Global Demand Transparency in the ABB Supply Chain

by

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B.S. Electrical Engineering, Korea University, 2006

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Abstract

This paper attempts to provide a solution to a problem facing many multinational firms: the lack of an accessible and comprehensive database for up-to-date component part forecasts. We consider this problem in the context of ABB BU DMPE. After considering various requirements and constraints regarding the consolidation of forecasting information, we propose a novel combination of standardized process and the use of certain IT tools as a first step. After a test run, we discovered that consolidation of forecasting information increases transparency within the supply chain. As a corollary result of our pilot program, we propose that prior to any attempt at consolidation, enforcement of a standardized form and method of forecasting at the local level.

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1.1 Problem Description

In order to secure on-time deliveries to customers, total supply has to match total demand. However, the ABB Power Electronics and MV Drives business unit under the Discrete Automation and Motion division (hereafter, "ABB DMPE"), which has multiple production locations around the world, faces tremendous challenges with balancing demand and supply, since ABB does not have transparency in its global supply chain. Total demand toward global suppliers that deliver to multiple ABB factories is visible neither inside ABB nor to the suppliers.

Although the global supply management division collects annual local supply forecasts for various materials, or component parts, these forecasts are unreliable and are not easily accessible for a number of reasons. First, because the supply forecasts are updated only annually, potential users of these forecasts do not have access to the most current forecasts, which may be sensitive to changing market conditions. Second, the quality of these annual forecasts is suspect because current procedures do not specifically dictate where these forecasts should originate. For example, some forecast figures are directly collected from local suppliers while other figures are derived from product forecasts. Furthermore, there is no single medium via which these annual forecast figures are collected: some figures are sent to the global supply management division in Excel spreadsheet form, while others are sent within the text of emails, and still others are simply sent via fax. Third, because of its ad hoc nature, the current process via which annual forecasts are collected is labor intensive, and therefore, extremely costly and time consuming. The current procedure does not avail itself of the time and cost saving IT tools that are available within ABB. Fourth, once collected the supply forecasts for the various materials, or component parts, are not consolidated: each global supply manager in charge of a specific component part maintains those forecasts in any manner he or she deems fit. In short, an overhaul of the procedures in place for collecting forecast figures, which includes standardization and the use of IT tools currently in place at ABB, will result in not only more up-to-date and frequent forecasts but also decreased costs in collecting and maintaining such forecasts.

This task is made more challenging especially when a shortage problem of global suppliers occurs suddenly. When this shortage happens, ABB supply management needs to manage the limited amount of supply amongst global production locations. Otherwise, each ABB location will be competing against the other locations to satisfy its own local demand. Currently, ABB supply management has difficulty prioritizing and allocating this limited supply to each production location due to lacking a valid forecast of how many commodities each production location needs. This lack of information also brings about a great deal of firefighting and obstructs the execution of timely actions to solve the shortage problem, such as a global business decision and second-sourcing actions.

1.2 Project Motivation

As the global presence of ABB expands, ABB's supply chain with global suppliers is becoming ever more complex. Evidence of this increased complexity can be found in the diversity and specialization of the various departments and organizations that comprise ABB. For example, ABB uses the term "local business *units*" (hereafter, "LBUs") for those operations on local campuses that have full functionality from sales, marketing, R&D, and sourcing, to production and delivery to the customers. In contrast, ABB uses the term "local production units" (hereafter, "LPUs") for local production plants when the site is mainly focused on production or when it is desired to emphasize the production function of that site. ABB uses the term "Business Unit" (hereafter, "BU") for an aggregate of LBUs plus the supervisory function (headquarters). To be clear, this project is about the communication and process flow between a BU and LPUs (not LBUs).

One result of this expansion by ABB in general and ABB DMPE in particular is that more than one production location has begun to produce the same products, causing the production locations to utilize the same global suppliers and components. Production outside of Switzerland has also been significantly growing (Figure 1). Meanwhile, the number of suppliers and commodities is also growing, as ABB produces more varied kinds of customized products for different customers around the world. Lastly, global suppliers have also expanded their footprint and support ABB with various supply chains of their own.

There have been severe constraints on the availability of several commodities purchased from global suppliers. A reason for this inefficiency lies in the non-existence of a methodical component part-planning process with global suppliers from the ABB side. When ABB started producing all products in just one factory, the supply chain process could be transparent without any specific planning process or tool. However, as ABB has grown both organically and inorganically, the number and the variety of customers, commodities, and suppliers have increased. Thus, more sourcing managers need to be involved in the component parts planning in different locations. This planning can no longer be handled manually due to the huge workload and lower level of reliability. Consequently, a methodical component parts planning process, along with the appropriate tools, is required.

(in %)	2010	2009	2008
Europe	48	54	58
The Americas	14	15	15
Asia	34	29	24
Middle East and Africa	4	3	3
Total	100	100	100

Favorable market development and a focused build-up of local activities have contributed to the increased share from Asia. Europe's share declined in 2010 due to low order backlog at the beginning of the year caused by the weak order intake in 2009.

Figure 1: The geographic distribution of revenues for Discrete Automation and Motion Division[1]

[1] ABB Ltd, "Strengthening the foundations for growth: The ABB Group Annual Report 2010," p. 57 (hereinafter "ABB Annual Report").

1.3 Project Objectives

The goal of this project is to develop a standardized process that consolidates the component part planning of multiple global production locations. This standardized process should help ABB DMPE to be more agile at any time with any supply shortage or delay circumstance, so that ABB will increase on-time deliveries, optimize its global supply chain, and reduce losses due to suboptimal solutions.

This project scope is outlined as follows:

Category	Scope
Commodities	Used in more than one production location
Frequency	More frequent than now. Monthly (less preferably quarterly)
Duration	12 months rolling
Production Locations	All locations that use certain commodities
Product Groups	All Product Groups should be included

Figure 2: Scope of project

The project will not consider or attempt to cover the following[2]:

- development of a completely new demand-forecasting process for LBUs (Refer to section 3.4.1);
- development or implementation of major changes to the existing IT tools;
- customized products;[3] and
- non- "active components"[4]

[2] These exclusions will not be covered by this project but should be and will be considered for any future follow-up project.

[3] Only standardized products produced by ABB will be considered for the project.

[4] See section 4.2.1 for a discussion of "active components."

By creating a component part planning forecast consolidation process, ABB DMPE will improve its profits and its ability to supply customers with the products they need.

1.4 Hypothesis and Expected Results

On-time delivery to customers can be improved through the creation and implementation of a high-level Sales and Operation Planning (hereafter, "S&OP") concept and a clearly defined process for global S&OP. Specifically, the component part planning part of S&OP will be the focus (as opposed to the front side of S&OP, sales planning). The new S&OP process will define role, responsibilities, deliverables, and timelines. Also, ABB DMPE will have better communications to internal and external stakeholders with the improved process, ultimately enhancing on-time delivery to customers. In addition, an electronic tool study of the new S&OP process will be done. From a pilot run of a few critical commodities, ABB DMPE will be able to closely monitor and evaluate the new process and improve the forecast consolidation process for a further roll out.

1.5 Methodology

First, an analysis of current S&OP will be done. Based on this "as is" of LBUs, a process of global forecast consolidation will be developed. Appropriate electronic tools will be studied amongst existing IT supply chain management tools. Selected globally-used components will play a role in the pilot run. Following each step of S&OP, any possible problems or issues will be monitored and solutions to such problems or issues will be reflected in the modified process development. This project also includes development of a global supplier commitment process based on the forecast and global supply assessment and decision making processes (and tools).

2 Company Background

This chapter introduces the ABB Group, Discrete Automation and Motion division, Power Electronics & MV Drives BU, ABB Turgi in Switzerland, and the Supply Management team in ABB Turgi.

2.1 The ABB Group

The ABB Group (ABB) is a global leader in power and automation technologies with a focus on improving customers' energy and industrial performance and lowering environmental impact. ABB was formed in 1988 when the Swedish company Allmänna Svenska Elektriska Aktiebolaget (ASEA) merged with the Swiss company Brown, Boveri & Cie. (BBC). At the time of the merger, ABB was headquartered in Zurich, Switzerland, where it still resides today. In 2010, ABB had revenues of $31.59B and net income of $2.56B. ABB currently employs approximately 116,500 employees in over 100 countries.[5] [1]

ABB has a matrix organizational structure with one axis being each geographic region in which ABB operates and the other axis its divisions. As of January 1, 2010, ABB operates five divisions across two key markets: the power and automation businesses. The power business focuses on power transmission, distribution, and power-plant automation and power electric, gas and water utilities. On the other hand, the automation business serves a full range of industries with measurement, control, protection, and process optimization applications.[6] The power business has two divisions: Power Products and Power Systems. The automation business has three divisions: Discrete Automation and Motion, Low Voltage Products, and Process Automation.[7] Within each division, there are Business Units (BU), and within each BU, there are Product Groups (PG).

[5] This description is extracted from the 2010 ABB Annual Report.

[6] Id. at p. 38.

[7] Id. at p. 39.

2.2 Division of Discrete Automation and Motion

The division "Discrete Automation and Motion" provides products and related services for industrial production. Major products are motors, generators, drives, programmable logic controllers (PLCs), power electronics and robotics.[8] These provide power, motion, and control for a wide range of automation applications.[2] Key applications include energy conversion; data acquisition and processing; actuation; automation; standardized manufacturing cells for applications such as machine tending, welding, cutting, painting, finishing, and packing; and engineered systems for the automotive industry. Revenues are generated both from direct sales to end users as well as from indirect sales through distributors, machine builders and OEMs, system integrators, and panel builders.

The Discrete Automation and Motion division had approximately 18,300 employees worldwide as of December 31, 2010, and generated $5.6 billion of revenues in 2010 through sales activities in more than 100 countries.[1]

2.3 BU of Power Electronics and Medium Voltage Drives

The Power Electronics and Medium Voltage Drives BU is under the Discrete Automation and Motion Division; this BU is divided into three smaller product groups: Power Electronics, Medium Voltage Drives (MV Drives), and Traction Converters as shown in Figure 3. (See illustrations in Figure 4.)

[8] Id.

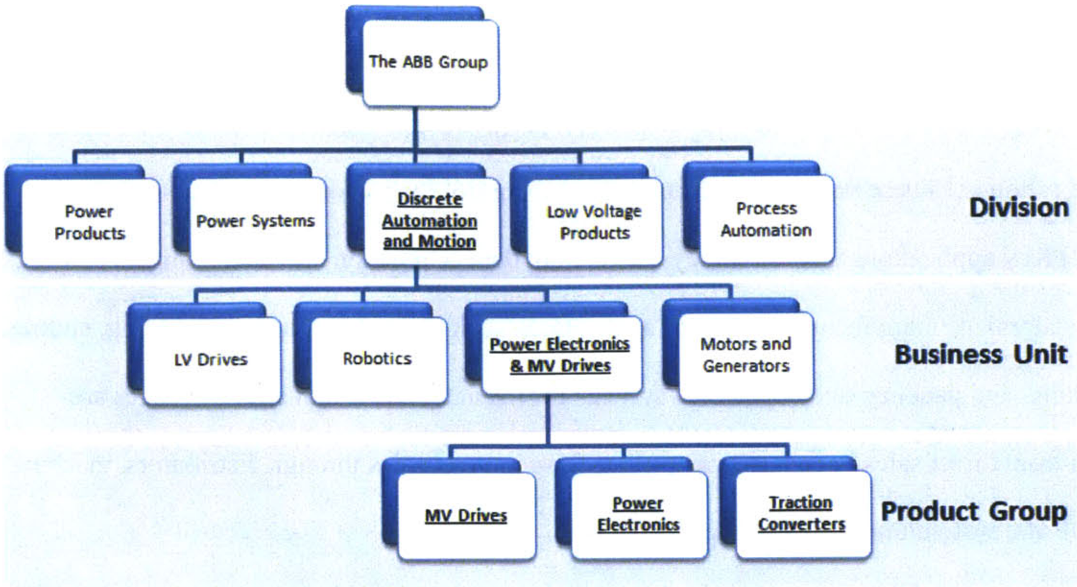


Figure 3: The organizational structure of ABB "Discrete Automation and Motion" Division, Turgi, Switzerland[3]

The Power Electronics group (PE) produces power conversion systems in three different sub-groups: excitation systems; high power rectifiers; power converters.[4] PE products are used in a wide range of industries from traditional industrial markets to emerging markets, such as automotive charging systems. The PE group not only supplies to external customers but also to other product groups within ABB. The PE group has the widest range of products and the most complex product mix among three different product groups because it offers a great deal of customized options.

The Medium Voltage Drives group manufactures medium voltage (~ 2.3 to 6.6 kV) alternating current (AC) drives in the range of 315 kW to more than 100 MW. These drives control the speed and torque of induction motors or synchronous motors to the actual need, thus reduce energy consumption. Their applications cover a wide range in numerous industries, such as the cement, mining, and minerals; power; water; and chemical, oil and gas.[5] This group's offerings can be classified as either general purpose drives (GPD) or special purpose drives (SPD). GPD are used to control standard motors of pumps, fans, compressors, mixers, mills, and conveyors. SPD are engineered drives especially for high power, high speed, or special performance applications such as marine propulsion and rolling mills.[6] In particular, among the three product groups, MV Drives group has the most standardized product lines and produces a higher volume and lower mix of products with a limited range of options.

The Traction Converters group provides "on-board" converters for propulsion and power supplies for trains, light rail vehicles, locomotives, and similar applications.[7] These traction converters are used in the 16.7 Hz rail electric network and the 50 Hz main power grid, providing power conversion at levels up to 1000 kW.[4] Currently, the market of the Traction Converters group is mainly focused on Europe due to the high market penetration of light rail travel. In particular, this group is a 2009 spin-off from another product group and is at the very introductory stage of growth. Therefore, the traction converters are less standardized across the product range and are offered in lower volumes with various options.

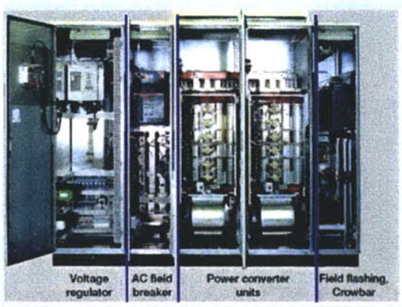
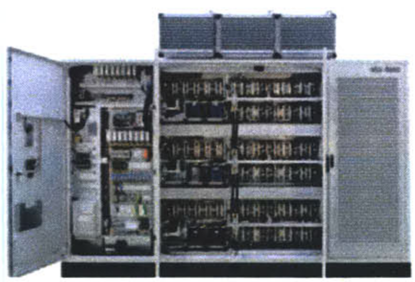
Group	Power Electronics	Medium Voltage Drives	Traction Converters
Product	UNITROL 5000	ACS 5000 air cooled	BORDLINE® CC400 [9]
	 [8]	 [6]	

Figure 4: Illustrations of the modular structure of one product in each group

ABB DMPE has one noteworthy organizational feature of its product groups. Each product group could become a separate BU itself with its wide range and the considerable number of products. Nevertheless, three product groups became a single BU, because all three product groups have similar technologies and are geographically co-located. Each product group independently operates sales, product development and manufacturing, whereas all product groups have one single supply management team. Consequently, this organizational structure has increased the complexity of the supply chain of the BU, "Power Electronics and Medium Voltage Drives," which is discussed in detail in the next section.

2.4 Supply Management, ABB Turgi, Switzerland

Of the four BUs in the Discrete Automation and Motion (DM) division, only one BU, Power Electronics and Medium Voltage Drives (PE), is in Turgi, Switzerland. In terms of functions, the Supply Chain Management team consists of supply management, supply quality, procurement, and logistic processes.

In particular, the supply management team of ABB DMPE at Turgi, Switzerland, has dual job functions: serving as headquarters for its BU and supporting all LPUs globally as well as serving to support local production at Turgi. (See Figure 5and the more detailed explanation of LPU and BU in section 3.4.1.)

