (in % terms) of total production for each firm across the categories of postponed production, regular production, and emergency production.

**Information Source:** This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top Box Industry Trade Association.

**Cost:** $5,000.

---

**Research Study #6: Benchmarking - Distribution**

**Purpose:** This research study provides distribution benchmarks for your industry. For each firm, distribution center existence and postponed production status at each regional distribution center are reported.

**Information Source:** This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top Box Industry Trade Association.

**Cost:** $5,000.
Research Study #7: Benchmarking - Transportation

Purpose: This research study provides transportation benchmarks for your industry. This research study reports firm-specific transportation cost breakdowns (as %s) for raw materials, sub-assembly components, plant-to-DC shipments, DC-to-customer shipments, and replacement parts shipments to customers. In addition, this research study provides plant-to-DC shipping benchmarks for your industry by providing each firm’s current plant-to-DC carriers. Estimated market shares are reported for each carrier in each region.

Information Source: This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top Box Industry Trade Association.

Cost: $5,000.

Research Study #9: Benchmarking - Generate Demand

Purpose: This research study provides generate demand benchmarks for your industry. Price and marketing statistics (minimum, average, and maximum) for each product category, market region, and channel are provided.

Information Source: This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top Box Industry Trade Association.

Cost: $5,000.
Research Study #10: Benchmarking - Info Tech & Research Studies

**Purpose:** This research study provides information technology and research studies ordering benchmarks for your industry.

**Information Source:** This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top Box Industry Trade Association.

**Cost:** $1,000.

**Additional Information:** The research study ordering frequencies are based on the last two months, to the extent that such historical data are available in the archives for your industry. Only research studies with non-zero ordering frequencies are reported in this research study output.

---

Research Study #11: Benchmarking - Operating Statistics

"There is no finish line." – Nike Corporation motto

**Purpose:** This research study provides a variety of operating statistics benchmarks for your industry. Various "Corporate P&L Statement" figures are reported as percentages of revenues for your firm and for three industry aggregates (minimum, average, and maximum). Average CSR monthly salary in all regions is reported. In addition, two sets of call center statistics are reported by region, total calls, and cost-per-call.

**Information Source:** This research study is based on information sharing and pooling agreements among all firms in the set-top box industry administered by the Set-Top Box Industry Trade Association.

**Cost:** $2,500.
Research Study #12: Market Statistics

Purpose: This research study provides a variety of market statistics for each region for the last four months:

- Industry demand (final customer purchases) and unfilled orders are reported for hyperware and metaware set-top box categories.
- Overall market shares for each firm are provided for each of the last four months. These market shares are based on end-user customer purchase volumes and not on manufacturer orders.
- End-of-month retail-channel (channel 1) inventory holdings for active products are reported in two ways: units and months of inventory (expressed relative to the current month’s retail-channel sales volume).
- Estimates of retail-channel (channel 1) margins for active products are reported. Note that "margin" is retail-channel sales volume times the retail-channel markup.

Information Source: This research study is compiled by your research vendor using a variety of sources.

Cost: $2,500.
Research Study #14: Regional Summary Analysis

"If you torture the data long enough, it will confess." – Anonymous

Purpose: This research study provides a regional summary analysis for each specified market region, including current-month market shares, prices, and perceptions of product quality, service quality, availability, and (overall) product performance of all active products:

- "Product Quality" is perceived product quality, reflecting customers’ perceptions of a product's configuration and its reliability and performance in actual usage. Failure of sub-assembly components in usage (after purchase) would presumably be reflected in reductions in product quality perception.
- "Service Quality" is perceived service quality, reflecting customers’ perceptions of the service quality associated with a product. Service quality derives from experiences with each firm’s regional call centers.
- "Availability" is perceived product availability, reflecting customers' perceptions of a product's top-of-mind awareness, channel presence, distribution accessibility, ease of access, convenience to purchase, and general presence/prominence in the market place.

Information Source: Perceived product quality, perceived service quality, and perceived availability are based on a survey of set-top box customers. These perceptual ratings are the percentages of survey respondents rating product quality, service quality, and availability as "excellent" on a 4-point "poor"-"fair"-"good"-"excellent" rating scale.

Cost: $5,000 per region.

Additional Information: Your set-top box manufacturing firm sells to retailers in channel #1, not directly to final end-user customers. Retailers in channel #1 maintain inventory of your set-top box products as well as selling your products to their customers. Thus, final end-user customers sales volume and market share in channel #1 (for example, as reported in Research Study #14) aren’t equal to your firm’s sales volume and market share to the retailers in channel #1 due to inventory holdings of retailers in channel #1.

These market shares are region-wide market shares and not channel-based market shares.
That is, these market shares are the relative sales volume across all channels in a region. You may wish to calculate your own channel-specific market shares, if you are interested in your market share only within a specific channel.

