Developing Product Configurators for Use in a Multinational Industrial Goods Company

by
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B.A.Sc. Mechanical Engineering, University of British Columbia, 2006

Submitted to the MIT Sloan School of Management and the MIT School of Engineering in Partial Fulfillment of the Requirements for the Degrees of Master of Business Administration and Master of Science in Mechanical Engineering

In conjunction with the Leaders for Global Operations Program at the Massachusetts Institute of Technology

June 2013

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Abstract

As multinational industrial goods companies (MNCs) selling low-volume high-complexity products move into markets across the globe, they develop an operations strategy to provide a product tailored to local markets, often also engineered and manufactured in that local market. As MNCs seek to provide more customization to their customers, they face issues with the resulting complexity of operations, leading them to pursue mass customization, i.e. providing variety at low cost through configurable products. An important step in this product strategy is the introduction of product configurators, i.e. software tools that permit the automatic or semi-automatic configuration and pricing of product variants. Through streamlining the specification and bidding process, product configurators lower process time and therefore also lower costs in both sales and engineering functions. However, difficulties arise in developing a product configurator for a global company operating in many different localized markets.

This study develops a framework for multinational companies to first evaluate the needs of their overseas divisions for a product configurator and second identify the gaps between the global and local product configuration and pricing. The objective of the framework is to provide a unified, centrally managed product configurator that provides the ability to tailor product options to specific local needs.

A case study of a power electronics multinational with 9 overseas locations is performed. Interviews of key stakeholders in the head office and in the overseas division provide preliminary indication of differing product configurator design requirements from country to country. A deep dive is performed using the framework into two of its oversea divisions, Canada and Brazil. The study reveals key differences in the product feature requirements, in costing products due to local labor costs, part costs and import taxes, in the pricing process due to margin structures and sales incentives and in usage patterns due to language, local technical terminology and collaboration modes between sales and engineering. Using survey techniques, prioritization of the configurator functionality requirements is determined. Combined with an organizational analysis of the company, an integrated implementation plan is developed to permit identification of solutions in conjunction with roll-out to the international organization.

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Table of Contents
Abstract...................................................................................................................................... 3
Acknowledgement ...................................................................................................................... 5
Table of Figures .......................................................................................................................... 9
Abbreviations ............................................................................................................................ 10
1. Introduction ............................................................................................................................ 11
   1.1 Motivation ........................................................................................................................ 11
   1.2 Thesis Question ............................................................................................................. 13
   1.3 Section Summary ........................................................................................................... 15
2. Context & Motivation ............................................................................................................ 17
   2.1 ABB ................................................................................................................................ 17
   2.2 Sales to Execution Process ............................................................................................ 20
   2.3 Motivation: Problems in Sales Process ......................................................................... 22
       Sales Process ..................................................................................................................... 22
       Identified Problems of Order Definition and Pricing ....................................................... 23
   2.4 Motivation: Local Engineering Centers ......................................................................... 26
   2.5 Section Summary ........................................................................................................... 29
3. Research Methodology ......................................................................................................... 30
4. Literature Review .................................................................................................................. 34
   4.1 Literature Review Framework ....................................................................................... 35
   4.2 Moving from Engineer to Order to Configure to Order – Mass Customization & Product Variety ......................................................................................................................... 35
   4.3 Product Configurators as tools for customization ............................................................. 38
   4.4 Software Tool Product Development for Multi Country Products – ................................ 39
   4.5 Section Summary ........................................................................................................... 40
5. Product Development Theory Applied to a Product Configurator in a Multinational Company .................................................................................................................................................. 41
   5.1 Understanding the Product ............................................................................................. 41
       5.1.1 General Case for Configurable Industrial Goods Products ......................................... 41
       5.1.2 Product Breakdown of ABB’s Excitation Systems ...................................................... 43
   5.2. Process Mapping of Tool Impact .................................................................................. 44
       5.2.1 Before and After Sales Process Map ........................................................................ 44
       5.2.2 Impact on Interface between the Sales Organization and the Engineering Organization .................................................................................................................. 45
Table of Figures

Figure 1: Balancing between decreasing product complexity and offering localized products
Figure 2: ABB Divisions, Source: ABB.com
Figure 3: ABB Power Electronics Structure
Figure 4: ABB Excitation Product Range (ABB Excitation Systems, 2012)
Figure 5: ABB Excitation System Processes
Figure 6: Base Sales Process Map
Figure 7: ABB Principal Global Operations, Source: ABB Internal Documents
Figure 8: On-Site Case Study Methodology
Figure 9: Literature Review Framework
Figure 10: Factors that influence the degree of optimal automation in a configuration system adapted from (Forza & Salvador, 2007)
Figure 11: Representation of Product Space
Figure 12: Capital Good Product Attributes
Figure 13: Before & After of Sales Process Flow of Information
Figure 14: Sales/Engineering Interface Current Situation
Figure 15: Sales/Engineering Interface with Product Configurator
Figure 16: Porter's Five Forces – Adapted from (Porter, Jan 2008)
Figure 17: Categorization of Drivers of Differences between Product Configurator requirements
Figure 18: Functional Categories for an ETO Product Configurator
Figure 19: Product Cost Model
Figure 20: Matrix of Needs/ Product Configurator Functionality
Figure 21: Utility Function Example
Figure 22: Utility/Cost Function
Figure 23: Roll Out Timeline
Figure 24: Example Roll Out Schedule
Abbreviations

ABB – Asea Brown Boverei
ATPE- ABB Excitation and Synchronization Equipment Product Line
BOM – Bill Of Material
BTO – Build to Order
BU – Business Unit
CRM - Customer Relationship Management (software)
CTO – Customize to Order
ERP – Enterprise Resource Planning
ETO - Engineer to Order
GPG – Global Product Group
GPL – Global Product Line
LEC - Local Engineering Center
MNC – Multinational Corporation/Company
NPS – Net Promoter Score
OPQ – Opportunities for Perfecting Quality
PRU- Product Responsible Unit
R&D – Research and Development
SG&A – Sales, General and Administrative Expenses
VAR – Value Added Reseller
1. Introduction

1.1 Motivation

Global multinational corporations (MNCs) face a challenge in developing products that meet their globally distributed customers' requirement while keeping their costs low. This is specifically a pressing problem for MNCs that offer industrial goods. Their customers are typically buying a product that is a large capital expense and therefore desire to buy a product that closely matches their particular local requirements. Variety creates complexity which is costly to maintain when everything works well and even costlier when it leads to error. An operations strategy that attempts to resolve this paradox is mass customization.

Mass customization is an operations strategy whose goal is to offer a set of product variety that covers a wide range of options for different client needs while using product or process modularity and a pre-defined set of product component parts to keep costs of variety low. (Pine, 1993). As companies have moved towards this form of operations strategy, they have needed to develop product configurators, software tools that enable them to configure and manage the products they offer, check the feasibility of offered configurations and their associated complexity, automating their sales processes and connecting it to their engineering and manufacturing functions.

With the rise of the emerging economics, as with several other sectors the global MNCs in the industrial goods sector have increasingly worked to sell their products internationally. Global operations strategy at engineer-to-order (ETO) or a customize-to-order (CTO) MNCs can run through several different combinations. They can sell locally, engineer and manufacture centrally, sell and engineer locally, manufacture centrally, or sell, engineer and manufacture
locally. They are then faced with the question of what should they sell, what will their costs be, at what price should they sell it, how and what information needs to flow across borders and what the ideal trade-off is between central standardization and local customization. These decisions will then inform the design and integration of a product configurator into their organization globally. Regarding the product configuration, the key question becomes: how does one roll out a product configurator in a global organization that seeks to move from a full customization model towards a mass customization model? Figure 1 shows the challenge and delicate balance that needs to be struck in developing a model that moves towards less product complexity at the same time as responding to the specific needs of customers in local and differentiated markets. To reduce complexity and costs, variety needs to be reduced in the move from ETO to CTO. However, to offer a product that is tailored to local markets, variety is increased.

![Diagram](image.png)

**Figure 1: Balancing between decreasing product complexity and offering localized products**
1.2 Thesis Question

This chapter defines the thesis question being answered, showcasing the different aspects of engineering and business that need to be considered. It identifies 6 sub questions that together need to be answered to answer the overarching question of the thesis.

The aim of this thesis is to answer the question of whether and how a multinational should develop product configuration throughout its global organization. The question is limited to companies that have developed the product platform strategy of modularization that permits product configuration in a home state and are seeking to investigate product configuration in their overseas locations. This thesis does not investigate the development of the product platform strategy.