The work reported here was done at the BU headquarters in the Global Supply Management team. This Global Supply Management team has responsibility for the value stream management of inbound logistics, especially in availability and cost.

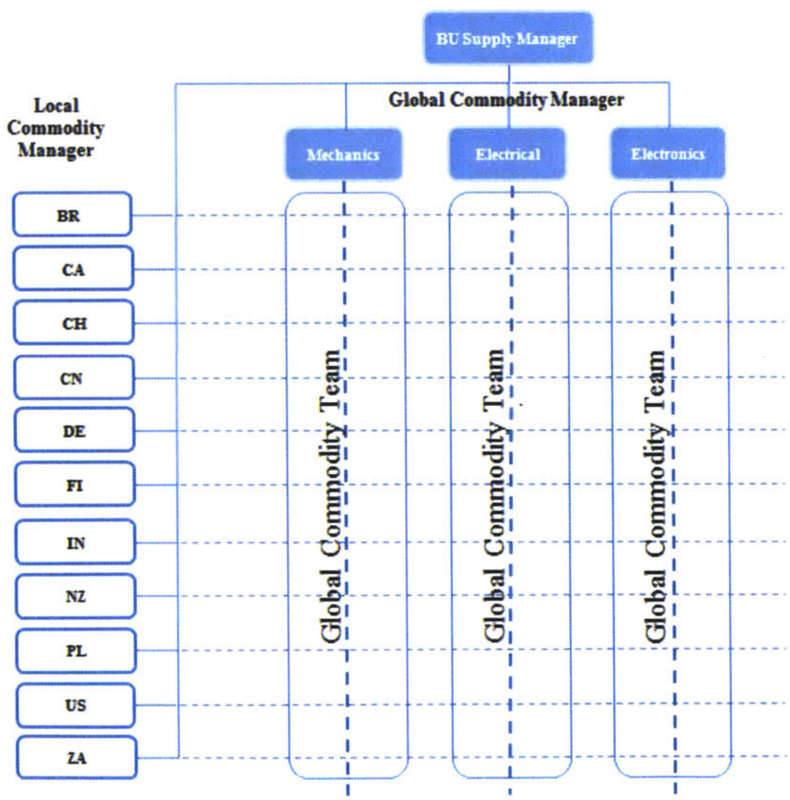


Figure 5: DMPE supply chain management organization.

3 Current State Analysis

3.1 Introduction

Before designing and implementing the new forecast consolidation process, it is essential to understand the current forecast consolidation system. This chapter analyzes the current forecast system in terms of its process, timeline, stakeholders, products, and organizational dynamics. ABB Turgi has been selected as the representative of LPUs and headquarters to aid in the understanding of the relationship (communication) between them. It is assumed that the other LPUs have a forecast process and system similar to ABB Turgi's. This investigation of the current forecast system can provide lessons for or against any new forecast consolidation process, clarify why the current forecast system was formed as it is now, and indicate what the takeaways are for further improvement.

3.2 Purchasing Process

When ABB purchases component parts, the purchasing process generally goes through several steps: forecast, pre-purchase order, and purchase order (See Figure 6). An order starts as a "forecast," and when ABB confirms the order, the order's status changes to a "pre-purchase order". When an ABB customer confirms, the order finally becomes a "purchase order". For the transition between these three states, no strict time line exists, but the presence of commitment from customers and ABB defines which state the purchasing process is in. First, the order has a status of "forecast" when an ABB customer has a production plan over a relatively long-term period with large uncertainty, but the customer may or may not (and is not obliged to) inform ABB of its production planning. However, neither the customer nor ABB is required to commit to this production plan. In the next step, "pre-purchase order,"[9] the customer has not sent any firm order to ABB, but it is almost certain that the customer order will be delivered soon. To help suppliers be prepared for the coming order, ABB then issues a "pre-purchase order" to its

[9] Note that as discussed further in section 7.3.1, one of the problems that arose with the pilot program was the inconsistent use of pre-purchase orders, or PPOs, by some of the LPUs in the pilot, namely Bangalore and Beijing.

suppliers based on the most probable information. The last step is "purchase order"; at this stage, the customer sends the firm order to ABB, and ABB sends the purchase orders to its suppliers.

	ABB's customer	ABB	Period
Forecast	Not yet confirmed	Not yet confirmed	6-18 months ahead of delivery
Pre-Purchase Order	Not yet confirmed	Confirmed	3-12 months ahead of delivery
Purchase Order	Confirmed	Confirmed	1-3 months ahead of delivery

Figure 6: The definition of purchasing process (step)

However, this is not always true. Sometimes, purchase orders are issued directly without any stages beforehand. And for some commodities[10], there is rarely, if ever, a forecast or PPO. This inconsistency of component part forecasts results in the erosion of the credibility of forecasts. Furthermore, this negatively affects availability and on-time delivery. This will be discussed in section 7.3.1.

[10] Most mechanical components and non-critical components are examples.

3.3 Forecast Process

ABB is well known as a decentralized company; most of its LBUs have autonomy. Instead of aggregating local sales forecasts and allocating them to multiple LPUs for manufacturing, most LBUs have their own local sales forecast and produce for it in their local plant. Therefore, it is more realistic to collect forecasts globally at the component part level, not the product level – the aggregation of all local component part forecasts is equal to the global component part forecast.

3.3.1 Creating Local Component Part Forecast

LBUs make component part forecasts as shown in Figure 7. Sales delivers its sales forecast based on incoming orders from customers to product managers. Product managers create product forecasts based on the sales forecast and production capacity. Once product forecasts are uploaded into SAP, the ERP system, product forecasts are broken down into component level by bill of material; component part forecasts are then created within SAP. Through Advanced Supply Chain Collaboration (hereafter, "ASCC" and refer to section 6.3.1), or using Excel and email, LBUs send their component part forecasts to suppliers. Sourcing managers and stock managers are not directly engaged in this process, but they are responsible for monitoring the component part forecasts from SAP onward through ASCC/Excel until delivery to suppliers.

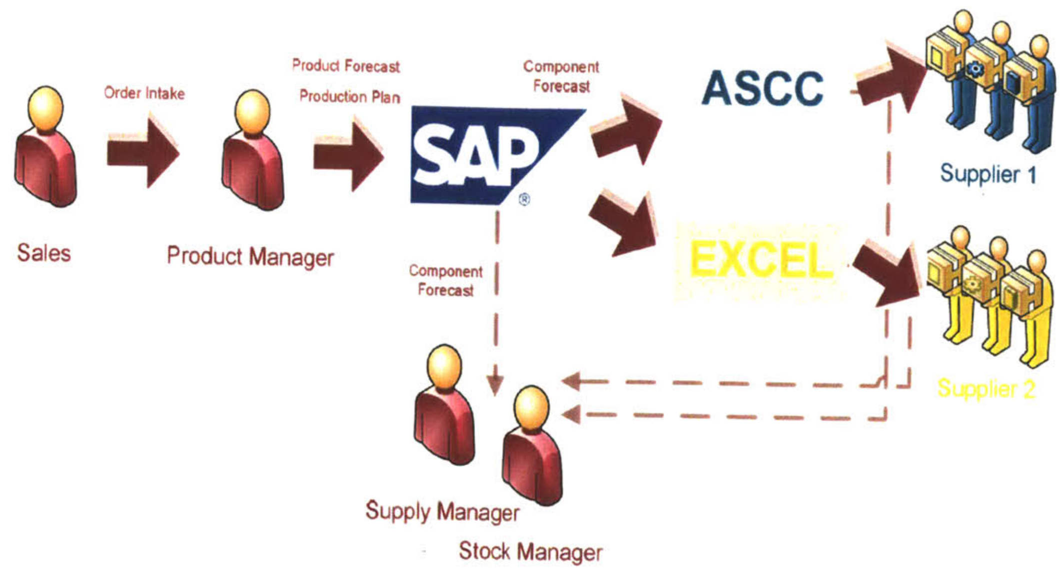


Figure 7 An illustration of the local forecasting process

3.3.2 Component Part Forecast Consolidation Process

The global sourcing managers of DMPE collect 18 month component part forecasts once a year from multiple LBUs worldwide for the purpose of price negotiations at the end of the year. BU sourcing managers ask local sourcing managers to upload the forecast onto "Team Space," a customized SharePoint[11].

For forecast consolidation more frequent than yearly, there is presently no standardized process, system, or IT tool to collect the component part forecasts. Therefore, each global sourcing manager works differently. For instance, some global sourcing managers ask the sourcing managers of the corresponding LPUs for the component part forecast data. Other global sourcing managers ask the global product managers for the product forecast data, and then the sourcing managers break down the product forecasts into component part forecasts by themselves. This component part forecast consolidation is mainly

[11] "A SharePoint intranet portal is a way to centralize access to enterprise information and applications on a corporate network. It is a tool that helps a company manage its data, applications and information more easily. This has organizational benefits such as increased employee engagement, centralizing process management, reducing new staff on-boarding costs, and providing tacit knowledge capture." Quoting Wikipedia.org entry for "Microsoft SharePoint," available online at http://en.wikipedia.org/wiki/Microsoft_SharePoint. Only members of the enterprise have access to information contained in SharePoint. Suppliers and other non-enterprise members do not have access to the content.

focused on electrical or electronic commodities, not on mechanical commodities. This is because electronic or electrical commodities are sourced globally, whereas mechanical commodities are sourced by each LPU individually from its local suppliers due to difficulties in delivering heavy products.

- Component Part Forecast Consolidation Process of Each Product Groups

The unique organizational structure of ABB DMPE (refer to section 2.3) precipitates the complexity of consolidating forecasts. Each product group has a different supply chain because of its different product configuration, production allocation, and growth history.

The PE group in Turgi collects product forecasts from all LPUs and breaks down how many sub-assemblies ABB Turgi should produce for the other LPUs. This is how the PE group consolidates the latest product forecast. However, this group had suffered from the low quality of LPU forecasts, and to remedy this, one product manager has assumed the responsibility for collecting and reviewing the product forecasts from all LPUs.

Unlike the PE group, the MV Drives group does not have a special person who is in charge of collecting product forecasts. Each product manager at headquarters is responsible for his or her respective product forecast globally.

In terms of subassembly, ABB Turgi supplies to other ABB LPUs, such as ABB Beijing and ABB Bangalore. Therefore, like the PE group, the MV Drives group is also well informed of the product forecasts in other ABB LPUs. However, as each LPU grows noticeably, each LPU increasingly sources locally and prepares for localizing the entire production process, even subassembly. The rationale behind localization is as follows: first, the component part cost is cheaper because of lower delivery cost compared to international shipping cost. Second, the quality of local suppliers is improving, which means that LPUs are not required to rely on supplies from abroad. Third, as part of its strategy, ABB aims to have a decentralized and autonomous organization.

In the Traction Converters group, the product managers of headquarters rarely collect the product forecasts from LPUs. This is because this product group has launched very recently and focuses more on growing than being organized. In addition, due to low volume and high product mix, no single product of the Traction Converters group is produced in more than one LPU.

- Component Part Forecast Consolidation Process of Each LPU

From another perspective, the component part forecasts can be integrated across product groups by each LPU, not across LPUs by each product group. Currently, ABB Turgi has tried the component part forecast aggregation across the three product groups ("the Jupiter project") for the first time among DMPE LPUs. Other LPUs do not yet have forecast integration. The Jupiter project is discussed further in section 4.2, however, it is worth mentioning the difference between the Jupiter project and the goal of this project. The Jupiter project is specific to ABB Turgi. The goal of the Jupiter project is to provide a standardized process to consolidate component part forecasts *for all three product groups within ABB Turgi* as shown in Figure 8. Therefore, supply forecasts for other locations will not be covered by the Jupiter project. The goal of this project is to provide a standardized process via which forecasts are consolidated across not only all three product groups, but also across all of ABB's LPUs.[12]

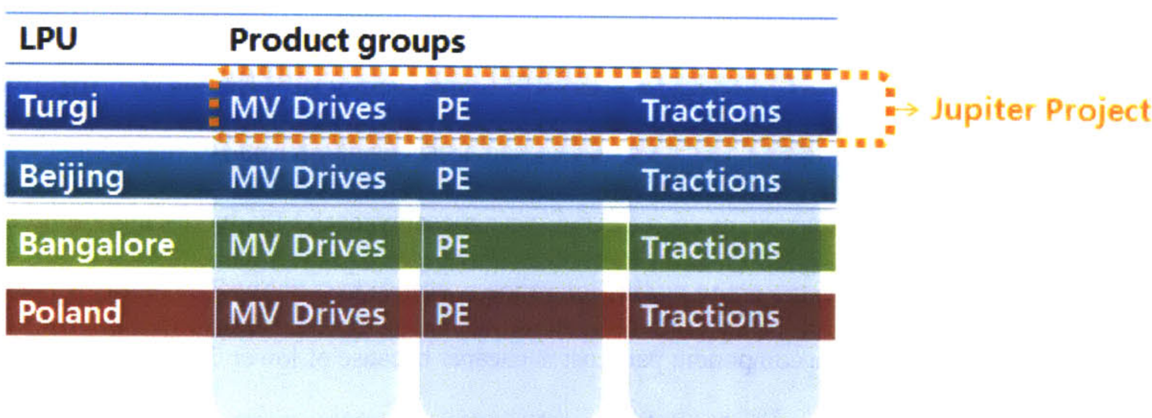


Figure 8: Two different ways to consolidate component part forecasts; vertical and horizontal

[12] See Figure 11 and Figure 12 for an illustration depicting the differing goals of the Jupiter project and this project.

3.3.3 Component Part Forecast Communication with Suppliers

- Communication with Different Suppliers

Given no standardized process for consolidating component part forecasts, there also exists no standardization for communicating with suppliers. For example, Enics, one of the largest Printed Circuit Board Assembly (hereafter, "PCBA") suppliers, produces different commodities in each of its plants. ABB LPUs then communicate directly with the Enics plants of their respective commodities. Because neither ABB nor Enics aggregates the component part forecasts of ABB commodities, neither of them knows what total amount of commodities will be supplied by Enics. This complex information flow of multiple one-to-one communications between ABB LPUs and Enics plants is applied to POs and PPOs as well. In contrast, ABB Semiconductor, one of the key suppliers, has a diversified information path. In terms of POs and PPOs, each LPU of DMPE contacts the respective ABB Semiconductor LPU directly. However, for the forecast, the headquarters of DMPE collects the LPUs' forecasts and delivers them to the headquarters of ABB Semiconductor. Then, the headquarters of ABB Semiconductors delivers the forecast to the respective LPUs. (Figure 9)

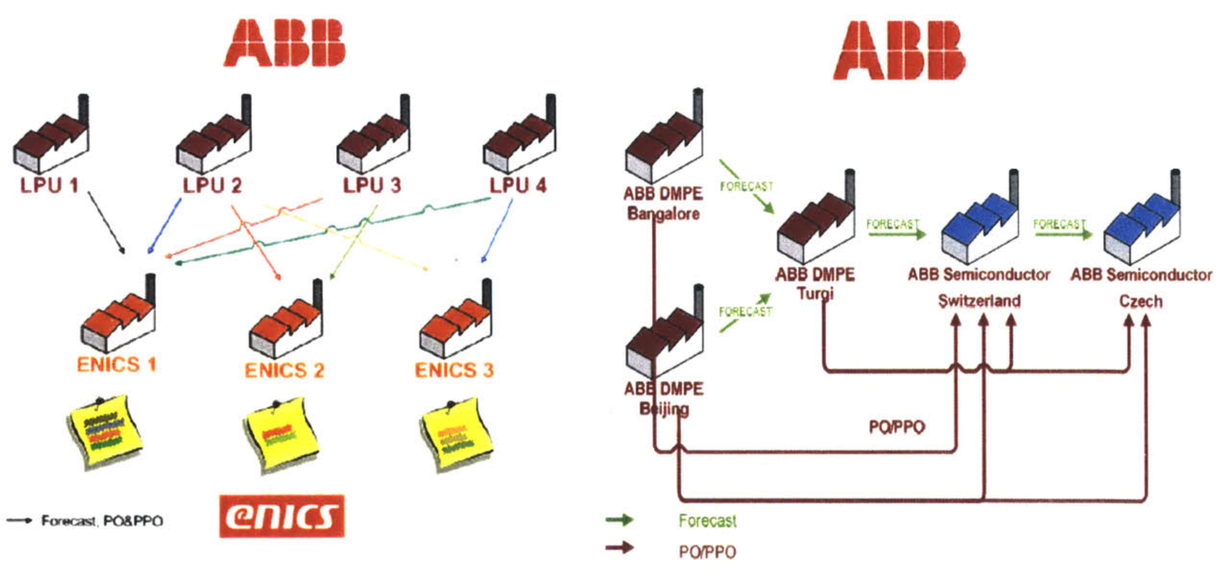


Figure 9: Different communication pathways for different suppliers

- Communication Methods

The ultimate purpose of component part forecasting is to enable the suppliers to be prepared at the right time with the right amount. For the suppliers' on-time delivery and availability, ABB should deliver the component part forecast to the suppliers in advance and obtain a commitment to the forecast amount and time from the suppliers. Therefore, this research focuses on how the forecast information is delivered, instead of the commodities.