Channel #1 ("Retail") results reflect final end-user customer activity. Thus, the prices reported are the prices paid by final end-user customers. These prices include the retailers' markups on the manufacturers' prices.

Research Study #20: Customer Satisfaction

**Purpose:** This research study provides customer satisfaction estimates of all products in all channels in all regions for the last four months.

**Information Source:** Customer satisfaction is based on a customer survey of current users. Customer satisfaction is the percentage of survey respondents rating their overall satisfaction with a product as "excellent" on a 4-point "poor"-"excellent" scale.

**Cost:** $10,000.

Research Study #24: Price Sensitivity Analysis

"Any sufficiently advanced technology is indistinguishable from magic." – Arthur C. Clarke

**Purpose:** This research study provides a price sensitivity analysis for a specific product in a specific region (or all regions) and a specific channel (or all channels).

**Information Source:** This research study is based on surveys of customers, using advanced marketing research techniques.

**Study Details:** These price sensitivity analyses isolate the impact of price on market share, while holding other market share drivers constant (product quality, service quality, and availability perceptions). With no user-specified price input, the nine price levels in this study are automatically centered around the current price (the “Reference Price”) of the product in each region and channel. Values of -20%, -15%, -10%, -5%, 0% (i.e., current price), +5%, +10%, 15%, and +20%, relative to the product's "Reference Price," are used.

If price is left at its default value (0), then Research Study #24 is executed with the existing product centered around the channel-specific current price of the specified product. Otherwise, the user-specified price (with the specified price being the “Reference Price”) is used. Market share predictions are provided for all tested prices in Research Study #24.

**In this research study, “Your Price” is the manufacturer price.** Your manufacturer price is the price that you input for this research study. In a retail channel (like channel #1), the LINKS software automatically estimates the “Market Price” (including the retail markup) that is presented.
to the final end-user customer in each price sensitivity analysis. In a direct channel (like channel #2), the manufacturer price is, of course, the final end-user customer price.

Cost: $20,000 per price sensitivity analysis (per product per region per channel). If you execute this research study for all products, regions, and channels in a 2-product, 3-region, and 2-channel LINKS environment, the total cost would be $240,000.