To answer this question of whether and how a multinational should develop product configuration throughout its global organization, several sub-questions must be answered:
- understanding the company's overall business benefits of moving to product configuration,
- understanding benefits and needs for a product configurator in the target countries,
- assessing the tool's design and scope for use in the branch countries,
- assessing the different processes and users of a product configurator,
- understanding the organization in each country and implementation,
- assessing the process of metrics of a global roll out.

1. Global Business Needs

The first question that needs to be answered is what are the company-wide benefits to rolling out a product configurator.
2. Local Business Needs

Do the operations in different countries have different requirements than the central operations in Switzerland? How do these differences affect the development of the product configurator?

3. Tool

What differences will be required of the tool and its functionality? In answering this, a framework for the development and implementation of product configurators in a global organization is formulated. It is postulated that the design of the product configurator software, logic and interfaces and the associate upstream sales processes and downstream engineering and manufacturing processes can be such as to provide the flexibility required for use in local markets while maintaining a global tool concept and its benefits of centralized data and easy maintainability.

How does a multinational industrial goods company design an internal software tool for a global organization? Can one integrate modularity or flexibility into a product structure, while gaining the benefits from a central frame that permits future developments from a common point, a common language and easy sharing of knowledge about the product? Which requirements for flexibility should the developers agree to and incorporate and which should they leave on the drawing board? Can one define a framework for decision making on flexible product attributes?

4. Process

What level of differences in processes can we find in the different operations? How do we determine whether different operations models are needed?
5. People

How does the organizational structure of a company affect the implementation of a new product configurator to its international locations? Do the cultures in the different location affect how the configurator should be rolled out? Does this impact the decision making on what flexibility to add to the configurator? Can we identify any issues ahead of time that will impact the benefits the configurator will have? Does an implementation plan address any of these?

6. Metrics

In large capital goods MNC, resources are scarce. Capital and improvement projects go through large continuous approval processes such as gate models. Projects need to be measured to assess their progress and impacts. When developing a tool and process that changes a dynamic process such as the sales process, how can one quantify the impacts? What performance metrics are already being tracked by the company that can be used? Or what information should the organization be monitoring? Ultimately, what amount of savings can be had in each country and does this change the decision for rolling out the tool to a more limited set of countries? Although this is a salient and important questions, due to time and information constraints, priority was placed on assessing the tool and the organizational impact of a roll out. The question of metrics is not addressed in this thesis and should be the subject of future research.

1.3 Section Summary

In this section, the concept of product configuration was introduced and presented in the context of use by multinational industrial goods companies. The problem of developing a product configurator for use in a decentralized multinational organization where decentralization favors an increase in product variants is determined as the central focus of the thesis. Specifically, the
question is posed of how to study the organization and determine the specifications of a product configurator in such a situation of multinational use.
2. Context & Motivation

This thesis research was performed in conjunction with ABB Switzerland, whose Excitation Systems and Synchronization Equipment product group served as a case study. This section provides context on ABB. It continues by providing a description of the processes surrounding product configuration and the identified issues with these that lead to a need for product configuration.

2.1 ABB

ABB, formed in 1988 by the merger of Swiss company Brown and Boveri and the Swedish company Asea, is a large industrial goods company specializing in the industrial power, electronics and automation sectors. With over 135,000 employees and revenue in 2011 of over $37 billion, ABB has operations and sales on all five continents.

ABB operates five different divisions: Power Products, Power Systems, Discrete Automation and Motion, Low Voltage Products and Process Automation as seen in Figure 2.

![Figure 2: ABB Divisions, Source: ABB.com](image)

This project falls within the Discrete Automation and Motion division in the Global Product Group (GPG) Power Electronics. Power Electronics centers all its products on technologies that use their expertise in power conversion technology. For example, as shown in Figure 3 this division also includes power converters for wind turbines, high powered rectifiers that transform AC to
DC for the aluminum smelting industries. Within this group, the Excitation Systems and Synchronization Equipment Global Product Line (GPL) designs, manufactures and sells excitation systems and synchronization equipment globally.

![ABB Power Electronics Structure](image)

The Excitations Systems GPL offers several products such as UNITROL, its excitation system line, SYNCHROTACT, its synchronization equipment line and MEGATROL, its combination excitation and gas turbine starter system.

Excitation systems are power control systems that are an integral part in power generation. Excitation systems provide variable DC current that creates the required magnetic field in a generator. A major function of excitation systems is to provide a control and stabilizing function to a generators output of electricity in the face of exogenous factors in the plant or grid. (ABB Group, 2012) Major clients of excitation systems are large private and government power utilities and large private power producers such as heavy industries like mining, metal
processing or shipping. Further details of the product and its components can be found in section 5.1.2 Product Breakdown of ABB's Excitation Systems.

Excitation systems are a low volume high complexity product. Each system that is sold needs to be fit to the operating conditions of the plant and to the specific properties of the generating units at the plant. ABB currently has three excitation system products in its product mix: UNITROL 1000, UNITROL 6080, UNITROL 6800, which correspond more or less to systems with increasing generator current and complexity. Figure 4 graphically shows the approximate areas covered by the different products.

![ABB Excitation Product Range (ABB Excitation Systems, 2012)](image)

Although ABB only offers three product groups, these translate into multiple possible options with different specifications such as voltage, frequency, redundancy level, environmental conditions, and breaker configuration preference.
2.2 Sales to Execution Process

The Excitation and Synchronization group at ABB(ATPE) has traditionally been an Engineer-To-Order (ETO) business. Sales processes in industrial goods companies are heavily dependent on the fact that the company is selling to another company and not a consumer. In addition, the long lifespan, high capital cost and need for integration into existing systems or new systems require strong customer involvement in the selling process. (Forza & Salvador, 2007). Due to these factors the majority of industrial good sales are based on a specification-bid model. Clients with a desire to purchase new equipment will send over a request for quotation with a specification of the product they require or the functions they need the product to provide. Salespeople at the MNC will review the quotation, select the appropriate product and price and provide a quotation to the customer. After the customer confirms the order, the information about the order is then passed for order fulfillment. Configuration engineering is then done, checking the variant that the sales team has sold, building bill-of-materials (BOMs) and manufacturing drawings. Manufacturing of the system is then undertaken and commissioning is down at the customer site after delivery and installation. This process is typical of most ETO
firms. The process from sales to an executed order at ABB is summarized below in Figure 5.

Sequential Order of Business Activities:

- Specifications are received from clients;
- Tenders are produced by a Sales Engineer showing both the ABB solution to the specification and the offered price;
- Purchase orders are received;
- Project is handed over to project management and engineering who log it into the ERP system;
- Engineering starts for the specific configuration, creating the BOM and production drawings;
- Parts are ordered;
- System is assembled by production team;
- System is shipped;
- Commissioning calibrates system for proper plant performance;
2.3 Motivation: Problems in Sales Process

Matching customer requirements to an appropriate variant, determining a suitable price and transferring the customer information to groups downstream of the order point is a complex process and has been identified as an area for improvement at ABB. This section identifies the issues in the sales process at ABB and the impact of errors.

Sales Process

During the sales process, in-depth knowledge of the product is needed to correctly specify a product that answers the specification of a client. Multiple tools are used from calculation software to drawing software to word processing software to produce the necessary outputs for a full quotation to the client.

Information transfer is also key. Once an offer has been accepted, information needs to transfer to the order fulfillment group. Figure 6 shows the process from receiving a specification to the interfaces with the different teams.

Figure 6: Base Sales Process Map
Steps in Sales Process:

- Review Specification
- Use Sys Calculation tool, get system parameters and basic type code
- Use product variant map to identify required noble parts and their interdependency rules
- Use drawing software to choose the appropriate Single Line and Layout drawing for the system
- Use cost spreadsheet to develop cost for system
- Use pricing spreadsheet to develop appropriate price for system
- Use word processing software and template to put together commercial proposal
- Use word processing software and template to put together technical proposal
- Get management approval

**Identified Problems of Order Definition and Pricing**

The order definition and pricing process that the sales team performed and the resulting transfer of information to the engineering and project management teams had been identified by ABB as an area for improvement. During the early parts of the case study, interviews with stakeholders across all the teams were held to further confirm the details of the issues that ABB has identified.

*Time to quote:*

Responding to the client in a timely manner is of key importance to ABB. The current sales process is difficult to use and creates longer than needed "time to quotation". This is especially true for processes were the client is unsure of what they are looking for and needs to consider several different variants of a solution.
Incomplete quotations:
Incomplete quotations, variants with parts that do not combine, solutions that do not correspond to the problem the client is trying to solve, all these are some of the issues that were found around the theme of the quality of the quotation. These errors create additional costs by requiring the purchase of additional materials, by additional engineering time, by delivery delay penalties, by knock on effects on the production line and by non-directly quantifiable costs such as customer dissatisfaction.