By and large, each LPU currently communicates with different suppliers differently. For example, this can be seen in the case of multiple LPUs in Medium Voltage Drives (hereafter, "MV Drives"), one of three product groups in ABB DMPE.

First, ABB Turgi usually uses a tool called Advanced Supply Chain Collaboration for communicating with suppliers. ASCC is an internally developed electronic tool, and suppliers also can access the ASCC web site for purchase orders, pre-purchase orders, and forecasts. (Please see chapter 6.3.1 for a more detailed explanation about ASCC.) When stock management issues a purchase order or pre-purchase order via the SAP ERP system, this information is linked to ASCC automatically and is sent to suppliers as a type of electronic notification. Suppliers who receive the email notification from ASCC can log on to the ASCC web site and respond to ABB "yes" or "no" regarding their commitment by clicking the link of the email. When suppliers reply "no," ABB and suppliers have further discussion about the coming availability problem. Although technically ASCC can display the information of a purchase order, pre-purchase order, and forecast, ABB DMPE uses only two functions: purchase order and pre-purchase order. This is because no component part forecast exists in SAP, which is the basis for ASCC, and ASCC cannot operate independently from SAP.

Second, ABB uses email communication with suppliers who do not use ASCC. Basically, the email includes the same information as ASCC does: purchase order and pre-purchase order. However, stock managers need to download the purchase order and pre-purchase order from SAP and write an email manually, in contrast to SAP, which can transfer the information to ASCC automatically. Suppliers who do not use ASCC send their responses via email.

Third, for some suppliers who do not use the email PO/PPO system, ABB sends faxes instead of email and suppliers respond via fax. This is decreasingly the case but still exists, especially for the small suppliers.

- Commitment from Suppliers

Currently, no feedback on ABB's forecast from suppliers exists. The component part forecasts have been communicated only one-way from ABB to suppliers as secondary information. Therefore, the ultimate purpose of component part forecasting, which is to enable the suppliers to be prepared, cannot be achieved.

Some suppliers even ignore component part forecasts from ABB for two reasons. First, ABB's forecasts are not always accurate. Second, ABB does not consistently prepare component part forecasts for every component parts.

3.4 Stakeholders

3.4.1 Commodity Managers and Stock Managers of LPUs and BU

Commodity managers (sourcing managers) are managing the respective commodities, including sourcing strategies; the commodities are classified into mechanics, MV transformers, power semiconductors, inductors and LV Drives capacitors, PCBAs, and so on. Stock managers are responsible for procurement and purchasing. Commodity and stock managers are jointly in charge of availability and on-time delivery. For component part forecast consolidation, the stock managers took initiative in the Jupiter project, and one of them collects the component part forecast across product groups in Turgi. However, when it comes to critical components, such as PCBAs and semiconductors, global commodity managers collect the component part forecast across LPUs. In other words, the responsibility for aggregating forecasts belongs to either commodity managers or stock managers. Therefore, both can become the process owner of forecast consolidation.

3.4.2 Product Managers

Product managers perform the most important role in creating component part forecasts. Because component part forecasts are completely dependent on product forecasts, the accuracy of the product forecast dictates the accuracy of the component part forecast. For a large production site, one product manager manages one product, whereas for a small production site, one product manager can handle a few products at the same time. Depending on the product group or location, some product managers input their product forecast into SAP by themselves, and the others send product forecasts to stock managers or commodity managers; either of these two uploads the breakdown of product forecasts, which constitutes the component part forecast.

3.4.3 Suppliers

To achieve on-time delivery and availability of commodities, the most important key suppliers play a pivotal role in the supply chain of ABB.

- Overview of DMPE suppliers

ABB DMPE has more than 2,000 suppliers around the world. About one hundred and fifty suppliers can be categorized as key suppliers, based on how critical the commodities are that the suppliers are producing, or how much ABB purchases from them. All 2,000-plus suppliers are classified as either external or internal suppliers (such as other ABB subsidiaries). Suppliers can also be divided according to the characteristics of their commodities: electrical, electronic, and mechanical. The size of suppliers varies greatly from a local small mechanical part manufacturer to a huge multi-national electrical part manufacturer. Compared to electrical commodities, mechanical commodities tend to be sourced locally due to difficulties in delivering heavy products.

This diversity in ABB suppliers makes the supply chain of ABB complex, not only in physical delivery but also in communication to and from suppliers.

- Dynamics of Suppliers

For their operation planning, including headcounts and budget, suppliers want to receive ABB's forecast as early as possible, and have it be as accurate as possible. Compared to suppliers for catalog products, the suppliers with a wide range of product configurations have an especially strong need for more accurate, highly up-to-date forecasts. Meanwhile, at the same time, suppliers are reluctant to commit to forecasts that do not have ABB's confirmation yet. In other words, suppliers cannot take a risk to lose the difference in case the actual order comes in lower than the forecast. If ABB wants to require suppliers' commitments to the forecast, suppliers may ask for ABB's commitment to the forecast, too. This is the dilemma of committing to forecasts.

From another perspective, because there are more customers like ABB that are in need of commodities than suppliers who are producing them, the supply market often favors suppliers, which is a so-called "supplier's market". Consequently, it would be to ABB's benefit to have accurate and reliable forecasts because ABB would be viewed more favorably by suppliers.

- Sourcing Strategy of DMPE

It is unusual for a multinational electric company like ABB not to have dual sourcing for all component parts. Yet single sourcing can save the cost of developing the second supplier for a certain component part and reduce the complexity of managing twice the number of suppliers. In addition, ABB quality managers say that it is not easy to find suppliers who meet the strict quality standards of ABB. (Quality is the first priority for ABB supply management.) ABB often prioritizes ensuring component part availability by keeping high safety stock over optimizing inventory. Consequently, the trade-off for the benefit of single-sourcing is the increased risks of shortage problems or delayed delivery.

3.5 Forecast Quality and Performance Management

One of the biggest problems with aggregating forecasts is that the accuracy, robustness, and quality of individual forecasts are often questionable. The reason is that the incentives of the individuals making the forecasts may bias these forecasts away from what is considered unbiased *ex ante*. To be more specific, in the context of this project, local sourcing managers or local product managers have the incentive to manipulate forecasting figures in his or her favor. For example, because of members of the sales team are penalized for not meeting forecasted customer order, sales team members have the incentive to underestimate incoming orders so as to minimize the probability of not meeting their forecasted orders. There are examples in Bangalore where product managers provided conservative product forecasts which were 25% of actual customer orders for the relevant time period. On the other hand, the sourcing manager's incentives, when it comes to providing forecast figures, are the opposite of the product managers. Sourcing managers' incentive schemes are such that they are penalized should there be a shortage of a component part. Therefore, it is in the sourcing managers' incentive to inflate forecasts so as to minimize the probability that there will ever be a shortage over a product he or she is charged with.

3.6 Other Sales and Operation Planning Projects in ABB

There are on-going efforts within ABB which are aligned with the component part forecast consolidation. First, the "One ABB" initiative was announced by the top management a few years ago, which encourages synergy across countries, BUs, and divisions, reduces unnecessary noise, and avoids disconnectedness. Second, the DM division is sponsoring the "Sales and Operation Planning" initiative and appointed the Low Voltage Drives (LV Drives) BU for leading this project. By and large, this project and LV Drives' project share the common goal of improving ABB's supply chain. However, there are some differences. First, the LV Drives project is currently focused on the front side of the supply chain: how to consolidate the sales forecasts; whereas this project is more concentrated with the back side of the supply chain: how to consolidate the component part forecast. Second, this project is initiated and sponsored by DMPE, but the LV Drives project is sponsored by the DM division. Hence, the LV Drives project was planned for a long time before and has gotten better IT team support. Third, in 2010, DMPE launched the Jupiter project. Jupiter aimed to overhaul Turgi's logistics processes. Among other tasks, the Jupiter project targets local forecast consolidation across product groups in ABB Turgi. The stock managers of ABB Turgi initiated this in order to unify and simplify the purchasing process within ABB DMPE. (Refer to section 4.2, "Jupiter Project at ABB Turgi".)

In order to prevent any disconnectedness and a consequent need for integration effort in the future, the improvements from similar projects in development or already existing should be incorporated, wherever possible, into the new process for component part forecast consolidation of ABB DMPE.

4 Learning from Related Projects

4.1 Introduction

Whenever ABB has grown organically or inorganically, ABB has until recently preferred to maintain local autonomy. However, this company strategy has brought as a trade-off a great many problems of inefficiency and unproductiveness. To overcome these problems, there has been a strong need for standardized processes and systems. Component part forecasts are no exception. There have been multiple efforts at component part forecast consolidation in different divisions or BUs within ABB.

This chapter introduces other projects with the same purpose of integrating component part forecasts; analyzes their process and system, including advantages and disadvantages; and evaluates whether they can be applied to the DMPE: Are circumstances similar or different? What know-how is needed? Can implementation time be saved by learning from others' experience?

4.2 Jupiter Project at ABB Turgi

At ABB Turgi, the Jupiter Project was launched at the end of 2010 and is now almost fully implemented. One of the work streams of this Jupiter project is mainly focused on consolidating the independent component part forecasts from three product groups in ABB Turgi.[13](Refer to section 2.3, and Figure 8.)

4.2.1 Active Components

The Jupiter project collects forecast figures for "active" component parts only, and does not collect forecasting data for all components. Component part is classified as an "active" component part when its lead time is longer than the corresponding product's general component part procurement time. The latter time is defined as the time left after deducting, from the delivery lead time, the time for order processing, production, and product delivery (Figure 10). The reason the Jupiter project is limited to the collection of forecasting figures for active component parts is because active components, which are subject to longer

[13] The Jupiter project includes only one locality of DMPE, Turgi. On the other hand, this project is developing a standardized process of forecast consolidation for all DMPEs.

lead times, are more likely subject to availability problems. Non-active component parts, or component parts which have relatively short lead times, are relatively less subject to availability issues and so not included within the Jupiter project. It is also worth noting that if a standardized procedure through which forecasting figures are generated is instrumental in alleviating availability problems for active component parts, then *a fortiori*, such a procedure should solve availability problems for non-active component parts.

Figure 10: Illustrates how to calculate the general component part procurement time

Therefore, the general component part procurement time varies from product to product. Each product manager determines the active components of his or her product. Regardless of whether they are electrical or electronic materials, the components can be selected as "active" components only by the above standard. By and large, the lead time of active components is about 10 weeks.

4.2.2 Forecast Consolidation Process

In this project, there is one process owner on the procurement team who is in charge of the forecast consolidation and leads a monthly meeting of product managers. Every 15th of the month, the "active" component part forecasts for the coming 12 months in ABB Turgi are integrated into what is called a "rolling forecast".

The first working day of each month, the process owner requests the monthly forecast preparation from all product managers for their respective products. Product managers consolidate sales forecasts globally from the respective sales and the project planning tool. Product managers then create a product forecast based on the sales forecasts and other related factors, such as the production capacity or the historical reliability of sales forecasts. The product forecast is broken down into component part forecasts, and among them only the active component part forecasts are sorted and integrated. Instead of imposing the same process on three product groups, ABB Turgi continues to have each product group break down the product forecasts by themselves for flexible implementation of the Jupiter project ; for the PE group and the Traction Converters group, product managers go through these processes *manually* using Excel, including all possible configurations of each product; for the MV Drives group, product managers upload product forecasts onto SAP and the component part forecasts are *automatically* created and selected out as active component part forecasts based on the configuration by SAP transactions.

Before moving on, it is worth noting one important lesson provided by the Jupiter project. There is a large up-front labor cost to consolidating forecasts if one uses the method employed by the PE group and the Traction Converters group: namely, the process is manually driven and relies on a relatively inferior IT application, Excel. Any attempt at a comprehensive consolidation of forecasting data, which is the goal of this project, should endeavor to cut down on labor costs by using more sophisticated technology, possibly SAP, or by developing a new tool that does not require any manual break down of component part forecasts.

4.2.3 **Forecast Quality Management**

After consolidating the forecast, the process owner organizes a monthly meeting of product managers to obtain their assessments of the quality of the forecasting. To raise the accuracy of forecasts, the Jupiter project compares the most recent twelve month forecasts of component parts with the actual, or realized, component parts consumption of the previous twelve months. For example, assuming that forecasts are available for the twelve months beginning on January 1, 2012 (which means that forecast figures for the period starting on January 1, 2012 to December 31, 2012 are available on January 1, 2012), these forecasts are compared to the actual component parts consumption that occurred during the previous twelve month period from January 1, 2011 to December 31, 2011. Interestingly, the previous twelve month forecasts (the twelve month forecast for the period from January 1, 2011 to December 31, 2011 in the example above) and the error between the previous twelve month forecasts and the actual consumption is not considered. The working assumption is that current forecasts are correlated with actual consumption in the previous twelve month period, but *are not* or *weakly* correlated with the forecasts for this previous period. This assumption is robust given the fact that component part forecasts originate from customer orders. As an empirical matter, ABB has found that current twelve month customer orders are very weakly correlated with previous twelve month customer orders. Therefore, previous twelve month forecasts are not considered when checking the quality of current twelve month component part forecasts.

Through the comparison between current forecasts and previous actual consumption, the process owner and product managers can assess the quality of product forecast, the timeline, the configuration of a product, and, hence, the component part forecast. In particular, for engineered products, the configuration of the product can be varied by the specific requirements from customers, and this affects which component parts will be needed. However, in many cases, the component part forecasts need to be prepared before the customers' requirements are firm. Therefore, product managers usually estimate the product configuration as the most probable one (in their judgment) and modify it later when the customers finalize their product requirements. In other words, the accuracy of the component part forecasts relies on the product managers' estimates of the product configuration. The comparison between the past 12 months' consumption and the following 12 months' forecast can give better guidance for product managers about what will be their most likely product configuration.

4.2.4 The Lessons for DMPE

The Jupiter project has a few noteworthy contrasts with the DMPE project and corresponding lessons for the DMPE project:

- Only products or sub-assemblies that will be produced in Turgi and component parts distributed through the store in Turgi are considered. However, the DMPE project will take into account any products produced in or distributed through any LPUs of the DMPE. Ultimately, the DMPE project pursues transparency of component part planning at the BU level.

- The Jupiter project put its effort on standardizing the component part forecast integration *across product groups but in one LPU*, ABB Turgi. On the other hand, to achieve the transparency in component part planning, DMPE wants to build the component part forecast aggregation *across product groups and across LPUs* at the same time. Figure 11and Figure 12 illustrate the differences between the Jupiter project and this project. This project integrates the component part forecasts both vertically and horizontally, whereas the Jupiter project has tried to integrate the component part forecasts only horizontally.

  Because most LPUs do not yet have forecast integration, the approach used in the Jupiter project can apply to this project as follows: first, integrating component part forecasts across product groups as the Jupiter project does, and then aggregating those integrated component part forecasts of each LPU into one - integrating horizontally first, and then vertically.