Sample Output:

```
RESEARCH STUDY #24 (Price Sensitivity Analysis)

PRODUCT 6-1H PREDICTED GROSS MARGINS IN REGION 1, CHANNEL 1 [HYPERWARE]
Configuration: H35322
Reference Price: 290

<table>
<thead>
<tr>
<th>Market Price</th>
<th>Your Price</th>
<th>Your Cost</th>
<th>Your Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>$351</td>
<td>$232</td>
<td>$171</td>
<td>$60</td>
</tr>
<tr>
<td>$373</td>
<td>$247</td>
<td>$171</td>
<td>$65</td>
</tr>
<tr>
<td>$395</td>
<td>$261</td>
<td>$171</td>
<td>$70</td>
</tr>
<tr>
<td>$417</td>
<td>$276</td>
<td>$171</td>
<td>$75</td>
</tr>
<tr>
<td>$438</td>
<td>$290</td>
<td>$171</td>
<td>$80</td>
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<tr>
<td>$459</td>
<td>$304</td>
<td>$171</td>
<td>$85</td>
</tr>
<tr>
<td>$481</td>
<td>$319</td>
<td>$171</td>
<td>$90</td>
</tr>
<tr>
<td>$503</td>
<td>$333</td>
<td>$171</td>
<td>$95</td>
</tr>
<tr>
<td>$525</td>
<td>$348</td>
<td>$171</td>
<td>$100</td>
</tr>
</tbody>
</table>

Sales Volume: 30,577
Market Share: 9.9%

Margin Change: -49.2%
MS Change: -36.4%
Net Change: -5.5%

Gross Margin (in $000s): $1,834

These estimated per-unit costs of $171.09 include these cost components:
  - Product Costs $155.47
  - Order Processing Costs $4.00
  - Replacement Parts Costs $11.62
  - Duties & Tariffs $0.00

Limitations: A maximum of four (4) research studies of this type may be executed each month. Each of these price sensitivity analysis research study requests must reference a single product and one or all regions and channels. This research study may only be conducted for products that are already actively distributed in a region and channel. This research study may not be used for products prior to their introduction into a region and/or channel.

Additional Information: These market share predictions and subsequent estimates of gross margins are based on the assumption that competing products don't change their generate demand programs. Obviously, large price changes will tend to evoke competitive responses.

The reported market shares in Research Study #24 are long-run estimates of market shares if you continue with all of your current customer-facing initiatives (configurations, marketing spending, service levels, etc.) as they are now and so do competitors. Market infrastructure issues (like current inventory holdings of retailers and unfilled order status) are not considered. Only your price is "manipulated" in Research Study #24. Thus, these Research Study #24 estimates of market share will not correspond exactly to your current actual market shares (as reported, for example, in Research Study #14).
Research Studies Decision Forms

Blank "Research Studies Decisions" forms may be found on the next page. Complete this decision form during your team deliberations.
# Research Studies Decisions

<table>
<thead>
<tr>
<th>No.</th>
<th>Research Study</th>
<th>Firm(s)?</th>
<th>Region(s)?</th>
<th>Channel(s)?</th>
<th>Price(s)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Benchmarking - Earnings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Benchmarking - Balance Sheets</td>
<td>Firm(s)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Benchmarking - Procurement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Benchmarking - Manufacturing</td>
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</tr>
<tr>
<td>6</td>
<td>Benchmarking - Distribution</td>
<td></td>
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<tr>
<td>7</td>
<td>Benchmarking - Transportation</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Benchmarking - Generate Demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Benchmarking - Info Tech &amp; Research Studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Benchmarking - Operating Statistics</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>12</td>
<td>Market Statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Regional Summary Analysis</td>
<td>Region(s)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Customer Satisfaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product?</td>
<td>Region?</td>
<td>Channel?</td>
<td>Price?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product?</td>
<td>Region?</td>
<td>Channel?</td>
<td>Price?</td>
</tr>
</tbody>
</table>

**Notes:**

1. *Circle the number of each research study that you wish to order*. If additional information is required for a research study, provide that information in the designated space(s).
2. *When region and/or channel numbers are required, enter a single region number and/or a single channel number*. Use region "0" and channel "0" as designations to run a research study for all regions and/or all channels, respectively. See the research study descriptions for details about the associated multi-region and multi-channel costs.

**Reminders**

Research study requests are for one month only. If you wish to reorder a research study in a subsequent month, you must reenter that research study request.
Chapter 15: Performance Evaluation

"In a good wind, even turkeys can fly." – Chinese saying

Chapter 15 Overview

Since there are many facets of evaluation to consider in a business, a multi-dimensional quantitative performance evaluation scorecard is used in LINKS. Current performance and change in performance are considered in this multi-dimensional quantitative performance evaluation scorecard.

The LINKS scorecard is perhaps described more aptly as a boardroom-level scorecard. It focuses on top-line boardroom kinds of financial, operational, and customer performance measures and sub-measures.

The LINKS scorecard is based on a ranking of performance on each sub-measure. These rank-order comparisons across all competing firms within your industry avoid the undue influence of particularly extreme values of individual sub-measures. This LINKS scorecard is a within-industry performance evaluation system. Comparisons across industries are problematic due to variations in environmental and competitive milieu.

The LINKS scorecard includes the following financial, operational, and customer measures.

- **Financial Measures:**