Workarounds:
The large number and complexity of spreadsheets that have to be used to identify the correct product for a customer specification and the number of potential variants have led to workarounds being created. For example, the sales team has developed a workaround spreadsheet with a small number of familiar variants out of a large number of product variants that are possible. Not only does this indicate a clear issue with the current tools being used, it also causes less variety being offered to the client which is a key requirement in the excitation system market.

Transfer of information to engineering:
Transfer of information between the sales group and the engineering groups happens at a handoff point once the purchase order has been inputted into the ERP system. Information flow was found to occasionally interrupt here. Product attributes that were in the contract to the customer or technical information about the customer’s power plant would be lost, resulting in additional engineering work to call up the customer and gather the information.

Slow onboarding of new sales staff
Multiple tools and technological complexity result in slow onboarding for new sales staff. Knowledge transfer between sales staff is very limited.

**Localized to each country**

Process development is strongly decentralized. Each global location has developed their own sales-to-engineering process and central knowledge of how the LECs operated was is very limited. No clear product requirement existed for how the product configurator needed to function or how the local processes might need to change in order to use the product configurator locally.

**Difficulties in measuring the process**

Measurement of the process issues were also an area identified for improvement. ABB has implemented two companywide performance measurements programs, Net Promoter Score (NPS) and Opportunities for Perfecting Quality (OPQ), respectively a measurement of external perception and a measurement of internal performance.

NPS is a customer survey program that asks all customers to rate ABB’s performance on a series of actions and results in a scale of green (good), yellow (improvement needed), red (immediate action needed).

More importantly, OPQ (Opportunities for Perfecting Quality) is an internal measure of performance that is defined as the ‘cost of not doing something without error the first time round’. In ATPE, the OPQ was measure for the following categories:

- Material
- Contingency
- Manufacturing
- Commissioning
Although measuring widely across the value chain, the causes for additional costs were often difficult to pinpoint. In addition to special sales costs, additional material costs and engineering costs were also found to potentially result from issues in the quotation and bidding process. Lack of systematic recording of the sources of errors make it difficult to measure the impact of changes in the sales process.

Having identified multiple areas for improvement in its order acquisition and customer information transfer processes, ABB ATPE identified development of automated product configuration and quotation software as a potential remedy to the above listed sales process issues.

2.4 Motivation: Local Engineering Centers

ABB Excitation & Synchronization Equipment (ATPE) serves the global power market. Headquarters for ATPE are in Turgi, Switzerland. Entitled the Product Responsible Unit (PRU), this group houses the support functions for a global network of sale & engineering centers. Support functions include marketing, finance, research & development, product management and global operations support. ATPE’s global network of subsidiaries and affiliates is designed with varying capabilities per location. As described in Chapter 1.2.6, this variation between global subsidiary requires consideration during the development of a product configuration system.
Historically, ABB ATPE has accessed individual markets through three different types of channels depending on historical factors and market factors.

The three different channels are as follows:

1) BU Local Engineering Center (LEC) - Sells, engineers and manufactures to its sales territory. BU LEC’s report functionally to the PRU

2) Non-BU Local Engineering Center – Sells, engineers and manufactures to its sales territory. Non-BU LEC’s do not report functionally to the PRU. Typically established due to strong ABB presence in another product group.

3) Value Added Reseller (VAR) – Third-party group that buy component parts from ATPE and sell, build and engineer ABB-branded systems. Not part of the ABB organization. Typically located in markets that require local companies to be nationally owned, e.g. P.R.China.

Although this study limits itself to studying the BU Local Engineering centers, it is posited that the challenges found in rolling out the product configurator and its implication on product strategy, sales and marketing, engineering and organizational reactions would be strongly similar for the Non-BU LECs and the VARs.

ATPE has 9 BU LEC locations around the world: Switzerland, Canada, Brazil, India, China, Italy, South Africa, Australia and Poland as shown in Figure 7. Each BU LEC is represented by a Global Operations manager at the PRU who helps them with technical issues. The core and high value parts of the excitation systems are bought by the LECs from the PRU at a transfer price suitable for the market. Additional, more common parts such wiring, cabinets and low value electrical assemblies are purchased by the LEC, either in country or imported from elsewhere.
From interviews done with PRU stakeholders, challenges arise with rolling out the configurator globally.

The principal issue is that each LEC has a culture of operations strongly independent from the PRU. Although they functionally report to the head of the PRU, in ABB’s matrix structure, reporting is also through country management. The result of this is that team members and management at the PRU are unclear about the processes and organization at the LECs. Little information beyond financial data and requests for help on challenging product projects is shared between the groups internationally.

Another challenge beyond organizational knowledge is the degree of localization of the product. As per an executive level manager at the PRU,
"It is a very local product. Yet the tool needs to be global for us to gain maximum benefit from it. We need to balance that." (PRU, 2012)

Localization was found to move in different directions for different countries. For example, low labor cost countries focused strongly on reducing material costs in assembling their systems as materials had a higher impact on their margins. Alternatively, high labor cost countries worked to reduce labor to manufacture due to labor's relative impact on margins.

### 2.5 Section Summary

A complex sales process and a decentralized international structure create the need for ABB to develop its product configuration tool for its international operations. This is the motivation for understanding the requirements that need to be considered when rolling out product configuration systems from a single country model to a decentralized multinational model.
3. Research Methodology

This section discusses the research methodology used in this thesis. The research uses two principal research methods: a comprehensive literature review and action research based case study. (McCutcheon & Meredith, 1993), (Coughlan & Coghlan, 2002) discuss the appropriateness of these methods for operations management research. (Baskerville & Pries-Heje, 1999) comment on the appropriateness of action research for understanding IT in practice. The literature review permits framing of the current status of product configurator development, use and strategy. Through an in-depth study of the literature, a framework for the implementation and impacts of globalizing a product configurator is developed. With a conceptual understanding of the key issues, a case study of a multinational based industrial goods company, ABB Switzerland, is used to understand how theory compares to the reality of the commercial world.

Case Study Methodology

The case study’s goal was to study one of the host multinational’s product line and work with them to develop a plan to roll out a product configurator to their international locations. The host company was ABB Switzerland’s Excitation Systems and Synchronization Equipment Global Product Line. The study was held over a 6.5 month period based out of Turgi, Switzerland.

Focus was on:

- developing recommendations for design changes to the current version of an in-house developed product configurator,
- studying several pilot locations overseas and how their sales and engineering processes might need to be changed,
- establishing an understanding of the organization's current performance metrics and identifying how they might be used to evaluate the impact of the product configurator
- analyzing the organizational issues with implementing the configurator internationally.

A sub-methodology was developed for the case study as shown in Figure 8 below.

![Figure 8: On-Site Case Study Methodology](image)

First, major stakeholders were identified within the group and around the group. Interviews with prepared questions and also an open ended discussion were held with the group of identified stakeholders to gather knowledge about the organization, the configurator and perceptions about implementation.
Interviews were held with the following roles within the organization:

<table>
<thead>
<tr>
<th>Organizational Unit</th>
<th>Title</th>
<th>Country</th>
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<tbody>
<tr>
<td>Excitations</td>
<td>Head of Products &amp; Technology ATPE</td>
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<td>Head of Technology Department</td>
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<td>Head of Engineering - Brazil</td>
<td>Brazil</td>
</tr>
<tr>
<td>Head of Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excitations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Subsidiary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head of Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales Engineer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: List of Interviews**

Process mapping was then undertaken on several versions of the order elicitation-sales-quotation processes for comparison:

- on the current state of the order elicitation and order fulfillment process in the main group,
- on how the process would develop with the new configurator incorporated
- on the pilot countries’ order elicitation process to identify any key differences.

Having identified the key processes and differences through process mapping, the next step was to gather an overview of the international operations of the company and gather expert
opinions about their markets and requirements for the product configurator. A combination of surveys, phone interviews, onsite visits with walkthroughs and company data was used to analyze the global operations.

The Three Lens model (Carroll, 2001) and change management literature by Kotter (Kotter & Schlesinger, July-August 2008) was used to analyze the organizational processes within the global product line. This provided the basis for the development of an implementation plan.

Finally, knowledge sharing was used through presentations and communication of results to provide feedback to the organization as well as to add one more feedback loop to the data gathered.
4. Literature Review

A first step in the research process was to proceed with a literature review. The goal of the literature review is to understand the current state of literature of companies moving from a fully customized product to a mass customizable product via use of a product configurator.

The literature review first seeks to answer Question 1 by reviewing operations strategy models. It seeks to understand the decision making involved with moving to a mass customization model. It then studies the literature around product configurators to understand the current scope of study on their use, advantages, and disadvantages and how firms use them.

The literature review then seeks to review how product configurators can be used in large multinationals across borders and seeks to understand the answer to the question how does one design a truly ‘global’ product configurator and integrate into an organization where the processes would be different across countries.