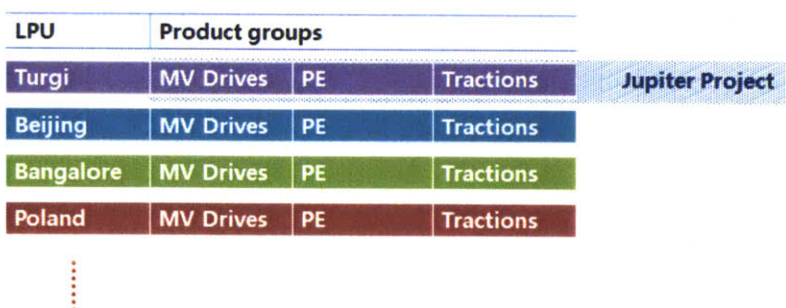


Figure 11: Consolidation target of Jupiter project

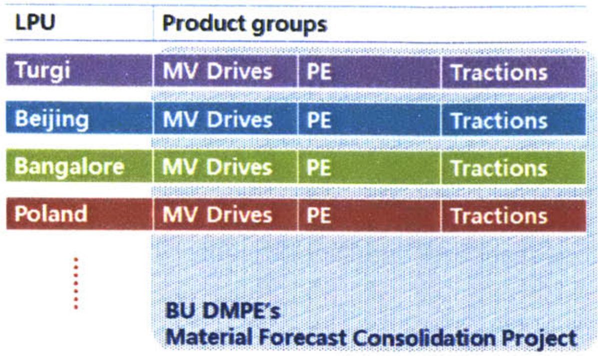


Figure 12: Consolidation target of DMPE's project

- The Jupiter project has newly deployed the appropriate SAP transactions and the standardized process for creating component part forecast, selecting "active" component part forecasts and evaluating the quality of forecasts. How to develop new appropriate SAP transactions will be benchmarked for other LPUs' SAP development. In addition, how far the Jupiter project forced the different processes to be standardized, or kept them as they were, will be studied and applied to the DMPE project.

4.3 Robotics BU

Robotics is known for its well organized overall operation planning. Robotics manages its supply chain transparently across two LPUs, Sweden and China. This is exactly what DMPE wants to achieve. However, the supply chain transparency within the Robotics BU is the result of several factors unique to the Robotics BU. Therefore, it may be difficult to apply the methods that have brought about transparency within the Robotics BU to DMPE. We consider these unique factors below.

4.3.1 Forecast Consolidation Process

In particular, every week, Robotics has a regular meeting called "mini S&OP," updating production and component part plans to meet the near future market demand. In this meeting, product managers decide together which plant will produce how many products. Component part forecasts are prepared accordingly. This strong and unique cooperation among LPUs is possible because the China factory works as a sub-production line of the Swedish factory and because the products produced by the Robotics BU is relatively more standardized than the products produced by DMPE.

4.3.2 IT Tool for Forecast Consolidation

Regarding IT tools, ABB Sweden and ABB China share SAP without restriction. This is a very distinctive characteristic compared to other ABB organizations.14 Thanks to this open access to SAP, Robotics does not need any additional IT tool merely to integrate multiple LPUs' forecasts. Robotics has also developed its own tool for its mini S&OP meetings and keeps the inventory updated accordingly.

4.3.3 The Lessons for DMPE

SAP integration, however, is not a good solution for DMPE. It would probably require a huge decision from ABB management. With more countries and more independent LPUs than Robotics, DMPE needs an additional IT tool to communicate component part forecasts under the conditions of multiple independently and incompatibly working ERP systems.

The Robotics LPUs' dynamics are also different from the DMPE's. DMPE LPUs work much more independently, with their own autonomy.

4.4 ABB Turbo Charger System in Baden (CHTUS)

4.4.1 Forecast Consolidation Process

ABB Turbo Charger System has done forecast consolidation across multiple LPUs for more than ten years. CHTUS' business can be classified into new turbo chargers and service (replacement parts). New turbo chargers can be forecast based on sales forecasts from customers, as with other manufactured products, but the demand for service products can be forecast based on calculation of the product life cycle. From another perspective, CHTUS production can be divided into products for Baden itself or

[14] In most cases, ABB builds the ERP system for each country. As a result, it has formed information silos among countries. As needed, additional IT tools have been developed, such as eSMART. (See section 6.3.2.)

products for other LPUs. However, the logistics team of headquarters[15] aggregates the forecasts only for the products or components that are either produced or distributed by CHTUS. In case any product is sold, manufactured, and sourced entirely within other LPUs, CHTUS does not collect that forecast and excludes it from headquarters' monthly forecast consolidation. This is similar to the case of the Power Electronics group of DMPE and the Jupiter project.

Every month, the logistics team requests the respective product forecasts from product managers of other LPUs and Baden. CHTUS's own IT tool creates component part forecasts automatically, as with the Jupiter project.

4.4.2 IT Tool for Forecast Consolidation and Forecast Quality Management

Turbo Charger System built its own IT system solely for forecast consolidation. Basically, this is an extended module of SAP, the ERP system, but runs independently from SAP. It has a critical function which helps to assess the quality of forecasting continuously by comparing the actual orders to the forecasts made a given number of months before the selected month. Since it has been built, this tool has saved the past forecasts in the SAP database. The most recent forecast for a given period can be compared to the forecast for the same period that was made a certain number of months before. By shifting the month of forecast creation, any users can see how the forecast is changing as the actual time comes nearer.

[15] ABB Turbo Charger System in Baden is the headquarters of ABB Turbo Charger System business unit.

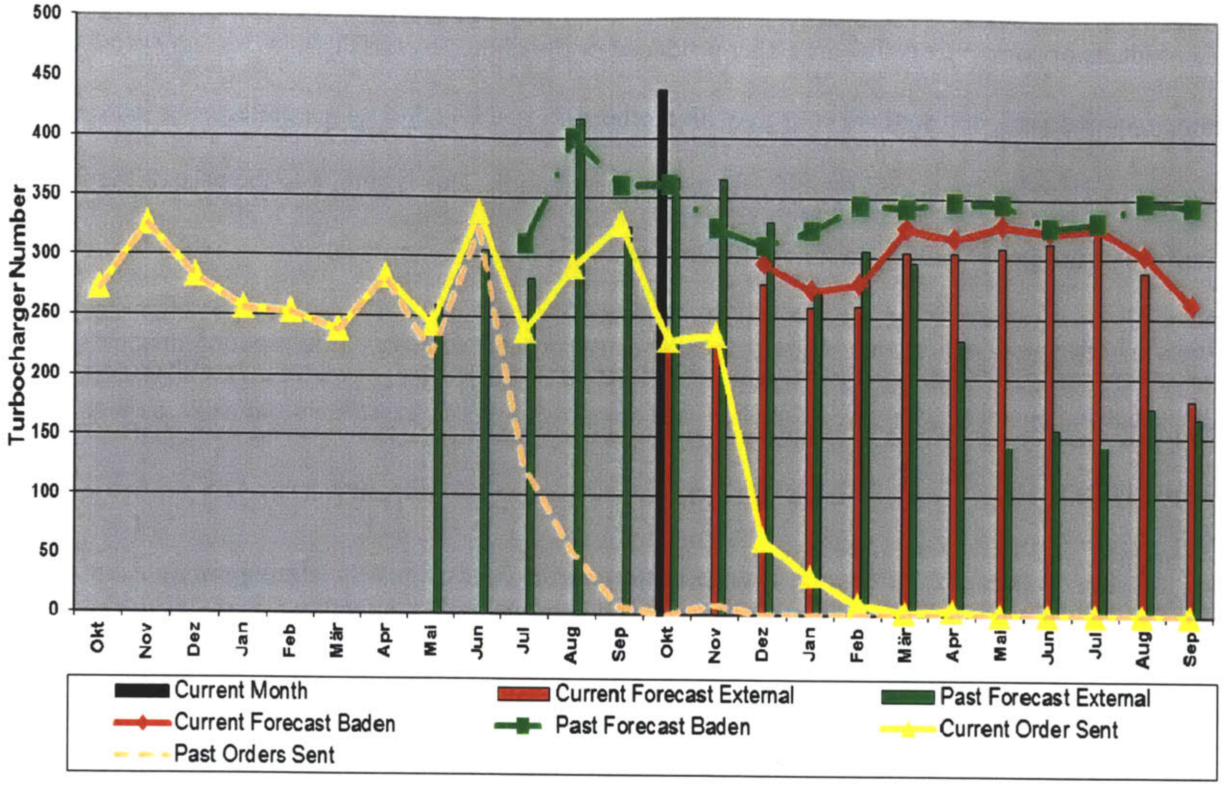


Figure 13: Comparison between forecasts and the actual purchase of CHTUS

Figure 13 is a diagram of the comparison among the current forecast, the forecast made at a certain point in the past, and the order sent (actual consumption) in the current month. (In this figure, the past month is May and the current month is October.) "External" means non-Baden products. "Current Forecast External" is the forecast of non-Baden products made in October.

4.4.3 The Lessons for DMPE

The CHTUS has experience with revising the forecast procedure and offers corresponding lessons for the DMPE project, as follows:

- Developing an additional SAP module can be an option for the DMPE project, especially how to store a large amount of past forecast data in an effective way and how to break down the product forecast into component part forecasts.

- The assessment of component part forecasts also goes beyond the simple comparison between forecast and the actual: it includes comparison among the current forecast, the past forecast, and the order sent

- One more distinctive characteristic of CHTUS forecast integration is specifying responsibility for the forecast quality according to the source of the forecast. This might be easier for performance management; products for other LPUs are the responsibility of the product managers of the respective LPUs, whereas products for Baden itself are under the product managers of Baden.

4.5 Low Voltage Drives BU

4.5.1 Overview of Forecast Consolidation

The Low Voltage Drives (LV Drives) BU is also working on an S&OP project at the direction of the DM division. The goal of this project is to balance demand and supply by managing one integrated sales and operations plan. The project scope aims to standardize demand planning, production planning, and the component part planning process across LPUs. It will begin with one pilot product family, ACx-550 / 510, in the main factories and will roll out to all LV Drives products across all production sites.

LV Drives is working on standardizing its forecast consolidation process and tools. However, the development phase and direction are different from MV Drives' project. First, during the time of this project, LV Drives was focusing on sales forecast aggregation, not component part forecast aggregation (which would follow later). This is also related to the development time: this project was 6 months in length but the LV Drives project will last at least two years. Second, LV Drives targeted transparency in the whole supply chain (including both sales forecasting and component part forecasting), compared to DMPE, working on sourcing and supply of materials.

4.5.2 IT Tool for Forecast Consolidation

For its IT tool, LV Drives is planning to use Business Warehouse, the extended application of the SAP ERP system. However, DMPE is unlikely to use Business Warehouse for integrating component part forecasts due to the high implementation cost. The reason for this is the following: software is usually purchased and implemented separately by each region and country. LV Drives has been using Business Warehouse for other purposes, and extending its usage to aggregate forecasts incurs no additional charge and is relatively easy to implement. However, this does not apply to MV Drives, which is located in another country.

4.5.3 **Forecast Quality Management**

In terms of how to qualify the forecast, LV Drives has intrinsic advantages over MV Drives. LPUs of LV Drives create component part forecasts based almost solely on past actual data, using statistical methods. Due to the stable market of LV Drives and high volume and low product mix, this approach works well most of the time. Compared to this, MV Drives has a relatively fluctuating market and low volume and high product mix. MV Drives derives component part forecasts from the sales forecast rather than the past actual data.

4.5.4 **Feedback Process from Suppliers**

Regarding feedback from customers, in the past, for example, LV Drives used to force one of its suppliers to commit to the LV Drives forecast and would compensate it for the difference in production amount when necessary. Today no such binding agreements are used and LV Drives depends on its tight relationship with suppliers. However, this practice is not a robust and reliable solution to DMPE's project.

5 Implementation of Global Forecast Consolidation Process

5.1 Introduction

This chapter describes the procedure of creating the new forecast aggregation process and explains this new process from various perspectives: which factors are considered, why this concept is selected over other concepts, how the IT tool supports the new model, and how the new process operates in detail.

5.2 The Development of the New Consolidation Process

5.2.1 **Major Considerations**

Through stakeholder interviews and analysis of the current forecast process and benchmarks, the requirements are defined for the future forecast aggregation process and system as follows:

- achieve with maximum effectiveness the following two goals:
  - transparency in component part forecasting and
  - feedback from suppliers

  (note that this project places greater emphasis on the former goal relative to the latter);
- minimize unnecessary changes caused by implementing the new forecast consolidation; such changes incur costs in time and money;
- continuously iterate between IT tool study and process development;
- standardize the consolidation process across LPUs;
- simplify the consolidating process flow (e.g., by reducing the number of steps in the consolidating process);
- alleviate the burden of additional work for extracting and uploading data and communicating with other stakeholders (other stakeholders/counterparts); maximize the automation in data creation and transfer;
- define the expected output; and
- make a sustainable improvement with consideration of further roll-out in the long term.

5.2.2 **Conceptual Models for Consolidation Forecasts**

Before drilling down into the details of the development of the future process, I will present a few conceptual models for consolidating the forecast. After reviewing technical aspects and current organizational circumstances, the most feasible concept has been selected.

- ASCC Model

Given that all LPUs and suppliers have been mandated to use Advanced Supply Chain Collaboration (ASCC), ASCC is the most ideal IT tool for forecast aggregation. The expected process is as follows: each LPU uploads its product forecast onto SAP, and then SAP generates component part forecasts. The component part forecasts are transferred to ASCC automatically, and both suppliers and ABB internal users can see the forecast through the ASCC website (Figure 14). This model is the most attractive solution for three reasons. First, ASCC is the only ABB IT tool that the suppliers can access. Therefore, if DMPE uses ASCC for forecast aggregation, no additional IT tool is necessary solely for communicating with suppliers. Second, ASCC is linked to SAP, and the forecast data with PO/PPO is uploaded onto ASCC without additional manual work. Compared to each country having its own SAP, ASCC, which is linked to all the individual SAP systems, combines each system into a single global whole. Consequently, ASCC makes it possible to integrate PO/PPO/forecasts across LPUs or product groups without changing the existing SAP system. Last, because ASCC is a web-based system, it can show the requested information at any time and at any place by pulling the data from SAP on request.

In spite of the advantages above, this model cannot be proposed at this time. The biggest obstacle for this concept is that the ASCC implementation level varies in every LPU or supplier. For example, ABB Bangalore is planning to implement ASCC in the near future, but ABB Turgi uses ASCC mainly for POs/PPOs (as mentioned previously in section 3.3.3). In addition, ASCC cannot store any data (which will be discussed in section 6.3.1, "Difficulties as Forecast Consolidation Tool").

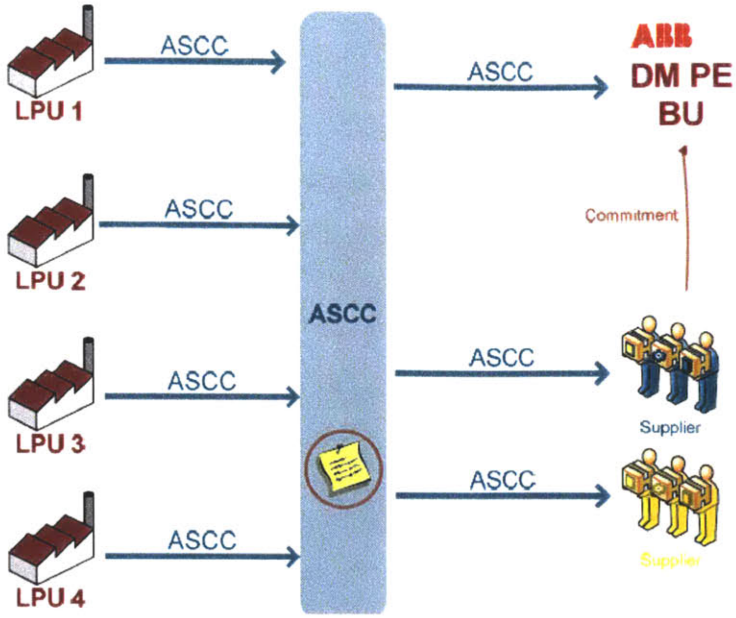


Figure 14: An illustration of conceptual model -- consolidating forecast using ASCC

- Compromise ASCC Model

This model is a compromise solution between ASCC users and non-users. Basically, this model has a similar process to the ASCC model discussed in the previous section. However, it has an additional IT tool after ASCC. This tool consolidates the output from ASCC (for an ASCC user) and Excel data (for a non-ASCC user) together. The forecast process can then be aligned to the process of PO/ PPO. Hence, no additional information flow needs to be created.(See Figure 15.)