  - Ratio of Net Income to Revenues
  - Change in Ratio of Net Income to Revenues
  - Return on Assets
  - Net Asset Turns

- **Operational Measures:**
  - Inventory Turns
  - Fill Rate
  - Unplanned Production
  - Failure Rate
  - Ratio of Controllable Procurement and Manufacturing Costs to Revenues
  - Transportation Costs Per Unit Sold
  - Forecasting Accuracy
  - Ratio of (Marketing + Service Spending) to Revenues

- **Customer Measures:**
  - Change in Market Share
  - Customer Satisfaction

This chapter describes the recommended LINKS quantitative performance evaluation mechanism. Since there are many facets of evaluation to consider in a business, a multi-dimensional scorecard is used. As you'll note, current performance and change in performance are considered in this multi-dimensional quantitative performance evaluation scorecard.
Many things matter in evaluating the performance of a business. It's hard to argue with profitability-like measures as the correct things to examine to assess the long-run performance of a business. However, in a shorter-run perspective, other things matter too. These "other things" are leading indicators of future profitability and root causes of profitability.

Multiple measures of performance evaluation obviously lead to conflicts. Short-run and long-run trade-offs are obvious. For example, by reducing inventories and product support spending (marketing and service spending), current costs will decrease and profits will tend to increase. However, in the long-run, these might be exactly the wrong things to do to maximize long-run profitability. Subtler trade-offs arise in potentially conflicting performance measures that move in opposite directions. For example, inventory reductions save costs on the inventory and manufacturing fronts but may lead to shortages to meet the levels of customer demand in the distribution centers. Balancing all of these conflicting trade-offs is the challenge for management.

The various performance measures within LINKS are designed to monitor all key elements of performance assessment: efficiency (input usage); effectiveness (output quality); productivity (conversion of inputs into output); firm-wide profitability; and, external performance (e.g., change in market share and customer satisfaction perceptions).

The LINKS Scorecard

The LINKS scorecard is perhaps described more aptly as a boardroom-level scorecard. It focuses on top-line boardroom kinds of financial, operational, and customer performance measures and sub-measures. The LINKS scorecard includes the measures and weights described in Exhibits 19-21. Each firm in your set-top box industry submits their raw data to the Set-Top Box Trade Association, which provides your firm's personal scorecard every month.

The LINKS scorecard is based on a ranking of performance on each sub-measure. These rank-order comparisons across all competing firms within your industry avoid the undue influence of particularly extreme values of individual sub-measures. This LINKS scorecard is a within-industry performance evaluation system. Comparisons across industries are problematic due to variations in environmental and competitive milieu.

Your firm receives weighted points for each competitor for whom your performance on a sub-measure is better. For some of the sub-measures, "better" means a lower sub-measure value (e.g., the "Ratio of Controllable Procurement and Manufacturing Costs To Revenues" is a lower-is-better sub-measure). For example, if your firm’s ratio of "Net Profits" to "Revenues" is better than three other firms' ratios, your firm receives 9 points. (Of course, the top-performing firm on "Net Income" to "Revenues" ratio in a 6-firm industry would receive 15 points.) In general, the maximum available points on any sub-measure are \( W \times (N-1) \) where "W" is the sub-measure’s weight and "N" is the number of firms in the industry. Points accumulate each month throughout the LINKS exercise.

To avoid an overemphasis on minor month-to-month variations in the calculation of the ranking of firms on the performance sub-measures in the LINKS scorecard, minor differences in the sub-measures are treated as ties in the calculation of ranking points. The thresholds for differences to be treated as meaningful are listed in Exhibits 19-21 for each sub-measure. For example,
differences of 0.2% or less for "Ratio of Net Income to Revenues" are considered to be statistically insignificant, and firms within 0.2% of each other would be treated as being tied. Thus, two firms with ratios of Net Income to Revenues of 4.5% and 4.6% would be treated as being tied in the calculation of ranking position and associated points received in any month.

A sample LINKS scorecard is shown in Exhibit 22. You receive this scorecard automatically each month as the first page of your financial and operating reports. This scorecard provides comparatives to assess how your firm’s data compares to the industry averages and industry bests on every KPI. You can assess where your firm stands compared to competitors with this scorecard.

### Exhibit 19: Scorecard Financial Measures

<table>
<thead>
<tr>
<th>Sub-Measures</th>
<th>Weight</th>
<th>Sub-Measure Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of Net Income to Revenues</td>
<td>3</td>
<td>Current profitability is the best overall signal of business performance, hence its high weight. Firms are &quot;tied&quot; if their scores are within 0.2% of each other.</td>
</tr>
<tr>
<td>Change in Ratio of Net Income to Revenues</td>
<td>1</td>
<td>Improvement in profitability is important but less important than current profitability. Firms are &quot;tied&quot; if their scores are within 0.2% of each other.</td>
</tr>
<tr>
<td>Return on Assets</td>
<td>2</td>
<td>Return means &quot;Net Income&quot; (from the &quot;Corporate P&amp;L Statement&quot;) and investment equals &quot;Total Assets&quot; (from the &quot;Balance Sheet&quot;). This ratio is expressed in annualized terms. Firms are &quot;tied&quot; if their scores are within 0.5% of each other.</td>
</tr>
<tr>
<td>Net Asset Turns</td>
<td>1</td>