Finally, the literature review identifies research associated with implementation of new internal IT tools across global borders to seek insight from across different software applications on key factors for success of tool development for a multinational setting.
4.1 Literature Review Framework

Figure 9, below, shows the topics of consideration for the literature review.

4.2 Moving from Engineer to Order to Configure to Order – Mass Customization & Product Variety

Since the industrial age, companies face choices of how to match their products and processes. A large body of research and literature exists detailing the decisions involved with this. (Beckman & Rosenfield, 2008) detail these decisions as the product-process matrix, separating processes into project, job shop, batch, repetitive and continuous flow and mass customization based on the flexibility and variety of product that needs to be built.

Firms with high-complexity low-volume products have typically operated an engineer to order model. (Hicks, McGovern, & Earl, 2001)
ETO processes

Literature surrounding high-complexity low-volume products typically focuses on the manufacturing processes and supply chain processes surrounding these products. Different product/processes are typically defined by the location of a point called the order decoupling process. (Gosling & Naim, 2009) Customer involvement in the product will happen after this point. Engineer-to-order firms are seen as having a very early decoupling point as the customer is involved in the specification of the end product tailored to their needs. Each order is engineered for the customer, leading to a large number of product variants and an intensive engineering effort.

Enter Mass customization.

Mass customization permits product variety, lowers cost of engineering and provides the ability to offer the variety of an engineer-to-order model in combination with the savings provided by lean business processes, modular product design and linking blocks. Mass customization has been strongly studied from the perspective of adding more variety to a mass production system. An extensive set of literature review the benefits and the implementation needs of this model. (Pine, 1993) Pine defines five ways to achieve mass customization (Pine, 1993):

- Customizing services around a standardized product or service
- Creating customizable products and services
- Providing point-of-delivery customization
- Providing quick response throughout the value chain
- Modularizing components to customize end products and services

The literature is less extensive for looking at mass customization in the reverse direction, for moving from full customization to mass customization than from mass production to mass customization. (Heiskala, Tihonen, Paloheimo, & Soininen, 2007). However, there has recently
been a renewed interest on this leading to more studies on how ETO or industrial good companies have moved to develop product configuration.

In a survey of the literature, (Blecker & Friedrich, 2007) identify the major advantages of moving from a fully customized, engineer to order model to mass customization model of configured products, listed below

**Benefits of moving from Full Customization to Mass Customization** (Blecker & Friedrich, 2007)

- Increased efficiency, more controlled production
- Improved, more uniform quality
- Shorter lead-times, more accurate on-time delivery
- Lower costs
- Reduced Design Effort
- Easier to do specifications, even by customers or retailers themselves, easier selling

In their survey of the literature, challenges of moving from full customization to mass customization are also identified and listed below.

**Challenges from moving from Full Customization to Mass Customization** (Blecker & Friedrich, 2007)

- Requires changes in operations and organization
- Achieving uniform quality
- Systemizing information management
- Finding right amount and balance of offered customization
- Customer needs elicitation, specification
- Sales staff must not offer changes outside pre-designed customization possibilities
4.3 Product Configurators as tools for customization

Product configurators are key tools of mass customization. (Warren & Karner, 2010)

To implement mass customization, two key elements need to be in place: the product architecture needs to be developed so the rules of configuration are determined and a process for gathering inputs, applying the rules and providing an input needs to be determined. (Forza & Salvador, 2007) describe in detail the major aspects of configurators, including the selection and design process and varying scopes of configurators. In several other papers, authors describe features such as product quality for configurators, (Trentin, Perin, & Forza, 2012). The literature also includes studies of how product configurators impact the bidding-tendering process in small enterprises. (Forza & Salvador, 2002), case studies of product configurator implementations (Hvam, Haug, & Mortensen, 2010) and uses of product configurators for customer relationship management (CRM) (Forza & Salvador, 2008)

A major takeaway of Forza & Salvador's work is the importance of fixing the scope of functionality of a configurator and determining the requirements for a configurator. Both of these end up determining the level of automation and interaction between the upstream functions, sales and the downstream functions of engineering, manufacturing and after sales. Figure 10 shows the four factors identified by Forza & Salvador that determine the level of automation in a configurator: product complexity, number of configurations produced per time
unit, degree of product knowledge required of the user, time and resources for creation and implementation of the configurator.

![Increasing Levels of Automation](image)

**Figure 10:** Factors that influence the degree of optimal automation in a configuration system adapted from (Forza & Salvador, 2007)

The scope of automation in a configurator is a key feature of a product configurator. Although the literature defines this as affecting the design of the configurator, there is a gap of literature addressing how to identify the actual requirements of a configurator in a situation where the company is large enough that different groups will require different levels of automation.

### 4.4 Software Tool Product Development for Multi Country Products –

A review of the literature of software tool product development and implementation in a multinational setting shows many studies on the development and implementation of enterprise
resource planning (ERP) tools internationally. Studies consider national differences such as language, culture, politics, government regulations, management style and labor skills of different countries in the context of global ERP implementation. (Sheu, Chae, & Yang, 2004). (Huang & Palvia, 2001) compare the differences between developing countries and developed countries. As mentioned in the previous chapter, development and implementation of product configurators have been studied. A gap is found to exist in the literature regarding development of product configurators for a multinational setting where the localization of products and the differences in business environments internationally potentially impact the configurator requirements.

4.5 Section Summary

A strong set of literature exists for mass customization and product configurators when moving from mass production to variety. A smaller set of literature deals with product configuration in an ETO context. Similarly, a set of literature addresses implementation of global software tools. Beyond theses, a gap of literature exists in the study of the implementation of product configurators in a global ETO setting. The next sections of this thesis will work to address this gap of implementation and global product configurator roll out knowledge.
5. Product Development Theory Applied to a Product Configurator in a Multinational Company

In this section, a framework is discussed for identifying the design requirements for expanding the internal sales process and tools globally using the principles of product development.

- Product Specification process for processes and tools:
  - Understanding the current product
  - Understanding the current process
  - Understanding the customer
  - Talking to the customers
  - Putting together needs statements

The first section breaks down the product being sold to understand its attributes. Section 2 maps out the current process and identifies areas that are susceptible to change when moved globally. Section 3 discusses an analysis of the “customer”, the overseas groups that will be receiving the new process or tool. Section 4 proposes a structured interview process to elicit needs from customer employees. Section 5 shows a method for needs prioritization and assessment.

5.1 Understanding the Product

5.1.1 General Case for Configurable Industrial Goods Products

Product configuration requires defining a clear product architecture and logic for the product being considered for mass customization. Designing a product that is configurable or reverse engineering a product so that it can be broken down into a structured architecture that defines product attributes, the variants of each attribute and the logic that allows or disallows
combinations of variants is the primary step taken in this. Figure 11 highlights the relationship between attributes and variants in a product. The product can be described by \( N \) attributes that will each take on an option of \( M_N \) forms. For example, attribute 1 could have 3 variants and attribute 2 could have 2.

![Figure 11: Representation of Product Space](image)

For a full product definition, it is important to note that attributes can have different levels of abstraction. For example, in the case study at ABB, major attributes would include major groups of parts vital to the prime functions of the product, called noble parts, groupings of small ancillary parts such as cabling, paneling, fasteners, called non-noble parts and finally optional add-ons. However, with the goal providing a tool for full quotation and sales, the breakdown of the product also needs to extend to the non-physical objects of the product such as training, documentation requirements, after sales service and shipping specifications. The product for a capital good can thus be broken down as shown in Figure 12 where both the manufactured product and the associated services are identified and the offered variants defined.
Boolean logic highlighting the ability of two or more variants to coexist in a product is then defined to finish defining the configurability of the product. This is a complex and important part of defining a product architecture and is crucial for product configuration. This task was mostly accomplished in previous projects at ABB. Further discussion of developing configurable products can be found in the following references: (Pine, 1993), (Forza & Salvador, 2007).

5.1.2 Product Breakdown of ABB's Excitation Systems

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Number of Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>31</td>
</tr>
<tr>
<td>Low Voltage Transformer</td>
<td>8</td>
</tr>
<tr>
<td>Converter</td>
<td>22</td>
</tr>
<tr>
<td>Breaker</td>
<td>133</td>
</tr>
<tr>
<td>Crowbar Thyristor</td>
<td>8</td>
</tr>
<tr>
<td>Add-On Options</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 2 shows the physical product broken down into its major attributes and showing the number of variants per attribute. The Frame attribute includes the overall size of the system and
lumps together many non-noble part attributes such as cabinet, wiring and bus bar. Low Voltage Transformer, Converter, Breaker and Crowbar Thyristor are all noble part attributes as they define the core functionality and performance of the product. Their specific performance and configuration is central to the ABB excitation technology. Add-On options include human machine interface (HMI) displays, testing options, additional redundancy options and documentation.