However, ASCC has an intrinsic problem as a consolidation tool. Although the result of the request can be extracted as an Excel file, only one supplier and one component part can be viewed at a time. Thus, it is not easy to request the forecast data for multiple commodities and multiple suppliers. If ASCC had a storage function, the problem above might be solved by viewing one item forecast at a time, but saving the results and integrating them into a consolidated forecast easily. This is one of the reasons that the storage problem of ASCC remains a handicap.

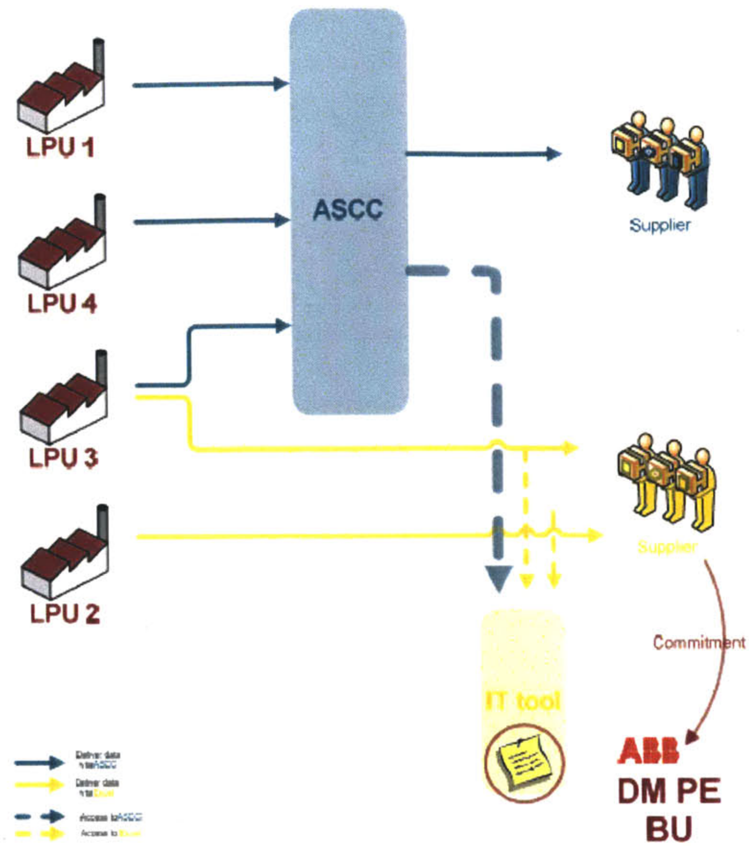


Figure 15: An illustration of a compromise ASCC model

- SAP Transaction Model

Because ASCC is middleware, it alone cannot be employed to consolidate forecast data. Another possible approach is integrating forecast data originating from SAP. In short, this approach would bypass ASCC completely and get forecast data from SAP directly and save such data in a separate database.[16] (Figure 16)Because SAP is used by all ABB LPUs, only a minimum change is required to modify SAP for standardizing the forecast consolidation process. In addition, the data is collected right before ASCC displays it; there is no distinction between ASCC users and non-users. All LPUs would need to upload their forecast data onto an additional IT tool before it goes to ASCC. This additional tool is adapted specifically for consolidating forecasts. The most probable candidate is SharePoint, which is already familiar within ABB, avoiding money and time costs of adopting a new tool.

[16] The database this project selects is SharePoint, which is described in footnote 2.

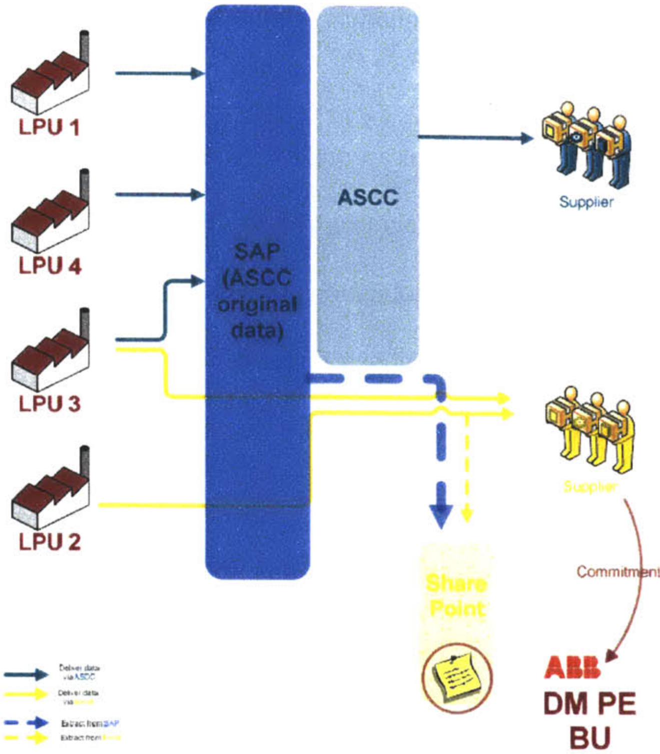


Figure 16: An illustration of conceptual model-consolidating forecast using SAP transaction

At this point, the concept is sufficiently nailed down: most probably the SAP Transaction model will become the foundation for the forecasting consolidation process. Hence, the new forecast consolidation process and its requirements can now be presented in detail.

5.2.3 Detailed Requirements for the New Consolidation Process

Based on an analysis of the current forecast process, there are several factors that should be considered in developing a new process. Currently, ABB DMPE has no cockpit view for component part forecasts. It has no consolidation system - including process, IT tools and responsible party. The problems with the current process are as follows:

- Data creation: In many cases, component part forecasts are created inefficiently by hand. This can be feasible for small sets of data, but the more products produced and the more materials that need to be handled, the more a systematic process is required for component part forecast creation.
- Data transfer: ad hoc transfer of information. No standardized method for data transfer exists.

When a forecast is necessary, the sourcing managers at headquarters need to find out how to get the necessary forecast and from whom in LPUs.

- Data Review: no reviews for continuous improvement of forecast quality. None of the LPUs has the opportunity to review its own data before the data are integrated by headquarters.
- Transparency: In the absence of a standardized forecast consolidation process, even the sourcing managers at headquarters lack a bird's-eye view of component part forecasts for DMPE as a whole. Each LPU knows only its own component part forecast, which is directly related to the respective LPU's production and distribution.
- Visualization: No database exists. Each sourcing manager in ABB Turgi stores the integrated component part forecasts of his or her respective component parts in various locations. Furthermore, these sourcing managers use different categories and labels to identify the same component parts forecasts. Consequently, they are not visible to all sourcing managers of DMPE and not easily understood.
- No feedback from customers: no response to ABB's forecast from suppliers. There is no way to confirm supply availability in a timely fashion based on the component part forecast.

5.2.4 The Proposed Forecast Consolidation Process

The proposed consolidation process addresses the preceding issues and is described in detail below. First of all, the proposed consolidation process involves personnel in six active roles: product manager and commodity manager in BU (headquarters); product manager, commodity manager, and process owner in LPU; and supplier.

In particular, BU commodity managers are the most responsible for the aggregated component part forecasts and for the critical roles of general management (such as suppliers' information, timeline, active commodities, and quality) and the initiating and closing of the consolidation period. On the other hand, local commodity managers are responsible for extracting forecasts and uploading those to SharePoint.

- Initiate Forecast Consolidation

The BU commodity manager initiates forecast preparation for the following month on the 15th working day of every month. In response, the BU product manager requests product forecasts from the product managers of LPUs.

- Create Product Forecast

The LPU product manager prepares his or her respective product forecast and sends it to the BU product managers. To insure the quality of the forecast, the BU product manager makes an assessment of the forecast accuracy based on the market situation and historical reliability of the forecasts. (Because component part forecasts are subordinate to their respective product forecasts, the quality of the product forecast is directly linked to that of the component part forecast.) If any correction is necessary, the product forecast is sent back to the responsible product manager. (See Figure 17)

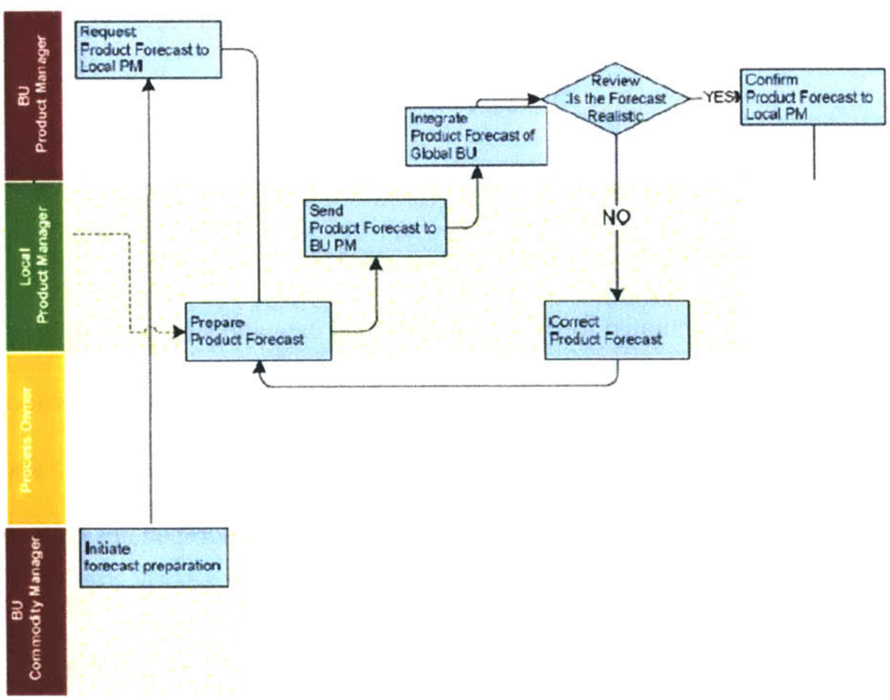


Figure 17: An illustration of creating product forecast

- Create Component Part Forecast

After finalizing the product forecast, the local product manager has the local process owner upload the product forecast or uploads the product forecast by him/herself. Once the product forecast is loaded into

SAP, SAP creates the component part forecast based on the product configuration, stored in SAP beforehand, and selects active components only. This procedure is basically taken from how the Jupiter project (See section 4.2) automatically creates component part forecasts. Finally, material requirements planning (MRP) is run, and the product forecast results in PO/PPO/forecast of component parts. A simple sanity check is performed to verify that the output of the SAP transactions is free of omissions and system errors. (See Figure 18)

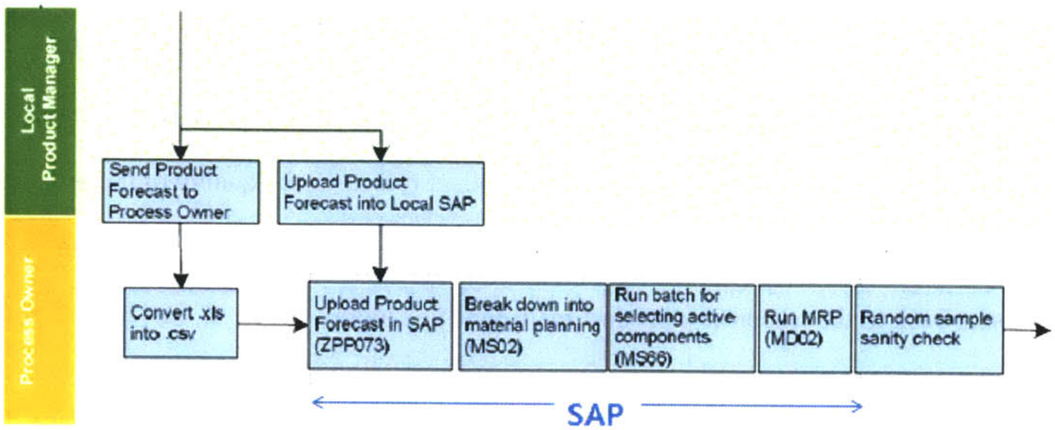


Figure 18: An illustration of creating component part forecast

- Insuring the Quality of the Component Part Forecast

Each local process owner organizes a review meeting with the product manager, stock manager, and commodity manager. They cross-check the generated forecast with historical data and strategic market trends. In case of major and urgent differences, the current forecast must be corrected manually. In cases when there are minor and non-urgent differences between the current forecast and the historical data and strategic market trends, the current forecast is not corrected. The reason that minor discrepancies between historical market trend data and forecasts is twofold: 1) the cost of correcting all minor errors to forecasts is greater than the cost incurred by posting forecast subject to minor error; and 2) all future forecasts are based on the most current historical market trend data and are invariant to past forecasts; in short, past forecasts, and the errors that they may embody, do not affect current forecasts.

As mentioned in Chapter4, there are two types of quality checks: comparison of the recent forecasts for the following 12 months to the component part consumption for the last 12 months, and comparison between the most recent forecast for a certain period and the forecast for the same period that was made a certain number of months before. As each product group and LPU is in a different situation, which method is used for the quality check is left to the discretion of the local process owner.

- SAP Data Extraction

To standardize the format of data and facilitate the data extraction, the output of a specific SAP transaction, which is also the ASCC original data, is extracted automatically from SAP using an Excel macro. Because most ABB LPUs use or will use ASCC for supply management, it is assumed that most LPUs have a similar SAP transaction to ZPP071[17] of ABB Turgi. This means that ABB can use the ASCC original data of SAP as the basic data for consolidating component part forecasts (in every LPU).

- Uploading individual Forecast Data to SharePoint

On the first working day of every month, local commodity managers upload what they extract from SAP without additional data modification (Figure 19).

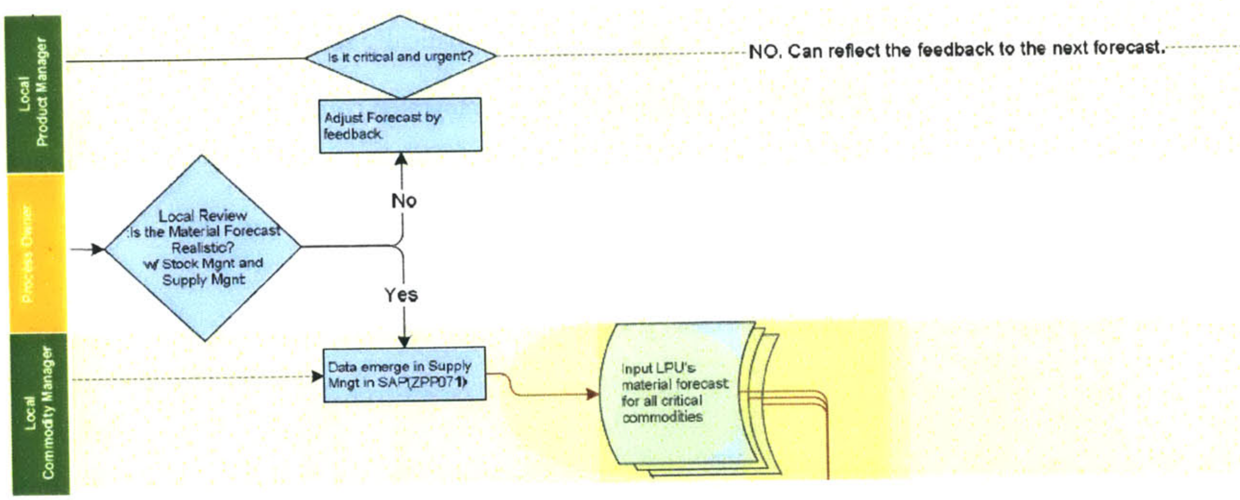


Figure 19: An illustration of uploading forecasts

- Finalize Consolidation

[17] An SAP commands that ABB Turgi uses for forecast consolidation.