<td>Ratio of revenues to net assets. Net assets are assets minus loans. This measure reflects the desirability of higher revenues relative to the assets deployed to yield these revenues. This ratio is expressed in annualized terms. Firms are &quot;tied&quot; if their scores are within 0.2 of each other.</td>
</tr>
</tbody>
</table>

**Notes:** Positive "weights" are associated with sub-measures where "more is better" and negative "weights" are associated with sub-measures where "less is better." "Change" measures are based on month-to-month changes.
### Exhibit 20: Scorecard Operational Measures

<table>
<thead>
<tr>
<th>Sub-Measures</th>
<th>Weight</th>
<th>Sub-Measure Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory Turnover</td>
<td>2</td>
<td>Ratio of product costs to average inventory value (average of the current and the previous months). If average inventory value is zero, then Inventory Turnover is defined to be 100. Firms are &quot;tied&quot; if their scores are within 0.2 of each other.</td>
</tr>
<tr>
<td>Fill Rate</td>
<td>1</td>
<td>The percentage of orders that are filled. &quot;Unfilled orders&quot; occur when available inventory and emergency production is less than orders in a month. Firms are &quot;tied&quot; if their scores are within 0.5% of each other.</td>
</tr>
<tr>
<td>Unplanned Production</td>
<td>-1</td>
<td>The percentage of total production (postponed, regular, and emergency) that is emergency production. Firms are &quot;tied&quot; if their scores are within 0.5% of each other.</td>
</tr>
<tr>
<td>Failure Rate</td>
<td>-1</td>
<td>Ratio of replacement parts demand to sales volume (orders). Firms are &quot;tied&quot; if their scores are within 0.5% of each other.</td>
</tr>
<tr>
<td>Ratio of Controllable Procurement and Manufacturing Costs to Revenues</td>
<td>-1</td>
<td>Controllable procurement and manufacturing costs include &quot;Disposal Sales,&quot; &quot;Emergency Procurement,&quot; &quot;Emergency Production,&quot; &quot;Inventory Charges,&quot; &quot;Procurement FC,&quot; and &quot;Production FC.&quot; Firms are &quot;tied&quot; if their scores are within 0.2% of each other.</td>
</tr>
<tr>
<td>Transportation Costs Per Unit Sold</td>
<td>-1</td>
<td>Equal to total transportation costs divided by total units sold (orders). Firms are &quot;tied&quot; if their scores are within 0.5 of each other.</td>
</tr>
<tr>
<td>Forecasting Accuracy</td>
<td>2</td>
<td>Forecasting accuracy is a relatively pure signal of management skill and expertise (in this case, in the area of understanding customers and customer demand generating forces). Firms are &quot;tied&quot; if their scores are within 0.5% of each other.</td>
</tr>
<tr>
<td>Ratio of (Marketing + Service Spending) to Revenues</td>
<td>-1</td>
<td>Service spending is service outsourcing costs. Marketing spending is an easy way to boost short-run sales volume without necessarily contributing to long-run profitability. Relative to revenues, spending less in marketing and service is desirable. Firms are &quot;tied&quot; if their scores are within 0.2% of each other.</td>
</tr>
</tbody>
</table>

**Notes:** Positive "weights" are associated with sub-measures where "more is better" and negative "weights" are associated with sub-measures where "less is better." "Change" measures are based on month-to-month changes.
Exhibit 21: Scorecard Customer Measures

<table>
<thead>
<tr>
<th>Sub-Measures</th>
<th>Weight</th>
<th>Sub-Measure Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in Market Share</td>
<td>1</td>
<td>Change in market share is an overall measure of customer reaction to the firm's offerings. (&quot;Market share&quot; equals customer purchases in all channels and regions.) Firms are &quot;tied&quot; if their scores are within 0.1% of each other.</td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>2</td>
<td>Customer satisfaction measures the performance of the product from the perspective of purchasers. Thus, it's a clear measure of customer performance and a long-run leading indicator of repeat purchasing behavior and customer retention. Average customer satisfaction across all products, channels, and regions is used here. Firms are &quot;tied&quot; if their scores are within 0.5% of each other.</td>
</tr>
</tbody>
</table>

Notes: Positive "weights" are associated with sub-measures where "more is better" and negative "weights" are associated with sub-measures where "less is better." "Change" measures are based on month-to-month changes.

Exhibit 22: Boardroom Scorecard Sample

<table>
<thead>
<tr>
<th>FIRM 3: Global Intergalactic STBs Pty.</th>
<th>INDUSTRY ABC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE EVALUATION REPORT, MONTH 8</td>
<td>PAGE 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Firm 3</th>
<th>Worst</th>
<th>Average</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FINANCIAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Income to Revenues</td>
<td>4.5%</td>
<td>4.5%</td>
<td>5.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Change in Net Income to Revenues</td>
<td>-1.7%</td>
<td>-1.7%</td>
<td>-0.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Return on Assets</td>
<td>13.8%</td>
<td>13.8%</td>
<td>16.4%</td>
<td>18.0%</td>
</tr>
<tr>
<td>Net Asset Turns</td>
<td>3.0</td>
<td>2.8</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>OPERATIONAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory Turnover</td>
<td>4.5</td>
<td>3.9</td>
<td>4.3</td>
<td>4.7</td>
</tr>
<tr>
<td>Fill Rate</td>
<td>91.1%</td>
<td>91.1%</td>
<td>96.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Unplanned Production</td>
<td>15.4%</td>
<td>15.4%</td>
<td>12.8%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Failure Rate</td>
<td>7.2%</td>
<td>7.5%</td>
<td>7.1%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Controllable Procure&amp;Mfg to Revenues</td>
<td>3.1%</td>
<td>3.1%</td>
<td>2.8%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Transportation Expenses Per Unit Sold</td>
<td>34.1</td>
<td>34.1</td>
<td>32.6</td>
<td>31.1</td>
</tr>
<tr>
<td>Forecasting Accuracy</td>
<td>81.8%</td>
<td>81.8%</td>