5.2. Process Mapping of Tool Impact

Process mapping of the impact of the tool within the sales process and at the interface of the sales and engineering process help show the improvements to process error and time brought by the product configurator.

5.2.1 Before and After Sales Process Map

Figure 13 below shows the typical ABB sales process in its current state and after, once the product configuration systems is implemented. The original step is strongly linear, with the user having to transport information from one tool to the next without automation. Using the product configurator, as information is entered, technical information, drawings and technical proposal is outputted at the same step, information entry and flows are therefore reduced reducing error and speeding up the process. Information on the selected product variant automatically updates the cost calculation and leads the user to determine pricing with the appropriate product variant costing/pricing information, reducing another step for erroneously transposing information.
5.2.2 Impact on Interface between the Sales Organization and the Engineering Organization
During interviews and observations of the sales process, it can be observed that the data that is passed at the interface between the sales team and engineering teams occasionally requires rework.

The configurator helps to solve these looping/information quality problems by prompting for the correct information during initial sales configuration and by acting as a common database for all the teams.

Figure 14 and Figure 15 respectively show the process map of information flow about the product moving from the bid stage to the engineering and manufacturing. Looping can be equated to informational defect similarly to how in manufacturing a product can be categorized as having a defect and would have to be sent for rework.

Figure 14: Sales/Engineering Interface Current Situation
5.3 Understanding the customer: Global LECs

5.3.1 Analysis of different country groups in Excitations

Similarly to understanding the product and the process, the next step in defining the needs for a product configurator in a global setting is understanding the "customer", i.e. the individual global organizations.

The first step in this analysis is an open-ended comparison of the international subsidiaries.

Information is gathered from company documents, interviews at the headquarters, interviews where possible with members of the international organization and through a survey of the international organization. Appendix 1 shows the survey sent to each organization.
Differences are then grouped and classified to present a better picture of the differences affecting each group. An example classification of the international organizations is shown here:

- Number of employees (giving an indication of the size of the group)
- Performance (typically financial performance such as revenue and margins)
- Systems quote annually (giving an indication of the size of the market that the group serves)
- Product Portfolio (giving an indication of the relative proportion of products types)
- Scope of operations (indicating the capabilities at each location and the value add provided by each)
- Miscellaneous notes (other important features)

Table 3 here below shows this method applied to the global operations of ABB’s Excitation Systems and Synchronization Equipment product line. Note that due to the sensitivity of financial information, the performance metric has been masked to show which group is considered a high performer and which group is seen as requiring improvement in its financial performance.

As can be seen from this table, the profiles of the international subsidiaries vary greatly along a few different dimensions.
Table 3: Comparison of different ABB Excitation System LECs

N.B.: Information in this table has been masked for confidentiality reasons

<table>
<thead>
<tr>
<th>LEC Name</th>
<th># of Employees working in Excitation</th>
<th>Performance (as per Management’s Perspective)</th>
<th>Systems Quoted Annually (6080/6800)</th>
<th>Product Portfolio</th>
<th>Scope of Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC A</td>
<td>Small</td>
<td>To Be Improved</td>
<td>Large</td>
<td>Maj: 6080 Min: 6800</td>
<td>Sales, production and engineering</td>
</tr>
<tr>
<td>LEC B</td>
<td>Large</td>
<td>Performer</td>
<td>Large</td>
<td>Maj: 6800 Min: 6080</td>
<td>Sales, production and engineering</td>
</tr>
<tr>
<td>LEC C</td>
<td>Small</td>
<td>To Be Improved</td>
<td>Small</td>
<td>Even Mix</td>
<td>Not full production, imports equipment and modifies controller</td>
</tr>
<tr>
<td>LEC D</td>
<td>Medium</td>
<td>Performer</td>
<td>Large</td>
<td>Maj: 6080 Min: 6800</td>
<td>Sales, production and engineering</td>
</tr>
<tr>
<td>LEC E</td>
<td>Medium</td>
<td>To Be Improved</td>
<td>Medium</td>
<td>Not offering systems yet, only VAR</td>
<td>Ramping up production</td>
</tr>
<tr>
<td>LEC F</td>
<td>Small</td>
<td>To Be Improved</td>
<td>N/A</td>
<td>Even Mix</td>
<td>Sales, production, ramping up engineering</td>
</tr>
<tr>
<td>LEC G</td>
<td>Large</td>
<td>Performer</td>
<td>Large</td>
<td>Even Mix</td>
<td>Sales, production, engineering</td>
</tr>
<tr>
<td>LEC H</td>
<td>Small</td>
<td>To Be Improved</td>
<td>Low volume</td>
<td>Unknown at date of writing</td>
<td>Sales and local modification</td>
</tr>
</tbody>
</table>
Volume of quotes:

Not all LECs are equal in the amount of quotations they produce and orders they receive.

Performance:

From a sales and profit margin standpoint, certain countries achieve expected performance. All other countries are regarded as being in need of improvements to their bottom line.

Scope of Operations:

The operations strategy for the concept of the LEC is for all countries to sell, engineer and manufacture in house their products. However, not all LECs correspond to this model. Dependent on the stage of development of the LEC and the realities of the market, different LECs each provide different levels of the value chain, from strictly sales, to final programming of pre-assembled systems. One can see through this analysis how different countries, in effect, require different needs. All of the differences identified in this section affect mostly the process.

5.3.2 Product Localization: Market Drivers

This section discusses the market based drivers that create pull for the LECs to localize their product and help to determine which direction the localization will go in. It is based on a combination of Ghemawat’s CAGE framework (Ghemawat, 2007) and Porter’s Five Forces Framework (Porter, Jan 2008).

Ghemawat’s CAGE Framework identifies the difference between a corporation’s home country and the market it is looking at for expansion through four lenses, Cultural, Administrational, Geographic and Economic.

Table 4 shows the composition of each dimension.
Table 4: CAGE Framework (Ghemawat, 2007)

<table>
<thead>
<tr>
<th>Country Pairs (Bilateral)</th>
<th>Cultural Distance</th>
<th>Administrative Distance</th>
<th>Geographic Distance</th>
<th>Economic Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Different languages</td>
<td>• Lack of colonial ties</td>
<td>• Physical distance</td>
<td>• Rich/poor differences</td>
</tr>
<tr>
<td></td>
<td>• Different ethnicities; lack of connective ethnic or social networks</td>
<td>• Lack of shared regional trading bloc</td>
<td>• Lack of land border</td>
<td>• Other differences in cost or quality of natural resources, financial resources, human resources, infrastructure, information or knowledge</td>
</tr>
<tr>
<td></td>
<td>• Different religions</td>
<td>• Lack of common currency</td>
<td>• Differences in time zones</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Lack of trust</td>
<td>• Political hostility</td>
<td>• Differences in climates / disease environments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Different values, norms, and dispositions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Countries (Unilateral or multilateral)</td>
<td>• Insularity</td>
<td>• Nonmarket/closed economy (home bias vs. foreign bias)</td>
<td>• Landlockedness</td>
<td>• Economic size</td>
</tr>
<tr>
<td></td>
<td>• Traditionalism</td>
<td>• Lack of membership in international organizations</td>
<td>• Lack of internal navigability</td>
<td>• Low per capita income</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weak institutions, corruption</td>
<td>• Geographic size</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Geographic remoteness</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Weak transportation or communication links</td>
<td></td>
</tr>
</tbody>
</table>

Porter’s Five Forces identifies an industry’s competitive dynamics by looking at the barriers to entry, substitutes, supplier power, buyer power and rivalry between firms in the industry. (Porter, Jan 2008)
Using these two frameworks and applying them to the issue of developing the process and tools for roll out overseas, the following four drivers were seen as strongly influencing each country's localization needs.

**Market Willingness To Pay:**

The willingness to pay in different countries affects the competiveness of the product in that country. Low cost countries develop different adaptations to the standard designed system to reduce costs of production. High cost countries offer customized adaptations that raise the willingness to pay of the target countries.

**Market Taste And Preferences**

Market cultural aspects also affect the end operations of the subsidiary as they strongly affect the end product required. Local regulations, local drawing symbols, local preferences for cabinet layout all are examples of market taste and preferences that affect local products and the ability to sell.
Markets Customer Or Supplier Power

Strong concentrated customers, such as in the case of national or state based utility companies, give the customer power to request systems that are customized to its own specific needs, ultimately changing the global sales operations from selling a standard product to selling a customized solution.

Market Competition

In order to capture business under competitions of strong market competition, customized solutions and pressure to keep costs low are strongly felt. These impact the need for faster operations and lower costs.