After all LPUs' commodity managers upload forecasts, the BU commodity manager finalizes forecast integration and makes any necessary corrections. The deadline for this is the fifth working day of every month.

The BU commodity manager has ownership of the whole component part forecast consolidation, including managing the master data sheet, deciding on the list of active components, and keeping to the schedule. The master data sheet is formatted to show the integrated result by suppliers, once all local commodity managers upload their respective component part forecasts.

After forecast integration is finalized, the forecast is ready to be sent to suppliers via email. The BU commodity managers select the consolidated forecast of their respective component part and send it to the respective supplier. (Each supplier cannot see the data of the other suppliers.)

- Reply from Suppliers

Email is more powerful than RSS feed or auto-notification from an IT system for commodity managers to inform suppliers of the forecast, given that many suppliers typically ignore the auto notification about the forecast from ASCC. Because of the relationship with commodity managers, suppliers will be more responsive to the email from commodity managers than to automatically sent notifications. Commodity managers keep track of the response from suppliers about the integrated component part forecast (See Figure 20).

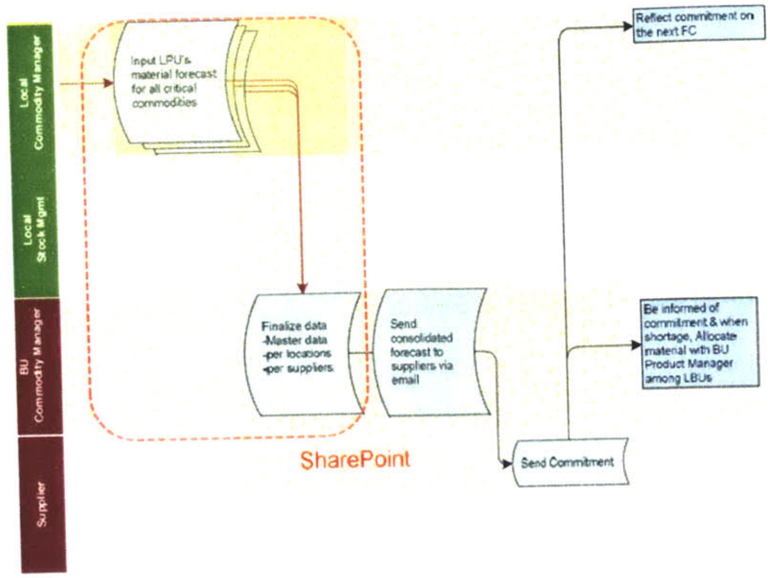


Figure 20: An illustration of communication with suppliers

The output of this proposed process will be discussed in Chapter 6.

6 IT Tool Study

6.1 Introduction

In order to find the most appropriate IT tool for consolidating component part forecasts, the requirements were defined and a study of existing tool was done. Differing according to the time horizon selected, a few suggestions for this project were proposed.

6.2 Requirements for the IT Tool

These are the requirements for IT tool, based on the interviews and analysis of the current forecasting system.

- Able to cover all commodities; across product groups (refer to section 2.3.)
- Linked to SAP (automatically)
- Easy to access from any place at any time
- Accessible to suppliers but with different access rights for different users
- Include all steps from FC to PPO to PO
- A tool already possessed by ABB
- An online database that should not depend on individual data resources. (No need to contact multiple people to get data)

6.3 Feasibility Check of Existing IT Tools

This chapter presents the study of existing IT tools within ABB – ASCC, eSMART and SAP. Because of the short development time, six months, the use of an existing tool was recommended instead of developing a new tool from scratch. This tool study is useful not only for running the pilot test, but also for any new tool development in the future. Advanced Supply Chain Collaboration (ASCC) and eSMART are customized global applications for supply management, whereas SAP is an enterprise resource planning (ERP) system across an entire organization.

6.3.1 ASCC

ASCC, Advanced Supply Chain Collaboration, is a platform for supplier collaboration between ABB factories and their internal and external suppliers (See Figure 21). This tool simplifies and standardizes communication with suppliers and improves supply chain processes. At the end of 2009, within ABB, 77 factories in 18 countries were connected to ASCC and over 1000 suppliers were active on ASCC. Additional implementations are on-going across ABB worldwide. (ASCC implementation can be measured by the ratio of electronic processing versus all order transactions.)

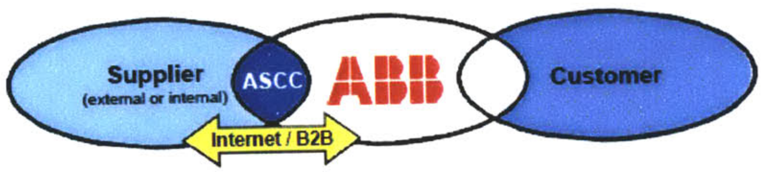


Figure 21: Intuitive illustration of ASCC

- How ASCC works

The ASCC integrates the supply chain elements of LPUs' ERP, SAP. Features in ASCC are based on existing processes in the SAP ERP. The ERP system is the source system and the target system for data viewed and created in ASCC. In addition, because ASCC is a web-based system, it enables real-time connection to the respective SAP. (Refer to Figure 22.) In other words, ASCC is like a "window" for suppliers into LPUs' ERP.

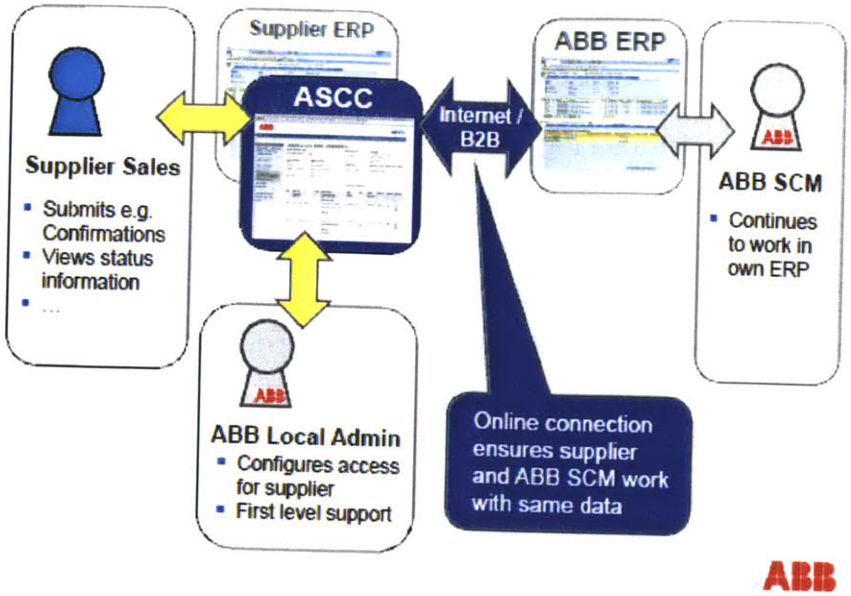


Figure 22: Simple presentation of ASCC

ASCC works as follows: Suppliers can log into the webpage (https://ascc.abb.com) with user IDs and select customers (for suppliers, customers can be one of ABB BUs). Using additional configuration and filter options, suppliers can view the PO, PPO, and forecast in separate lines. For an example, see Figure 23. Within ASCC, there is no field with the label "forecast," but the "dependent requirements" field is equivalent to "forecast." The report displays all PO/PPO/forecast items with a requested delivery date within the selected timeframe. All open items in the timeframe selected can be downloaded into one PDF document or one Excel document. Quality reports such as on-time delivery can be displayed. The suppliers can generate a confirmation with change. It is possible to change delivery date, quantity, price and to split order lines.

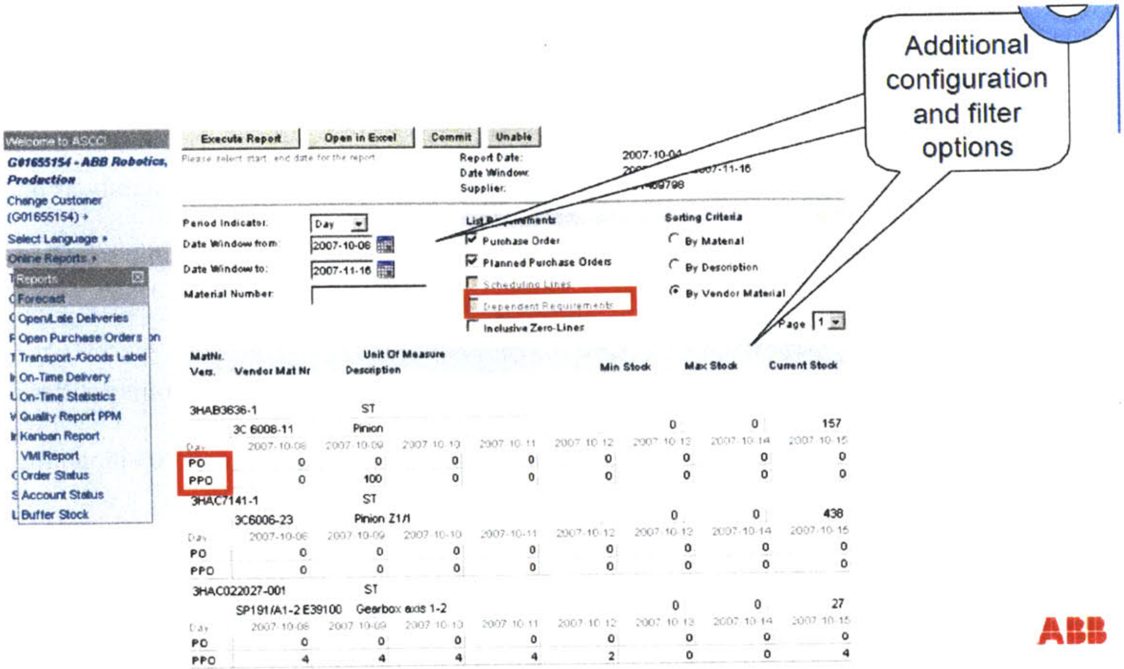


Figure 23: Sample output of ASCC

- Detailed Review: The Possibilities

ASCC was considered the most applicable tool for forecast integration. First, as noted in the previous subsection, ASCC's "dependent requirements" field, listed under "List Requirements" can be used to display the forecast. Second, the forecast, the target data of this project, is closely related to PO/PPO, ASCC's data. In fact, the information categories (i.e., component part number, timeline, and quantities) that are required by PO/PPO are the same as those required by the forecast. (Refer to the section3.3.3). Third, ASCC is also open to suppliers, and so, no additional tool is required for communicating forecasts with suppliers and getting feedback from them. Fourth, ASCC is also universally used within ABB LPUs. Because ASCC, like eSMART,[18] functions as a middleware, ASCC users can access forecast data from the multiple ERP systems used by the ABB LPUs. Finally, because ASCC is web-based, it can be easily accessed wherever and whenever access to the internet is available.

- Difficulties as Forecast Consolidation Tool

[18] See section 6.3.2 below for a discussion of eSMART.

ASCC has many potential benefits if utilized for the purpose of consolidating forecasts. However, because ASCC was not originally designed for this purpose, a number of problems exist.
First, for security reasons, ASCC restricts each user to view his or her component part data only as one screen. Users cannot view other suppliers' information. For consolidation purposes, multiple suppliers need to be selected and displayed, but ASCC technically does not support this function.
For example, when a commodity manager wants to know Enics' forecast of, how many commodities will be consumed ABB wide for the coming twelve months, he must login via Enics' ID and download the data multiple times by changing the customer code field. With about 160 key suppliers and multiple LPUs, the integration of forecast can be a huge work load.

Second, ASCC does not allow users to contemporaneously access quantity and time information for multiple component parts. In short, the ASCC user can view the quantity that will be supplied at a future date for only one component part at a time. Given that ASCC users will desire quantity and time information on tens of thousands of components, ASCC fails to provide the user with a comprehensive snapshot of ABB's consolidated forecasts.

Third, because ASCC functions as a middleware, it does not provide for real-time updating once a user accesses quantity and time information and such information has been displayed. This means that any updates occurring after the user has called up the quantity and time information for a specific component part will not be displayed to the user. In short, the information that an ASCC user views on his or her display is valid only at the exact time such information was accessed.

6.3.2 eSMART

The application eSMART is an electronic supply management action and reporting tool. eSMART provides supply chain decision-makers with information on spending and cost savings reporting by gathering data from various SAP ERP systems. By providing comprehensive spending information, eSMART increases supply chain transparency.

With regards to the viability of using eSMART in the pilot program, eSMART, like ASCC, is compatible with SAP, which means that we can access SAP forecasting data through eSMART. However, because eSMART is not a flexible platform which can be easily updated to user needs, any change to eSMART would result in changes to all ABB users of eSMART.[19]

Like ASCC, eSMART's compatibility with SAP is a favorable feature for consolidating forecasts. However, because the eSMART is mature and used by almost all ABB locations, any change of this tool requires strict pre-tests.

6.3.3 **SAP ERP, Excel, and SharePoint**

As noted above in section 6.3.1, because the consolidation of forecast data is not possible via ASCC, a possible alternative method of consolidating forecast data could be by extracting forecast data directly from the multiple SAPs and integrating such information in a completely new database, SharePoint. The sole function of this new database would be to consolidate SAP forecast information and allow such information to be displayed to users in a comprehensive and user-friendly way.

SAP forecast information can be accessed via the SAP command ZPP071[20] , which transfers forecast data to ASCC. For a detailed list of the types of information provided via the SAP command ZPP071, see Figure 25: An example of output ZPP071. Each LPU commodity manager, using ZPP071, can access the SAP forecast information and transfer such information to an Excel spreadsheet for incorporation into a single Excel spreadsheet on the new database, SharePoint. In short, each LPU will upload their SAP forecast data as one "sheet" of the "master" Excel spreadsheet.

Furthermore, given that the purpose of this project is to provide greater access to more reliable forecast information, additional information categories related to forecasting were also required to be included in

[19] For further discussion of eSMART's relative weakness as a possible candidate for this project's IT tool, see section 6.4.

[20] Note that the SAP command which accesses forecast data, "ZPP071," is specific only to SAP Turgi. Different SAPs have different commands which provide access to forecast data. For example, SAP Beijing uses "ZPP 2R035."

each LPU's Excel spreadsheet. Input on what additional forecasting information would be helpful was solicited from BU commodity managers. The result was that each LPU's forecast data Excel spreadsheet would provide access to the following forecasting data:

SAP forecasting data provided via the SAP command ZPP071

+ Product (Which products use this part)

+ Production locations

+ Suppliers' component part number

+ Sourcing manager

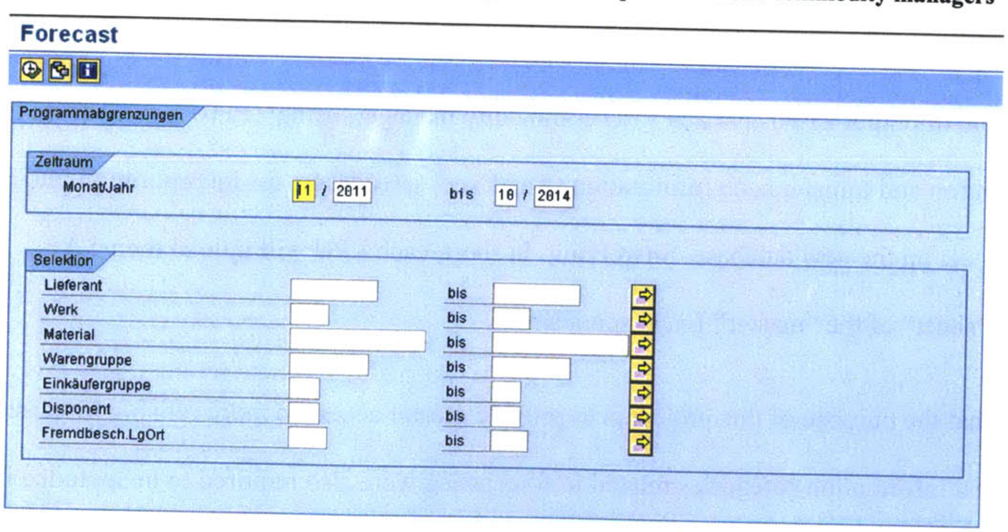
+ Lead time

+ Stock location

The type of information that each LPU commodity manager would transfer to master spreadsheet on SharePoint can be seen in Figure 24.