<td>85.2%</td>
<td>87.7%</td>
</tr>
<tr>
<td>(Marketing + Service) to Revenues</td>
<td>8.7%</td>
<td>9.0%</td>
<td>8.7%</td>
<td>8.5%</td>
</tr>
<tr>
<td><strong>CUSTOMER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Market Share</td>
<td>-0.1%</td>
<td>-1.0%</td>
<td>0.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>26.6%</td>
<td>24.4%</td>
<td>25.3%</td>
<td>26.6%</td>
</tr>
</tbody>
</table>

* Specifications vary based on industry and firm performance.*
Chapter 16 Overview

This chapter reviews a variety of relevant topics related to managing your LINKS firm. Issues related to planning are discussed. Several worksheets are provided to assist you in your planning-related tasks within LINKS. In addition, some suggestions regarding your decision making near the end of the LINKS exercise are offered. Specific and general advice is offered regarding your participation in LINKS.

Three worksheets help you in LINKS planning.

- The SWOT Analysis Worksheet is the classic strengths-weaknesses-opportunities-threats template to organize your thinking under the "What is happening?" and "How are we doing?" questions.
- The KPI Worksheet is a template to structure your thinking and analysis related to specific KPIs that you might wish to improve as a result of your planning efforts. Use the KPI Worksheet frequently to organize your thoughts on performance drivers.
- The Supply Chain Management Scorecard provides a comprehensive listing of best-in-class benchmarks for excellent supply chains.

Planning

Planning occurs throughout the LINKS exercise. Your decisions are your plans. But that's not the whole story. How are plans developed? And, much more importantly, how are good plans developed? Planning and plans are the consequence of careful analysis and formulation of appropriate strategies and tactics. Your plan is, therefore, the natural consequence of considerable prior analysis and thinking. This analysis-planning-implementation-evaluation sequence iterates through time as the results of your plans are revealed in the market place (and in your financial and operating statements).
The essence of planning involves answering these questions (and in this order):
(1) What is happening?
(2) How are we doing?
(3) How and what are "they" (our major competitors) doing?
(4) What factors are important for success?
(5) What are we going to do? Why? With what effect? At what cost?
(6) Who - specifically - is to do what to make the plan work?

Three worksheets help you in LINKS planning.
• The SWOT Analysis Worksheet is the classic strengths-weaknesses-opportunities-threats template to organize your thinking under the "What is happening?" and "How are we doing?" questions.
• The KPI Worksheet is a template to structure your thinking and analysis related to specific KPIs that you might wish to improve as a result of your planning efforts. Use the KPI Worksheet frequently to organize your thoughts on performance drivers.
• The Supply Chain Management Scorecard provides a comprehensive listing of best-in-class benchmarks for excellent supply chains.

These worksheets may be found on the following three pages.
## SWOT Analysis Worksheet

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>What are your firm’s strengths relative to your competitors? What are your most important strengths? Why?</em></td>
<td><em>What are your firm’s weaknesses relative to your competitors? What is impeding you from achieving your desired results? Prioritize your weaknesses.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>How can you convert these strengths, weaknesses, and threats into opportunities for your firm? What considerations are most important for your success?</em></td>
<td><em>What organizational, competitive, and environmental threats do you face now and in the near future?</em></td>
</tr>
</tbody>
</table>
Key Performance Indicators (KPIs) are central to managing processes and sub-processes, such as those that comprise supply chain management. Use this worksheet to analyze a specific sub-process for your LINKS firm. Develop specific action plans for improving your performance on this KPI.

<table>
<thead>
<tr>
<th>What KPI?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>How/Why Is This KPI Relevant To Customers and Customer Requirements?</td>
<td></td>
</tr>
<tr>
<td>Why Is This KPI Noteworthy Now?</td>
<td></td>
</tr>
<tr>
<td>What Is Your Standing on This KPI Now?</td>
<td></td>
</tr>
<tr>
<td>What Are Leading/Key Competitors' Standings on This KPI Now?</td>
<td></td>
</tr>
<tr>
<td>What Is Your KPI Future Objective?</td>
<td></td>
</tr>
<tr>
<td>What Can You Do To Influence This KPI? (What Drives This KPI?)</td>
<td></td>
</tr>
<tr>
<td>What's Your Specific Action Plan To Achieve Your KPI Future Objective?</td>
<td></td>
</tr>
</tbody>
</table>
## Supply Chain Management Scorecard

<table>
<thead>
<tr>
<th>Agility</th>
<th>Organizational Performance</th>
<th>Poor</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respond to short-term changes in demand or supply quickly; handle external disruptions smoothly.</td>
<td>Promote information flow with suppliers and customers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Develop collaborative relationships with suppliers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Design for postponement</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Build inventory buffers by maintaining a stockpile of inexpensive but key components</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Have a dependable logistics system or partner</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Draw up contingency plans and develop crisis management teams</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adaptable</th>
<th>Organizational Performance</th>
<th>Poor</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjust supply chain’s design to meet structural shifts in markets; modify supply network to strategies, products, and technologies</td>