5.4 Talking to the customer: Identification of Differences

Once a clear understanding of the overall markets of the different countries is developed, stakeholders at both at headquarters and at several global subsidiaries can be interviewed and prompted on identifying the different needs their operations require. Reviewing interview transcripts, one can then isolate the recurring items that are identified by the stakeholders. If this is done with one or two countries adeptly chosen to be on opposite spectrums of needs, a set of needs can be identified and categorized, permitting then easy cross checking with the remaining countries. Figure 17 graphically shows the categorized facets of the industrial goods sales and engineering process that are candidates for change when a product is to be sold overseas.
5.5 Mapping specification change requirements to tool functionality

The identified customer needs must then be transformed into a potential specification. (Ulrich & Eppinger, 2012). Because the task is to transform the different needs and match them to the planned process and tool, the next step is to identify the current functionality of the planned process/tool. We will then see how the above needs require changes to the planned process/tool. Figure 18 shows the major functionality categories of a product configurator. Each of these is explained below.
1. **PRODUCT functionality:**

   A *product-space* has been defined for the product to be configured, with all the potential variations of products. This product-space leads to the different choices and logic that is the backbone of the configurator. When a country’s market requires a product that is outside this product space, the configurator cannot select this product. Proper product selection is a key function of the configurator. Understanding if a country’s requirements fit with the configurators defined product-space is needed for global roll out.

2. **COST functionality:**

   Costing out the product is a second key functionality. Determining the base cost of the system involves developing a cost model with the input costs of each country. Costs can be calculated in multiple ways such as full bottom up calculations based on BOMs, top down prices based on historical prices for similar systems or a combination thereof.

   Breaking down the logic and understanding the model of how the costs are developed in the product configurator are important steps to mapping the cost functionality. ABB’s cost model is based on developing estimates for 31 base configurations which include basic material, engineering, project management and fabrication costs for those base
configurations and are then built upon by adding specific costs for noble parts and add-on options. Figure 19 shows this graphically. The countries’ costs differ in the price they pay for noble parts, local supplies and labor rates. Complexity in assessing costs can considerably complicate this function, for example when material costs have import taxes that are variable based on the final destination of the product.

![Diagram of Total Cost: A%, B%, C%, Frame Size, Noble Parts, Options](image)

Figure 19: Product Cost Model

3. PRICE functionality:

Pricing is the third key functionality. The configurator incorporates a pricing model, taking into account SG&A, R&D and other overhead cost factors to take into account the fixed costs of the products and ensuring an appropriate margin is set. When taking this model internationally, variances in full cost models can be important and need to be determined. Differences typically include additional inputs to the fixed cost (ABB Country margins, sales commissions, hedging etc.).
4. USE functionality

The title of this functionality is broad. It is intended to hold all the aspects of the configurator that make the tool reduce errors and save time. It includes all the interconnected automation for the outputs (drawings, proposals, etc.), the planned links to exogenous software, the user management features that permit easy transfer of information and the GUI.

5.6 Mapping of product drivers onto product functionalities

<table>
<thead>
<tr>
<th>Need Statement</th>
<th>Configurator Functionality Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Cost</td>
</tr>
<tr>
<td>Parts Localized</td>
<td>X</td>
</tr>
<tr>
<td>Regulations &amp; Standards</td>
<td>X</td>
</tr>
<tr>
<td>Customer Preference</td>
<td>X</td>
</tr>
<tr>
<td>Retrofit vs. Newbuild</td>
<td>X</td>
</tr>
<tr>
<td>Management Approval Levels</td>
<td></td>
</tr>
<tr>
<td>Interface with Enterprise</td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td></td>
</tr>
<tr>
<td>Currency Hedging</td>
<td></td>
</tr>
<tr>
<td>Tariffs &amp; Duties</td>
<td>X</td>
</tr>
<tr>
<td>Terms &amp; Conditions</td>
<td></td>
</tr>
</tbody>
</table>

Figure 20: Matrix of Needs/ Product Configurator Functionality

Figure 20 shows the mapping of the needs statements to the functionality categories of the configurator. Having identified the need statement’s categories, their impact on the major functionality groups of a product configurator is then defined. For example, a localized part will have an impact on the product definition if it is a part required uniquely by that local market and will also have an impact on the functionality of assessing a cost for a product variant as that local part is typically priced differently in different locations around the world. This is done for all
the need statements. Using this information, the areas of the configurator that need to be modified to respond to the new locations need statements are quickly identified. Looking at these functionality areas, discussions can then be held with the software designers and product managers to identify solutions to the requirements and develop potential costs for implementing these solutions.

5.7 Assessing importance of specifications

To assess the relative priority of each main function and sub function of the configurator and the importance of the needs involved, a survey was sent out to all the LECs to managers in both the sales function and engineering function. It included a general list of functions that captured the total range of functionality the configurator is planned to have. Survey responders were prompted to rate the functionality based on their operations need for that functionality. The information gathers permits the developers to identify the pressing needs and their distribution globally. Averaged results of this functionality survey are shown below in Table 5:

Priority:
On a scale of 1-5, with 1 as lowest priority and 5 as highest priority, please rate the following functionality based on how much help (e.g. making the task easier or faster, reducing mistakes, etc.) it would be to your organization to have this as part of a configurator.

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate system parameters and noble parts for standard configuration (as defined by configuration table and including standard options)</td>
<td>Base functionality</td>
</tr>
<tr>
<td>Storage and easy transfer of data about configuration from sales to engineering</td>
<td>Base functionality</td>
</tr>
<tr>
<td>Add in non-standard options</td>
<td>Medium</td>
</tr>
<tr>
<td>Calculate cost of system</td>
<td>High</td>
</tr>
<tr>
<td>Calculate price of system</td>
<td>High</td>
</tr>
<tr>
<td>Determine available spare parts and add to quotation</td>
<td>Medium</td>
</tr>
<tr>
<td>Automatically create required transformer spec</td>
<td>High</td>
</tr>
<tr>
<td>Create System Losses Report based on configuration</td>
<td>Medium</td>
</tr>
<tr>
<td>Create Braking Transformer Spec</td>
<td>Low</td>
</tr>
<tr>
<td>Create Load List</td>
<td>Medium</td>
</tr>
<tr>
<td>Create System Calculations Report</td>
<td>Medium</td>
</tr>
</tbody>
</table>
Numerical averages were transformed to cover a level of need of 'low', 'medium' and 'high'.

Multiattribute utility theory (Pandey, 2011) is then used to develop a measure of utility of each desired product configurator functionality from the perspective of headquarters and its interest in balancing the global needs with the available resources. Combining the priority levels of the different functionalities with the size of LEC and its need for improvement, both found in, Table 3: Comparison of different ABB Excitation System LECs, provides a utility function. This utility function highlights which modifications to the product configurator to prioritize.

\[
Utility = Prior \times N \times Perf
\]

\(N\) is the annual number of orders as a measure of the size of impact of the configurator. A modifier \(Prior\) of 0.5 was given to Low Priority functionalities, 1 for Medium and 1.5 for High. Additionally, a modifier \(Perf\) of 1.5 was given to countries identified as “Performance to be Improved” to emphasize the additional benefit the configurator will have on improving the performance situation. An example of a result is found in the utility graph in Figure 21 below. Note that this utility graph uses the aggregate functionality prioritizations for illustration purposes. A more accurate use would be the individual priorities of the ‘customers’, i.e. the individual LEC sales teams and engineering teams.
Figure 21: Utility Function Example.

It can further be improved by determining an estimate of cost of the modifications and comparing utility to costs. This is illustrated in Figure 22 below. Resources should then be focused on the top left functionalities that combine the maximum utility with the lowest cost. The cost impact of added functionality was not calculated during the internship due to time constraints related to the product configurator development.

Figure 22: Utility/Cost Function
5.8 Section Summary

In this section, a framework for identifying process or tool changes when taking said process or tool into a new overseas subsidiary was presented. The benefits of going through a systematic process of understanding the tool, the process that surrounds it and its new 'customers' are that no crucial elements are missed. This leads to gaining maximum benefit from the tool and reducing any disruption that as-is roll out of the tool would have.
6. Case Study Results: Tool & Process Requirements

During the period of action research at ABB’s ATPE group, two countries, Canada and Brazil, are used as case studies for showcasing the results of the needs elicitation process. It should be noted that the data has been masked for confidentiality reasons.

6.1 Canada

LEC Canada is one of the largest subsidiaries in the ATPE group. It serves the North American market including Canada and the U.S.A. Its Canadian clients are province wide government utilities while its USA clients are more diverse due to wider de-regulation of the power industry in the US. Data was gathered through onsite interviews of the sales, engineering and project management team as well as reviewing LEC Canada documents.