Template															
											Will Update every quarter/month				
SAP	SAP	NEW	SAP	SAP	SAP	New	New	NEW	New	SAP	SAP	SAP	SAP	SAP	SAP
Supplier Information		Material Information						General Information		Forecast Element	Quantity	+0	+1	+2	+3
Local Supplier Nr.	Supplier's name	Supplier Material Nr.	ABB Material Nr.	Material Description	Stock located	Batch Size	Lead Time (Week)	ABB Location	ABB Product	Element	Sum	12/2011	01/2012	02/2012	03/2012
61037	Dynex Semiconductor Ltd	DS1112SG60	3BHB023235R0001	Rectifier Diode DS1112SG60	ZRL1	500	20	Turgi	ACS5000	FC	1477	169	184	122	27
61037	Dynex Semiconductor Ltd	DS1112SG60	3BHB023235R0001	Rectifier Diode DS1112SG60	ZRL1	500	20	Turgi	ACS5000	PPO	0	0	0	0	
61037	Dynex Semiconductor Ltd	DS1112SG60	3BHB023235R0001	Rectifier Diode DS1112SG60	ZRL1	500	20	Turgi	ACS5000	PO	0	0	0	0	
61037	Dynex Semiconductor Ltd	DS2012SF60	3BHB023302R0001	Rectifier Diode DS2012SF60	ZRL1	500	20	Turgi	ACS5000	FC	1610	331	174	191	27

Figure 24: An example of the output from local commodity managers



Forecast

Kreditor	Name 1	Material	Materialkurztext	Element	Summe	V-Preis	Warengrp	EKG	Disp.	I	Werk	FLOrt	Gew.	11/2011	12/2011	01/2012	02/2012	03/2012	04/2012	05/2012	06/2
80023	Enics Schweiz AG	3BHE006373R0101	XV C769 AE101: OEI-Board	FC		75.45	3QA	301	301	R	0003	5340	0.01								
80023	Enics Schweiz AG	3BHE006373R0101	XV C769 AE101: OEI-Board	PI-Auf + BS-Anf		75.45	3QA	301	301	R	0003	5340	0.01								
80023	Enics Schweiz AG	3BHE006373R0101	XV C769 AE101: OEI-Board	BS-Ein		75.45	3QA	301	301	R	0003	5340	0.01								
80023	Enics Schweiz AG	3BHE006373R0101	XV C769 AE101: OEI-Board	FC	158.100	61.94	3QA	301	301	R	0004	ZRL1	0.01	52.600	28.800	10.400	8.000	8.800	6.800	4.000	9.C
80023	Enics Schweiz AG	3BHE006373R0101	XV C769 AE101: OEI-Board	PI-Auf + BS-Anf	288.000	61.94	3QA	301	301	R	0004	ZRL1	0.01					72.000		72.000	
80023	Enics Schweiz AG	3BHE006373R0101	XV C769 AE101: OEI-Board	BS-Ein	120.000	61.94	3QA	301	301	R	0004	ZRL1	0.01		60.000	60.000					

Figure 25: An example of output ZPP071

After all LPUs' forecasts are uploaded to the master Excel spreadsheet, the information can be summed up resulting in one integrated component part forecast.[21] BU commodity managers will have access to all information contained within the master spreadsheet, and will send suppliers forecast information relevant to each supplier. For an example of the information provided to suppliers, see Figure 26. Once received by the supplier, the supplier must confirm the forecast and deliver the component parts within the allotted timeframe, or inform the BU commodity manager of any issues that might prevent the supplier from fulfilling its forecasted order.

DS1112SG60			**3505.4**
Bangalore	**3BHB023235R00C**	DS1112SG60	236
Beijing	**BBB6977**	Diode DS1112SG60	858
Turgi	**3BHB023235R00C**	Rectifier Diode DS1112SG60	2411.4
Grand Total			**3505.4**

Figure 26: Output for suppliers: suppliers only see their own component part forecasts.

Like ASCC, the customized SharePoint makes it easy to access this consolidation file at any time, anywhere. As a database, unlike ASCC, which does not have any information storage capabilities, SharePoint can also store monthly consolidated forecasts.

6.4 Plan for IT Tool Development

Considering all requirements and constraints, among the existing IT tool the combination of SAP ERP, Excel, and SharePoint appears to be the best solution, given the constraints considered above, to the problem of providing easily accessible consolidating forecast data.

[21] An Excel macro was used to sum up each and every LPU's forecasting information which was entered as a single "sheet" in the master Excel file. The sums were displayed on yet another "sheet" in the master Excel file.

With regards to ASCC, the ASCC team reviewed possible solutions for the three problems identified in section 6.3.1. The ASCC team found a possible method to access forecast data for multiple component parts. However, the ASCC team was unable to find a technical solution to finding a way to display component part forecasting information for multiple suppliers. Furthermore, because of strategic negotiation concerns, it is not in the best interests of ABB to allow suppliers to have access to the price information of other suppliers, and so ASCC does not appear to be a viable solution for this project. In conclusion, ASCC cannot be a solution because of these intrinsic limitations.

As for eSMART, it is used extensively within ABB and is well-ingrained, and therefore, can be thought of as the most applicable platform via which to consolidate forecasting data and provide access to such data. However, it is the pervasiveness of eSMART within ABB that prevents us from running a pilot program utilizing eSMART as a way to consolidate and display forecasting data. Any change to eSMART for the purposes of furthering the objectives of this project would affect how eSMART is used throughout ABB and this is a risk that ABB is not willing to take.

7 Pilot Run

7.1 Preparation for Pilot Run

This section lays out the procedures employed to select the most appropriate component part to be used in the pilot run. Because there exist tens of thousands of component parts, it was necessary to restrict the pilot run to a representative sample of approximately 20 component parts. The new forecast consolidation process is pilot-tested to assure both its internal and external validity and detect unexpected issues in the early stages (before complete implementation). The results of the pilot run can be used to evaluate the strengths and weaknesses of the currently proposed forecast consolidation process, modify the process where necessary, confirm whether the new forecast consolidation process is fiscally viable and cost effective, and confirm that the process increases transparency within the global supply chain at ABB DMPE.

7.1.1 **Product Selection**

We selected the ACS 5000A, which is manufactured by three separate LPUs, as the pilot product. If multiple LPUs separately produce the same product, in most instances these LPUs will employ the same supplier for the same component part. Furthermore, because the ACS 5000A is independently produced by three different LPUs,[22] the forecast data on the component parts of ACS 5000A is currently dispersed across three different SAPs. Therefore, the BU commodity manager currently does not have access to a tool which will provide him or her with a consolidated view of the quantities of the component parts which will be ordered by each of three LPUs. This dispersion of forecasting information is the crux of this project and so the ACS 5000A provides me with a representative informational environment in which to run a pilot.

[22] ABB Bangalore currently purchases some of component parts which are included in the sample in the form of pre-assembled bundles from ABB Turgi. For example, the component parts making up the power cell, which are all included in the sample, are bought and assembled by ABB Turgi and then sold to ABB Bangalore. ABB Beijing and ABB Turgi purchase all component parts included in the sample separately from suppliers.

7.1.2 Components and Suppliers Selection

Although the ACS 5000A is comprised of more than six thousand (6000) component parts, the sample was whittled down to a total of twenty-one (21) component parts using the following criteria. First, component parts supplied by global or multinational, as opposed to local, suppliers were included in the sample. Our focus on global suppliers with operations in various countries and locations was because of the increased complexity of information flows that result when these suppliers deal with various ABB LPUs and because we could confirm whether the pilot increased transparency in this complex environment.

Second, only "active" component parts, as defined in section 4.2.1, were included as part of the pilot, because, as noted above, shortage and availability issues arise most often for active components. One of the purposes of this project is to consolidate forecasting information to alleviate such shortage and availability concerns, and so the pilot is limited to active component part.

Third, low volume component parts were excluded from the sample because their impact on the complexity of the informational environment was minimal. Furthermore, even if included within the pilot, because low volume components are by their definition not traded often, they would have little effect on the increase in transparency, if such an increase were to result from the pilot program.

Fourth, component parts which had never been subject to availability or on-time delivery problems were excluded.

Fifth, component parts which would become obsolete due to design changes were excluded for obvious reasons.

Finally, to reduce redundancies within the sample, component parts from only one of three suppliers of capacitors were included in the sample. The one capacitor supplier was randomly selected. Given that the four suppliers or capacitors have similar firm-level characteristics, this simplification should not bias our results.

The suppliers selected for the pilot program were as follows: for semiconductor commodities, ABB Semiconductors AG and Dynex Semiconductor Ltd; for PCBAs, Enics Schweiz AG and SVI Public Company Ltd; for power supply, GvA Leistungselektronik GmbH; and for capacitors, Vishay Electronic GmbH. (See Figure 27)

Supplier	ABB Partnumber	Description	Turgi	Beijing	Bangalore
ABB Semiconductors AG	3BHB0[redacted]	RC-IGCT [redacted] Semiconductor	Direct	Direct	N.A.
	3BHB0[redacted]	RC-IGCT [redacted] Semiconductor	Direct	Direct	N.A.
	3BHL0[redacted]	Diode Pre[redacted] Semiconductor	Direct	Direct	N.A.
	3BHL0[redacted]	DIODE P[redacted] Semiconductor	Direct	Direct	N.A.
Dynex Semiconductor Ltd	3BHB0[redacted]	Rectifier [redacted] Semiconductor	Direct	Direct	N.A.
	3BHB0[redacted]	Rectifier [redacted] Semiconductor	Direct	Direct	N.A.
Enics Schweiz AG	3BHB0[redacted]	XV C767 [redacted] PCBA	Direct	Direct	N.A.
Enics Schweiz AG	3BHB0[redacted]	XV C768 [redacted] PCBA	Direct	Direct	N.A.
Enics Schweiz AG	3BHB0[redacted]	XV C768 [redacted] PCBA	Direct	Direct	N.A.
Enics Schweiz AG	3BHE0[redacted]	UF C765 [redacted] PCBA	Direct	Direct	Direct
Enics Schweiz AG	3BHE0[redacted]	XV C769 [redacted] PCBA	Direct	Direct	Direct
Enics Schweiz AG	3BHE0[redacted]	XV C770 [redacted] PCBA	Direct	Direct	N.A.
Enics Schweiz AG	3BHE0[redacted]	KV C758 [redacted] PCBA	Direct	Direct	N.A.
Enics Schweiz AG	3BHE0[redacted]	UF C762 [redacted] PCBA	Direct	Direct	N.A.
Enics Sweden AB	3AFE6[redacted]	LD GRB-[redacted] PCBA	Direct	Direct	Direct
SVI Public Company Ltd.	3BHE0[redacted]	XV C724 [redacted] PCBA	Direct	Direct	N.A.
	3BHE0[redacted]	PP C907 [redacted] PCBA	Direct	Direct	Direct
Vishay Electronic GmbH	3BHB0[redacted]	Kond. 0,5[redacted] Capacitor	Direct	Direct	N.A.
	3BHB0[redacted]	Kond. 0,[redacted] Capacitor	Direct	Direct	N.A.
	3BHB0[redacted]	DC-Link [redacted] Capacitor	Direct	Direct	N.A.
GvA Leistungselektronik GmbH	3BHB0[redacted]	Isoliertes [redacted] Power supply	Direct	Direct	Direct

Figure 27: Pilot Commodities of ACS 5000A. Part numbers and Descriptions partially redacted for confidentiality.

7.1.3 LPU selection

Currently, the ACS 5000A is produced in Turgi, Beijing, and Bangalore, and all three LPUs are pertinent for this pilot testing. It is worth noting that, as previously stated in footnote 11 and shown in Figure 27, not all component parts included in the pilot sample are ordered and supplied directly to ABB Bangalore. ABB Bangalore purchases power cells in pre-assembled bundles from ABB Turgi, and so, the components for such power cells are not purchased directly by ABB Bangalore, but by ABB Turgi. Despite this inconsistency between the three pilot LPUs, we decided to include ABB Bangalore in the pilot sample because situations where one LPU purchases bundles of components from another LPU is fairly common. When a specific product, such as the ACS 5000A, is newly launched at a new production site, such as ABB Bangalore, it is rare for the entire production process to be contained within the new production site. To reduce risk, the LPU usually begins with a fraction of the production process and outsources the rest of the production process to other LPUs. As the new LPU matures, it gradually increases the share of the production process it operates directly. Given the relative abundance of these types of inter LPU transactions occurring within ABB, it was determined that the external validity of our pilot would be increased by the inclusion of ABB Bangalore.

7.1.4 IT Tool Selection

As noted above in section 6.3, SharePoint was used for the pilot program, and LPU forecasts were uploaded and integrated on SharePoint into one consolidated forecast available on a master Excel spreadsheet. As mentioned earlier in section 1.1, DMPE consolidates yearly forecast data at the end of each fiscal year using SharePoint. Therefore, SharePoint was considered the natural choice as the IT tool to be used in the pilot program. Although the application was not conceived for purposes of systematically and consistently consolidating forecast data for time periods of less than a year, SharePoint does have the advantage of familiarity throughout ABB. In short, in addition to its widespread use within ABB, SharePoint had the advantage of not requiring any additional training to implement the pilot program.

7.1.5 Roles and Responsibilities

This table of Figure 28 shows the roles and responsibilities for the pilot run.

Local Product Manager	Prepare his/her respective product forecast Send to BU product managers
BU Product Manager	Requesting product forecasts from LPU product manager Make an assessment of the forecast's accuracy
Local Commodity Manager	Upload local forecast onto SharePoint
BU Commodity Manager	Initiate forecast preparation for the following month
Process Owner	Uploads the product forecast to SAP

Figure 28: Roles and responsibilities for the pilot run

7.2 Implementation of the Pilot

The pilot was implemented in late November. Prior to implementation, all stakeholders were apprised of their roles and responsibilities regarding the consolidation of forecast information via the pilot program's new consolidation process. The duration of the pilot program was approximately 20 days, and during this time each LPU's process owner and BU commodity manager were tasked with uploading SAP forecast information to the SharePoint master Excel spreadsheet. Any unexpected problems or concerns faced by the stakeholders were communicated to the project leader, and guidelines dealing with such problems and concerns were devised. If relevant to the stakeholders of other LPUs, such problems and concerns, and their relevant guidelines were communicated to these other LPUs.

7.3 Analysis of Pilot Run Results

The most important result of our pilot is that forecasting data on the component parts comprising our sample was now consolidated in one easy-to-access location, namely, our master Excel spreadsheet available on SharePoint.

Furthermore, the effort and cost, in terms of labor, of consolidating and making accessible forecast data decreased substantially. These cost savings arose because the implementation of the pilot program required the clear assignment of roles, responsibilities, and deadlines pertaining to the consolidation of data. In short, standardization replaced the haphazard manner, as described in section 3.3.2, in which forecast data was previously consolidated.

A corollary result of the pilot program was that suppliers had greater access to consolidated forecast data; suppliers could now view information on the forecasts of multiple component parts. Therefore, suppliers were able to provide more salient feedback to the BU commodity managers. This, in turn, better informed BU commodity managers on the possibility of future shortages or availability concerns that might occur.