<td>Monitor economies all over the world to spot new supply</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Use intermediaries to develop fresh suppliers and logistics infrastructure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Evaluate needs of ultimate customers, not just immediate customers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Create flexible product designs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Determine where companies’ products stand in terms of technology cycles and product life cycles</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Organizational Performance</th>
<th>Poor</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create incentives for better performance</td>
<td>Exchange information and knowledge freely with vendors and customers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Lay down roles, tasks, and responsibilities clearly for suppliers and customers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Equitably share risks, costs, and gains of improvement initiatives</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

You are a member of a team in LINKS. Managing your team to obtain the best efforts of all team members is a continuing management challenge.

- Your most limited resource within LINKS is your team's available time. Well-performing teams inevitably manage their management time carefully and thoughtfully. Think carefully about how to allocate your management time to necessary tasks that exist within LINKS.
- As you gain experience with LINKS, it may well appear that a review is needed of an earlier group decision about how to allocate tasks, responsibilities, and available management time. Don't be shy within your LINKS team about asking the question: "Are we organized in the best way for the tasks ahead?" This is always a good question.

There are predictable signals of well-performing teams in simulations (and in real life!). Pamela Van Rees (Boston University MBA student), provided the following list of characteristics of well-functioning simulation teams:

- The firm's long-term well-being is the top priority of all members.
- Relevant issues are fully and adequately explored.
- Proposals and objectives are clearly explained.
- Members feel comfortable and spontaneous.
- Feedback is given freely and directly.
- Members feel respected, supported, and listened to.
- Disagreements are tactfully stated without being offensive.
- Differences and misunderstandings are resolved in such a way as to strengthen and deepen rather than weaken relationships (by exploring the origins and implication of ideas).
- Everyone's judgment is acknowledged and explored.
- Interruptions are minimal.
- Everyone's schedule is accommodated as fully as possible.
- At any given time in a group meeting, each firm member is either engaged in holding the focus (proposing an idea or decision), listening to another's focus, giving feedback about the focus, or facilitating (creating the structure or leading) the discussion.

The principal causes of poor team performance in the simulation are a combination of the following factors:

1. uncoordinated supply chain management;
2. not really meeting customer requirements for set-top boxes (i.e., failure to establish any meaningful differential advantage, particularly regarding product configuration);
3. lack of focus (capacity, reconfiguration, time, and human resource constraints combine to favor concentrated effort in fewer than "all" market regions);
4. limited research and/or limited efforts to interpret the research studies that are available;
5. limited attention to competitive developments (i.e., lack of in-depth competitor analysis to discover the underlying drivers of market behavior);
6. financial mismanagement related to cost structure management (variable and fixed costs management, covering corporate-wide overheads, etc.), production and inventory levels, and capacity management;
7. not understanding the simulation's structure/environment (i.e., treating the participant's manual in a cursory fashion, rather than something to be studied and referenced regularly);
8. poor work ethic (not spending enough time on the simulation); and,
9. team mismanagement (not spending enough time thinking about and discussing team management issues and related human resource deployment strategies and tactics).
End-Gaming Strategies and Tactics

"It's time to break camp." – Dwight Dowdell, Accenture

Should you do anything special or unusual at or near the end of your LINKS exercise? Behave as if the simulation will not end at any specific pre-announced month. Keep a long-run view and continuously try to improve your firm's performance. Attempts to end-game the simulation can easily be counter-productive, resulting in substantial last-minute deteriorations in hard-earned market share, margins, and profits.

The best counsel about end-gaming is simply to manage your firm to improve its profitability through time. You don't have to get it perfect (i.e., achieve "optimal" profits, whatever that is), but you must improve through time. You take over a LINKS firm that is profitable as of month 3. Seek to improve your firm's profitability through time ... and that time extends to and beyond the actual end of your particular LINKS simulation exercise.

General Advice

"The fight is won or lost far away from witnesses, behind the lines in the gym and out on the road, long before I dance under those lights." – Muhammad Ali

Based on extensive observations of the performance of thousands of past LINKS participants, these general suggestions and summary-advice nuggets are of well-proven value:

- Read and re-read this LINKS participant's manual (there's lots of good stuff in it).
- Regularly think about general business and management principles and how they might relate to and work within LINKS.
- You don't have to know everything about the LINKS set-top box industry at the beginning of the exercise, but you must consistently increase your knowledge-base through time.