LEC Canada faces the following drivers of requirement changes:

- Retrofit projects for buyers with strong market power
- Different accepted practices for cabinet layouts
- Regulations unique to the North American market: NEMA, ANSI, CSA
- Hedging practices
- Local sourcing
- Local third party players
- Different margin structures

Product:

Of the above, the main impact on the product space is the customization required by the market due to the customers having strong market power. Its product differs from the standard offering due to requirements for North American electronics standards, customer preference for redundancy and locally sourced non-noble parts
Costs:
Canada's methods for costing are similar to the head's office but due to locally sourced parts and local labor costs are different. The country needs to transfer its costs from its current format to the new cost model that permits linking to the configurator. This will require time and support from the PRU as well as getting buy in from LEC Canada that the new cost model works.

Price
Generally, the price calculation of Canada operates on the same principle as the price calculation of Switzerland.

Price Model
It is solved based on both target price and target margin.

Material Costs
Different % are prescribed for material overhead between Canada and Switzerland ("Materialzuschlag"): X% for CA – Y% for CH.

Assembly Costs
Rates for assembly and testing are different and should be adjusted. Importantly, the measure is different. CH measures per day and CA measures per hour. Additionally, assembly specific overhead is not found in the Canadian cost calculation.

Project Engineering Costs:
CH provides more detail in the full cost model.

Commissioning & Training:
The configurator provides less detail than the CA full cost model provides. CA also provides details about the components of the installation supervision (erection), site engineering, commissioning and training costs. It breaks each of them down into prep time, travel time, flight costs, sustenance and site time, attributing a daily rate for each of these. This is used for management approval of costs. To gain the benefits of the configurator (i.e.
reduction of several tools for quotations), it is recommended that the level of detail required for management sign off be included into the configurator pricing calculation.

Additional Costs:

Shipping Costs: Calculated as a % of sales price in CH and calculated as a lump sum based on # of units sold for CA. This should be resolved to permit Canada to enter a lumpsum or to change Canada's process to go to sales price %.

ABB Risk Contingency: Based on a % of Sales price for both. % is X% for CH, but Y% for CA.

Warranties: Canada's warranty calculation includes a standard warranty and an extended warranty if required. Their full cost model adds on X% of the target sales prices for the standard warranty and then an additional Z% to the target sales price for the extended warranty. This contrasts the Swiss warranty model which adds a financial guaranty and only an additional warranty cost above and beyond the standard warranty. The warranty process should be confirmed with Canada.

Escalation: There is a provision for escalation in both full cost models, but the names are different. In Switzerland it is called, "Surcharge for Fixed Price" and in Canada, it is called "Escalation". The calculation for Escalation is also different in the two full cost model

The Swiss formula multiplies the production cost by a % inflation depending on the monthly duration of the contract.

The Canadian formula asks the salesperson to input a number close to the sales price and applies a yearly inflation cost.

The formulas are basically achieving the same goal. As the Swiss formula provides more flexibility and is solving against the actual production costs, it is more precise and should be used.

Hedging: The two full cost models also use different hedging processes. As LEC Canada only works with the USA in an export situation, they have defined a hedging model
that provides them a buffer from fluctuations in the USD-CAD exchange rate. For each price, quoted in USD, they add X% points onto the exchange rate at the time of quotation. In the configurator, there is simply a line space for inputting hedging costs and fixing the exchange rate. These are two very different processes. It is recommended that the hedging process be discussed with Canada upon implementation. It is likely that they will only need to have the ability to input the USD cost and quote it with an appropriately hedged exchange factor.

**Use Factors**

A few use factors need to be considered for Canada's configurator.

The primary adaptation will be to ensure that terminology is accurate for the reality of the Canadian market and gets accurately reflected in all the output documents.

Terminology changes will include imperial to metric changes but also material specification standards changes. Examples of these that are different are wire size, cabinet size, bus bar sizes, paint specs, other standards such as NEMA.

Canada should therefore have the ability to have its base drawings as part of the output. With symbols and terminology that can be different, a database of North American drawings are required for implementation in Canada. Additionally, the technical proposal and commercial proposal should also be considered for modification as this is a key contact point with the local market. Although there is a move to provide a harmonized “quotation process” through the CQP project at ABB, terminology and local requirements such as local terms & conditions will need to be included in the proposals.
6.2 Brazil

LEC Brazil is the second largest subsidiary of the ATPE. It has responsibility for the entire Central and South American market, including Mexico. Data was gathered through interviews with sales and engineering managers from the Brazilian organization.

LEC Brazil serves the South American markets.
It faces the following drivers of localization:
- Strong market competition
- Strong conservatism in new technology adoption
- Unique and complex taxation structure

Brazil also has a few key drivers that help promote the adoption of a configurator:
- Organizational change putting pressure on the sales workforce
- Upcoming separation of sales and engineering forces geographically that increase the need of a knowledge management tool like the configurator

Product:
Brazil faces strong product conservatism. Although the technology has moved forward, the Brazilian market has stayed with older technology, requiring breaker contactors. This is a departure from the product standards defined by the PRU.
Limited information was available to determine the impact of this on the product configurations.
A key point with regards to this product issue is the long term product strategy. There is an optimal point between a localized product and an international standard product. Localization creates a greater amount of product variants and greater complexity that must be managed at both the local LEC scale and ultimately at the PRU level. This complexity is traded off by greater
response to market needs in the local market, ensuring competitiveness. Based on interviews with LEC Brazil employees and PRU team members, this specific issue of contactors seems to be based on customer conservatism and not a strict need of the market such as regulatory needs or machine/grid needs. In such a case, a possible long term strategy would be to engage in an education campaign amongst the customers of LEC Brazil to change their perceptions towards product technology.

**Costs:**

Similarly to Canada, Brazilian costs are different than headquarters for both material and labor and will have to be modified in the configurator database. Taxation was found to be a major issue with implementing costs into a product configuration system in Brazil. Brazil has a complex import/export taxation scheme that is based on both the type of products being imported and the ultimate destination of the product (at both a state and country level). Therefore, for Brazil to accurately calculate their production costs, they need to be able to add import taxes on an item per item basis, depending on the tax levied on the specific category of item. Based on a study of example Brazilian full cost models, the level of detail required for this tax assessment might only need to be that of the noble parts/options/frame separation that already exists in the cost model.

Nonetheless, verifying the costs and implementing the cost model will take extra work for Brazil because of this and will require more attention from the PRU.

**Price**

Brazil similarly to Canada and Switzerland must process several price margins into its final price structure.

The main difference in Brazilian requirements is the sales commission it offers its sales engineers. The sales commission works as a % of sales, with the % level changing as different levels of sales are achieved. Because it becomes part of the final price of the product quoted,
this functionality is a requirement for roll out to Brazil should the sales incentive model be
continued.

Other
The Brazilian full cost model is a sophisticated excel spreadsheet that is used both by sales to
establish costs and prices and by project management to track cash flows and work tasks and
progress. The spreadsheet permits sales and engineering to link information in a way that is
tailored to Brazil. As the original goal of the configurator is to facilitate configuration and reduce
errors in transfer of information, any modifications to the Brazilian process could engender more
work as information would have to transfer between the configurator and the sales/PM
spreadsheet.

6.3 Summary of Tool Requirements

Table 6: Need Statements for Case Studies

<table>
<thead>
<tr>
<th></th>
<th>Brazil</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Impact</strong></td>
<td>• Older technology still seen as technical norm and requested by clients</td>
<td>• Customization due to local client requests is normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• North American Standards</td>
</tr>
<tr>
<td><strong>Cost Impact</strong></td>
<td>• Import/Export taxes impact final costs of parts</td>
<td>• Different labor and parts costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Relatively easy implementation</td>
</tr>
<tr>
<td><strong>Price Impact</strong></td>
<td>• Additional pricing items Specific to Brazil</td>
<td>• Additional pricing items specific to Canada</td>
</tr>
<tr>
<td><strong>Use Factor Impact</strong></td>
<td>• Language requirements (Portuguese)</td>
<td>• Metric to Imperial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Different technical nomenclature</td>
</tr>
</tbody>
</table>

For these two case studies, several unique needs are identified for both countries in almost all
categories of functions. This is an important result from studying the potential roll out. We can
see that moving through a systematic framework of understanding the base product and process to create functional areas, understanding the international subsidiaries through what drives their markets and their individual characteristics (differences) and mapping these together to identify what changes the organization will have to make to the tool or processes permits the overseas implementation manager to develop clear need statements for his/her global roll out. Given additional information about utility and costs, these can then be prioritized to direct development of solutions.
7. Case Study Results: Organizational Analysis and Implementation Plan

In addition to developing the product configurator for the identified needs of the LECs, a further key step is developing an organizational understanding and plan for the roll out to enable smooth change. This section describes an implementation plan developed based on analysis of the organizational systems and culture in the two pilot countries, Canada and Brazil, in comparison to the organizational system and culture in the head office in Switzerland.