Of course, the pilot program did produce several shortcomings which will require further attention and resolution. The following sections identify these problems and their causes and consider possible solutions.

7.3.1 Problems Identified by Pilot Program

- Pilot Program's Assumption on Process Incorrect

Based on the order processes in operation in Turgi, we made the assumption that there existed three order processes in DMPE: forecast (FC), pre-purchase order (PPO), and purchase order (PO), as defined in Figure 6, "The definition of purchasing process (step)." However, the reality was that Bangalore and Beijing did not classify their order processes as finely as Turgi: both Bangalore and Beijing did not produce PPO figures, and only used FC and PO figures to manage their order processes.[23] Because it would be impossible for Bangalore and Beijing to retroactively collect PPO figures for purposes of the pilot, we decided to sum the FC and PPO figures for Turgi. This manipulation allowed us to compare order processes across the three relevant LPUs at a cost of adding coarseness to the data for Turgi.

- Under-utilization of SAP

We assumed all LPUs would create FC, PPO, and PO figures in SAP. Therefore, the newly designed forecast consolidation process of the pilot program utilized forecasting data accessed from SAP, as discussed in section 6.3.3. Surprisingly, we discovered that this assumption was incorrect, and that both the Bangalore and Beijing LPUs under-utilized SAP for purposes of generating and managing forecast information. For example, ABB Beijing creates PO figures for SAP and even uses such information to issue POs via ASCC. However, ABB Beijing eschews SAP for purposes of creating FC figures, and so,

[23] We can conjecture that the reason ABB Bangalore did not have figures for PPO is because it is a relatively new LPU. However, given the maturity of the Beijing LPU, PPO data may not be available because the relationship between the LPU and their customers is such that it is not profitable for ABB to commit in advance to customer orders. One possible reason for this is that customer orders are subject to a high degree of uncertainty and so it does not make sense for ABB to confirm an order in advance of the customer. If this is true, then no value would be added, at least for purposes of consolidating forecasting data, by requiring ABB Beijing to collect PPO figures.

FC figures are not available for ABB Beijing on SAP.[24] Bangalore also sidesteps SAP for purposes of creating FC figures for SAP, although it does generate such figures for POs. However, because ASCC is not fully implemented within India, Bangalore cannot issue POs automatically with its suppliers. In short, ABB Bangalore lacks the infrastructure to take full advantage of SAP and ASCC, and this is yet another reason why forecasting data in SAP may not be up-to-date or missing.

Therefore, forecasting data pulled from SAP probably did not correspond to current forecasts, and that the integrity of the forecasting data from SAP did not warrant the high degree of confidence that we had assumed. This under-utilization of SAP for purposes of forecasting was not only problematic for purposes of this pilot project, but would need to be a major consideration for any future attempts at consolidating forecast information using figures from SAP. Given the fact that this under-utilization is not likely to be limited only to the Bangalore and Beijing LPUs, increased utilization of SAP will have to be implemented in tandem with any forecast consolidation efforts.

- Organization and Structural Problems for Implementation of Pilot

The organizational structure of the three relevant LPUs varied considerably which inhibited our implementation of the pilot program. In Bangalore and Turgi, because there were a sufficient number of employees allotted to DMPE and we could draw upon these employees for technical and administrative support, we were able to implement the pilot program successfully. However, in Beijing, because of the relatively low volume of ACS 5000A produced and the small number of DMPE employees, we did not receive the needed support from employees who were reluctant to take on additional job responsibilities. If the pilot program is to be extended more widely, in LPUs with relatively few DMPE employees, additional manpower will be needed for successful implementation of forecasting consolidation.

- Consolidation Delayed because of Late Updating of LPU Forecasts

[24] See text on "Pilot Program's Assumption on Process Incorrect" and footnote 12 for possible reasons why ABB Beijing does not create figures on PPO.

Undoubtedly preventing delays is a problem for all pilot programs, and this was no different for this particular pilot. Deadlines for the new forecast consolidation procedures set by the pilot were not met by two of the three relevant LPUs.

7.3.2 Causes of Problems Identified by Pilot Program

This section considers the possible causes of the problems with the pilot identified above. These causes provide us with guidelines which future forecast consolidation efforts will have to take into consideration.

- Cause of Inconsistencies across LPUs' Usage of PPO and Under-utilization of SAP

Each LPU was established at a different time, and therefore, their respective level of operational maturity is different. For example, as noted previously, of the three LPUs in the pilot sample, Bangalore was the most recently established LPU and it is in the process of increasing its operational independence and reducing its reliance on other LPUs as a source of component parts. On the other hand, Turgi has full operational autonomy, and in fact, Turgi is at a level of maturity such that it provides support to LPUs with less mature operational capacities, for example, by providing power cell component parts to Bangalore for production of ACS 5000A. As the Bangalore and other less developed LPUs inevitably converge, in terms of the level of their operational maturity, with Turgi, Turgi will decrease its supporting role.

This relative level of operational "maturity" and "immaturity" across the three LPUs[25] in the pilot sample resulted in inconsistent uses of the SAP purchasing processes[26] and relatively low usage of SAP in Bangalore and Beijing, as compared to Turgi. The pilot program assumption was that each of the LPUs in the pilot sample would have a level of maturity that would allow them to follow the pilot programs prescriptions; for example, each LPU would be able to consolidate forecast information using SAP data

[25] Of course, the different levels of operational maturity that we found across the three LPUs in our sample must be strongly correlated with and caused by external factors such as the level of economic development of the country in which the LPU is located, the level of infrastructure and human capital investment in that country, and other factors that are well beyond the scope of this paper.

[26] See section 3.2 for a discussion on purchasing processes.

and each LPU would create SAP forecast data per the purchasing process as defined in section 3.2. However, these pilot program assumptions failed and it is one of the most important reasons why the level of forecast information consolidation fell below expectations.

A valuable lesson was learned through the pilot program: namely, that forecast information consolidation efforts using assumptions that hold true in more "mature" LPUs may not hold for LPUs with lower levels of operational maturity. Furthermore, given the inconsistencies the pilot program uncovered, future efforts at forecast information consolidation must standardize according to either a "mature" or "immature" LPU's forecasting standard. For example, as discussed in section 7.3.1, given that unlike Turgi, Beijing and Bangalore do not create FC figures, forecast consolidation must standardize according to Turgi's forecasting measures (which would mean that Beijing and Bangalore would be required to calculate FC figures going forward) or according to Beijing and Bangalore's approach (which would mean that information contained in PPO figures for Turgi would be lost in the consolidation effort).

- Cause of Organizational and Structural Problems

The causes of the problems identified in the pilot program arising from the organizational and structural differences across the three LPUs can also be analyzed in light of the relative "maturity" and "immaturity" of the relevant LPUs. However, these concerns are of relatively little importance given the fact that as the less "mature" LPUs mature over time, the manpower concerns identified above should be alleviated. More importantly for the purposes of future efforts to consolidate forecasting information, the organizational and structural problems that arose during the course of the pilot shed light on the need to clearly delineate the responsibility of creating SAP forecasting figures.[27] Without such clear assignment of responsibilities and the relatively uncertain benefits of consolidating forecast information,[28] LPUs, and especially the less mature LPUs, are not incentivized to provide accurate forecast information in a timely manner.

[27] Obviously, this applies to any new task assignment within the context of a bureaucracy or firm.

[28] This is discussed more thoroughly in the next bullet point.

- Cause of Late Updating of LPU Forecasts

The most important reason[29] for why two of the three LPUs failed to meet the deadline for the pilot project is the uncertainty surrounding the task of forecasting. Given that the level of effort and amount of time expended on forecasting is not perfectly correlated with the quality of the forecasts, LPUs do not have the incentive expend such effort or time. In short, whether a forecast is able to predict an actual shortage of component parts or a future availability problem is not perfectly determined by the stakeholder's effort; this in turn dulls the incentives of the stakeholders to meet the deadlines set in the pilot project.

7.3.3 Solutions

The causes, described in section 7.3.2 above, to the problems identified by the pilot program provide us with possible avenues to solving these problems in future attempts to consolidate forecasting information. Because the final two bullet points discussing the incentive problems in section 7.3.2 have relatively straightforward solutions, this focuses on what should be considered the most important problem for purposes of future forecast information consolidation: inconsistencies across the various LPUs.
The chief concern raised by the pilot program was the inconsistencies in creating and managing SAP forecasting figures and the different levels of SAP usage across the relevant LPUs. Given the level of inconsistencies that were experienced during the course of the pilot program with three LPUs, we can conclude that the level of divergence between the many ABB LPUs is greater. This is the result of the relatively decentralized organizational structure of ABB and the decentralized manner in which ABB has expanded its operations.

Undoubtedly, there are costs and benefits to ABB's decentralized organizational structure, just as there are costs and benefits to a relatively centralized structure.[30] However, based on the results of the pilot

[29] The belief in the relative importance of this project for the stakeholders and the pilot nature of the project are also reasons for why LPUs were not incentivized to meet deadlines.

[30] The optimal industrial organization of firms within ABB's industry is well beyond the scope of this paper.

program and the goal of the program, namely, to increase transparency and accessibility to consolidated forecast information, a seemingly uncontroversial proposition appears to be as follows: if the sharing of information increases the efficiency of ABB, then attempts at standardization of such information which increases information sharing are also efficient.

Assuming that this proposition is true, then one possible solution to the inconsistencies mentioned above is to force a standardized form and method of forecast information at the local level. To be specific and within the context of this project, ABB DMPE should require that all LPUs collect and generate forecasting data at the local level in accordance with specific requirements spelled out in advance. Whether these requirements conform to the practices of Turgi, Bangalore, or some other LPU is immaterial,[31] as long as the result is consistency across all LPUs. For example, all LPUs may be required by ABB DMPE to create FC, PPO, and PO figures for SAP and transfer this data to SharePoint on a specific day each month. The result would be a more accurate and robust consolidated forecast, which is also easily accessible to the users in need of this information.

[31] Intuitively, ABB DMPE may require that all LPUs conform to the "best" practices of a Turgi. However, given the technological, human capital, or "maturity" constraints faced by some LPUs considered above, a "second best" practice may be implemented.

8 Conclusion

8.1 Summary of Research Problem, Motivation, and Objectives

ABB DMPE, which has multiple production locations around the world face tremendous challenges in getting reliable demand forecast and translating that forecast into consolidated component part forecast to suppliers, because ABB's global supply chain is such that ABB's demand for the component parts of global suppliers that deliver to multiple ABB factories is visible neither within ABB nor to the suppliers. Although the global supply management division collects annual supply forecasts at year's end, this global supply forecast becomes outdated due to the fluctuating market situation during the year. An overall view of the supply forecast cannot be obtained during the middle of the year, despite having access to such forecasts would be desirable for multiple actors.

As ABB DMPE has expanded globally, multiple LPUs produce similar products utilizing the same global suppliers and components. Furthermore, because of severe constraints on the availability of several commodities purchased from global suppliers, inefficiencies within ABB have become apparent. One reason for these inefficiencies is the non-existence of a methodical component part planning process with global suppliers from the ABB side.

In light of the non-existence of an accessible and consolidated component part planning process and the attendant inefficiencies, the goal of this project was to develop a standardized process that consolidates the component part planning of multiple global production locations. Implementation of Global Forecast Consolidation Process

8.2 Summary of the New Consolidation Process

The new consolidation process proposed in this paper addresses several issues discussed above and can be summarized as follows.

The proposed consolidation process involves personnel in six active roles: product manager and commodity manager in BU (headquarters); product manager, commodity manager, and process owner in LPU; and supplier. The BU commodity manager initiates forecast preparation for the following month on the 15th work day of each month, which is then followed by the BU product manager requesting product forecasts from LPU product managers. LPU product managers prepare his or her respective product forecast and send it to BU product managers. To insure the quality of the forecast, BU product managers make an assessment of the forecast's accuracy based on the market situation and historical reliability of the forecasts. Once the product forecast is finalized, either the local product manager or the process owner uploads the product forecast to SAP, and thereafter, SAP creates the component part forecast based on the product configuration. To standardize data formatting and facilitate data extraction, the output of a specific SAP transaction is extracted automatically from SAP using an Excel macro. LPU commodity managers then upload what they extract from SAP to SharePoint. After all LPUs' commodity managers upload forecasts, the BU commodity manager finalizes forecast integration and makes any necessary corrections. The deadline for this is the fifth working day of every month. After forecast integration is finalized, the forecast is ready to be sent to suppliers via email so that suppliers have an opportunity to comment on the forecasts.

Considering all requirements and constraints regarding the consolidation of forecasting information, a combination of SAP ERP, Excel, and SharePoint was selected for the pilot program.

8.3 Summary of Pilot Program

The pilot program selected, according to predetermined criteria, a representative sample of approximately 20 component parts for the pilot product, the ACS 5000A. The forecast data for the ACS 5000A, which is manufactured by three separate LPUs, is currently dispersed across three different SAPs: Turgi, Beijing, and Bangalore. The pilot was implemented in late November for approximately 20 days.

The most important result of our pilot was that forecasting data on the component parts comprising our sample was now consolidated in one easy-to-access location, namely, our master Excel spreadsheet available on SharePoint. Furthermore, the effort and cost of consolidating and making accessible forecast data decreased substantially because of the clear assignment of roles, responsibilities, and deadlines pertaining to the consolidation of data. A corollary result of the pilot program was that suppliers had greater access to consolidated forecast data, meaning that suppliers were able to provide more salient feedback to the BU commodity managers.

Of course, several problems arose during the course of the pilot program. First, the pilot program's assumption on process was incorrect. Second, it was discovered that in many LPUs, SAP was under-utilized. Third, the pilot program was plagued by the lack of manpower to implement the new consolidation processes because of organizational and structure problems. Finally, there were considerable delays during the process of consolidation.

We considered the causes of these problems and discovered the following. First, the relative level of operational "maturity" and "immaturity" across LPUs in the pilot sample resulted in inconsistent uses of the SAP purchasing processes and relatively low usage of SAP in Bangalore and Beijing, as compared to Turgi. A valuable lesson we learned was that assumptions that hold true in more "mature" LPUs may not hold for LPUs with lower levels of operational maturity, and so, future efforts at forecast information consolidation must standardize according to either a "mature" or "immature" LPU's forecasting standard. Second, we noted that future efforts at forecast consolidation would need to clearly delineate the responsibility of creating SAP forecasting figures, because without such clear assignment of responsibilities and the relatively uncertain benefits of consolidating forecast information, LPUs, and especially the less mature LPUs, were not incentivized to provide accurate forecast information in a timely manner. Finally, we found that LPUs failed to meet program deadlines for the pilot project because of the uncertainty surrounding the task of forecasting.

8.4 Key Recommendation

This study proposes the following seemingly uncontroversial proposition: if the sharing of information increases the efficiency of ABB, then attempts at standardization of such information which increases information sharing are also efficient. Therefore, assuming that this proposition is true, then one possible solution to the inconsistencies plaguing the pilot program is to force a standardized form and method of forecast information at the local level. More specifically, we mentioned above that ABB DMPE should require that all LPUs collect and generate forecasting data at the local level in accordance with specific requirements spelled out in advance by ABB DMPE. As we noted above, whether these requirements conform to the practices of Turgi, Bangalore, or some other LPU was immaterial, as long as the result was consistency across all LPUs. This, in turn, would lead to a more accurate and robust consolidated forecast, which is also easily accessible to the users in need of this information.

8.5 Final Concluding Remarks

ABB DMPE is currently expanding its global footprint, and its business is becoming even more complex under its decentralized culture. In this highly complex informational environment the need for easily accessible and comprehensive information on forecast data cannot be overstated. This paper described a procedure to develop a forecast consolidation system for an organization with multiple production sites, and dealt with one of the BUs within ABB, ABB DMPE. It is worthwhile noting that the principles and lessons drawn from this project can be generalized to any other multinational companies.

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