- "Share toys" (i.e., work hard at sharing your useful fact-based analyses and important insights with all members of your LINKS team). "Knowing" something important personally is only a part of the LINKS management challenge. Exploiting that knowledge effectively throughout all of your LINKS team's deliberations, with and through your whole LINKS team, is the key to harvesting the maximum ROI from your data, facts, analysis methodologies, insights, and knowledge.
- Get the facts and base your decisions on the facts, not on wishes, hopes, and dreams.
- Coordinate demand and supply by continually striving to see the whole demand-chain and supply-chain within the LINKS set-top box industry. Don't focus myopically on a single part of the LINKS demand-chain without regard for how it relates to, and is influenced by, other LINKS parts and to the "whole" of LINKS. The source of the "LINKS" name is the simulation's focus on managing the interrelationships, the linkages, among all supply-chain elements.

Postscript

"The journey is the reward." – Steve Jobs, Apple Computer Founder

Good luck and try to have fun in LINKS. It's all about learning and, in a "learning marathon" like LINKS, everyone can cross the finish line in a personal-best time.
Appendix: Web-Based LINKS Access

LINKS has no software to download/upload/install. Point your favorite web browser at the LINKS Simulations website to interact with LINKS http://www.LINKS-simulations.com and then access the LINKS Simulation Database using your firm’s case-sensitive passcode. You'll be e-mailed your LINKS firm's passcode just before your LINKS event begins.

LINKS uses e-mail to communicate with all LINKS participants. Please ensure that your preferred e-mail software is configured to receive e-mail messages from domains ending with:

@ChapmanRG.com   @LINKS-simulations.com   @LINKS-simulations.info

You may wish to consult your personal information technology advisor to ensure that your e-mail software is configured appropriately to receive LINKS e-mail from these domains.

While the LINKS Simulation Database works with all web browsers, Microsoft’s Internet Explorer is recommended. LINKS website access requires a Java-enabled browser.

Output Retrieval After a LINKS Round: You'll be advised via e-mail when LINKS game-run results are available on the LINKS Simulations website. Links within the LINKS Simulation Database permit you to access your Word doc and Excel results after a game run.

Inputs For the Next LINKS Round: When you're ready to input decisions for the next LINKS round, access the LINKS Simulation Database and make your input changes.

- While any number of members of a LINKS firm may access the LINKS Simulation Database simultaneously to “browse,” only one team member at a time can input new decisions. If multiple members of a LINKS firm attempt to make inputs simultaneously, problems can arise; all decision inputs might not be saved successfully on the LINKS server with simultaneous inputs from multiple members of a LINKS firm.
- You may make some inputs now and others later. Only your final LINKS inputs at the input submission deadline for your LINKS industry are included in the next LINKS round.
- Within the LINKS Simulation Database, current decision values are displayed on the input screens. You only need to make changes. All LINKS decision variables are "standing orders" and remain in effect until changed. However, you must input specific instructions each LINKS round for ordering research studies. Otherwise, research studies will be executed only once since "standing orders" don't exist for research studies.
- Inputs are checked for input integrity, including upper and lower bounds on permissible numeric inputs. Invalid entries result in an error message reporting valid minimums and maximums. And, informative messages are reported at the bottom of each web screen.
  - Save Input Changes on a LINKS input web screen before moving to another input screen in the LINKS Simulation Database. Review reminder, warning, and error messages reported at the bottom of the regenerated web screen after the inputs are processed by the LINKS web server.
• **Decision Inputs Audit**: To provide decision inputs auditing support, the LINKS Simulation Database includes Decision Inputs Audit. Accessible on the initial login and Exit web screens in the LINKS Simulation Database, the Decision Inputs Audit checks a firm’s current decision inputs for potential problems and inconsistencies. This LINKS Simulation Database audit function is not an audit of the individual quality of each decision input (e.g., there’s no attempt to assess whether a price of $345 is good or bad). But, possible problems are flagged for attention. For example, forecasts that haven’t been changed since the last decision round are noted in the audit display because forecasts are normally updated every decision round.

**Accessing LINKS Results Files Via a Browser on a Public Computer**: Web browsers leave “tracks” to previously accessed web-pages in browser history files. If you access LINKS results files on a public computer (e.g., in a public PC lab), others could access your results too via the browser history.

Instructions for cleaning the cache in Internet Explorer follow. Other web browsers have similar browser-cache cleaning protocols.

If you access LINKS results files on a public computer, follow these steps to clear Internet Explorer’s browser history (cache):

1. Exit/close Internet Explorer after accessing your LINKS results file.
2. Re-start Internet Explorer.
   a. Click on “Tools” and then “Internet Options.”
   b. On the “Internet Options” screen, look for the “Browsing History” sub-section. Check “Delete browsing history on exit” (it may already be checked).
   c. Click the “Delete” button in the “Browsing History” sub-section.
   d. Check the “History” box on the “Delete Browsing History” screen (it may already be checked).
   e. Click the “Delete” button at the bottom of the “Delete Browsing History” screen.
   f. Wait until the “Internet Options” screen re-appears.
   g. Click the “OK” button.
3. Exit/close Internet Explorer.

These steps clear the browsing history from Internet Explorer on any computer and preserve the security and privacy of your LINKS results files.
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