7.1 Overview

Time wise, global roll out should include preparation time for converting data for the countries, installation and training, time for testing and trialing and finally a step wise roll out that rapidly builds on its own momentum.

The following timeline in Figure 23 shows an ideal timeline for roll out over the next year.

Figure 23: Roll Out Timeline
7.2 Roll out Steps

7.2.1 Pass Configuration Test Cases and Cost/Price Test Cases

Passing the 5 test configuration cases and passing cost/price test cases are the first required step of global roll out. At date of writing, no fixed plan existed for verifying that the cost and price data included in the configurator was functioning correctly. It is suggested that a series of past projects with related cost calculations be inputted into the configurator to verify that the cost/price/margin combination outputted is outputted correctly. This could be done by the project’s delegate from Sales as a way to involve them again in the project and build their support.

7.2.2 Roll Out to CH

Following successful testing, the next step is roll out in Switzerland, the headquarters. This is not discussed in more detail in this report as the focus is on the global portion of the roll out. Figure 24 shows a generic roll out schedule that could be used at headquarters and replicated at each global subsidiary selected for roll out.

![Figure 24: Example Roll Out Schedule](image-url)
7.2.3 Prepare Pilots for Roll Out

Key Goals: Develop databases and implement necessary software changes for roll out to Canada and Brazil.

Both Canada and Brazil require work ahead of roll out to prepare the cost databases to fit the product configurator's format. Specific tasks will include communicating frame size definitions to the LECs, working with them to develop costs in the required format, defining responsibilities for future maintenance of costs, implementing and then testing the cost databases.

Additionally, the following tasks need to be performed:
- modifying the output documents (drawings, technical specification and commercial specification) for localized content
- setting up user management for the countries
- training key users

It is estimated that this task could take approximately 3 months for each of the countries.

7.2.4 Roll Out to Canada and Brazil

Key Goals: Train all users to configure 6080 systems; collect feedback about the functionality requirements of the LECs

Roll out to Canada and Brazil will involve training and building momentum for the rest of the users in the LECs beyond the key or super-users.

A meeting should be set up with the management of the LEC, including head of Power Electronics, head of Excitation Engineering and head of Excitation Sales to introduce the final product to them and address their concerns about the roll out process.
Individual training sessions would then be carried out by the Area Managers and the key users from the country.

The Area Managers should be set up as contact points to collect issues experienced by the country. Additionally, they could collect information about which functionalities create the greatest benefit and which are potentially slowing down the sales and quotation process. A status for successful roll out should be defined. For example, successful roll out could be defined as when all users have been trained and Canada and Brazil have achieved 5 quotations sent to the client using the product configurator.

7.2.5 Roll Out to BU LECs

Key Goals: Implement key functionality in other BU countries, train users

The main difference between roll out to Canada and Brazil and roll out to the other BU LECs will be the different functionalities and the lack of localization. Essentially, due to the limited order and sales from some of the countries, adapting the configurator to their specific country needs will not provide greater benefits than the cost of doing so.

Based on preliminary questionnaires sent out to each BU LEC, it is recommended that the following countries should take first priority for further roll out and localization be strongly considered: LEC E, LEC D and LEC F. A third stage of roll out could bring the configurator to LEC C and LEC G.
7.3 How

Throughout the roll out process, careful attention should be paid to how the roll out is progressing and how the organization is reacting to it. It is important to remember that the UNIsmart changes the way the LECs set up and control the cost and pricing of the systems they are selling, making it a sensitive change. Additionally, the LECs are in essence also sharing much more information about the products they are selling and their methods of customization, which could be seen as sensitive information.

To understand how the change will affect the organization, a classic method is to use a ‘3 Lens Analysis’ (Carroll, 2001). The ‘3 Lens Analysis’ looks at an organization through:

1. strategic lens: how the organization is structured, who reports to who, etc.
2. political lens: who has political power in the organization, indirect influence, or who is at the center of a network within the organization;
3. cultural lens: what is the culture of the organization, its values and symbols.

and looks to see if how the organization is changing or needs to change for the project to be successful.

Using these lens on ATPE, a few key points come out:

**Strategic:**
ATPE internationally is a strong matrix structure with the LECs reporting both to the PRU and to the head of the country and region. It is thus important to get buy-in from the members of the Product Responsible Unit and of the country management in question.

**Political:**
Priority at ATPE goes to the management of projects for systems that are already sold. In times of tight resources, resources will be given to these projects. This can leave little resources for the long term development projects such as the product configurator project. Although maintaining strong focus on the core business of selling excitation systems is key, the lack of
resources over time can seriously delay the long term projects, sapping morale and adding fuel to the fire of the pessimists. As will be detailed below, showing the department that this project is supported by management and needed is greatly important.

**Cultural:**

The main cultural aspect that needs to be taken into account is actually the different cultures between LEC Canada, LEC Brazil, and headquarters in Switzerland. Based on interviews with the sales and engineering groups in all three locations, observations about the driving cultural aspects were made.

Turgi, through observations and interviews, has a culture of relatively autonomous work, with an ability to rapidly deliver on promised tasks.

LEC Canada, through observation and interviews, tend to prefer to work more as a group and to pass information and questions back and forth in many meetings ahead of a quotation being sent to the client, regardless of whether the system is more or less complex and/or standard. This highlights the importance to stress during roll out to Canada the ability to seamlessly transfer information using the product configurator.

LEC Brazil, through observations and interviews, has a culture where hierarchy is strongly important. Members of the team tend to be concerned about answering questions without first confirming with their supervisors. Additionally, based on available literature, Brazil is seen as having a culture where initial face-to-face contact is important. Due to both of these factors, when the roll out to Brazil starts on the ground, it could be highly valuable to have key members of the Products & Technology team to travel to Brazil to show the importance of the new product tool.

### 7.3.1 Change management process

As we have seen that cultural differences are an important part of a global roll out, the new tool will create a change in the global organizations and should be managed with this in mind.
Organizations can be very resistant to change, which could slow down or decrease the expected returns from implementing the new tool. A well-known model for thinking about how to manage change is by John P. Kotter, a former professor at Harvard Business School. (Kotter & Schlesinger, July-August 2008)

**Kotter's 8 Step Change Model**

1. **Create Urgency:**
   a. Develop a dialogue about why this needs to happen, why now, why their support is needed

2. **Form a Powerful Coalition**
   a. Lead the change, identify the true leaders in your organization, ask them to commit vocally to your project

3. **Create a Vision for Change**
   a. Link the details of change to an overall vision of what we are trying to achieve

4. **Communicate the Vision**
   a. Talk about the project. Give updates regularly that bring it front and center
   b. Address people’s concerns honestly and publically

5. **Remove Obstacles**
   a. Continuously check for barriers, be they people or otherwise, and work to change them from barriers to enablers. Reward people who are helping make the change happen.

6. **Create Short-Term Wins**
   a. Use short term targets to create short term wins

7. **Build on Change**
   a. Keep the focus on the change long term. Do not declare victory too early. Set goals to build on the change.
8. Anchor the Change in the Corporate Culture
   a. Ingrain the change into your corporate culture. Celebrate it, acknowledge it, introduce it as the 'way of doing things' to new staff.

7.3.2 Kotter's Change Model Applied to the UNIsmart Global Roll Out

Taking the above general steps and applying them to the UNIsmart Product Configurator project in its current form and with its current goals, we can translate the above items into a series of actions that can be taken within the ATPE organization:

1. Create Urgency:
   - Talk about the reasons to build the configurator. Highlight the need to be more competitive, the need to respond to NPS ratings.
   - Highlight the opportunity for greater integration of the global operations
   - Answer the question: why now? The configurator is a necessary next step to the Montana/Arosa project, which developed the product structure/modularization. The configurator is the tool that can take advantage of this work to reduce costs and errors and improve knowledge and product management.

2. Form a Powerful Coalition:
   - For the roll out, bring the positional leaders of the global LECs up to date and into the team (e.g. Head of Excitation Systems and Head of Global Operations, Excitation Systems). Then, ask them to communicate their position about the configurator publically to the global organizations.
   - Identify influencers in each global organization in each of the departments affected by the configurator. This should include a champion in the sales team, a champion in the engineering teams and a champion in the project
management team. All three will either use the configurator or have to be happy with the outcome of the configurator.

3. Create A Vision for Change:

- Linked to the concept of urgency, helping people understand the long term vision for the configurator will greatly help them to willingly move forward the plan.
- Communicate Short Term Vision:
  - Emphasize short term reality of Version 1 of the configurator: its benefits, its functions and the reason why Version 1 has been decided as the first step
- Communicate Long Term Vision:
  - Talk about the future versions of the configurator and how these will affect the different groups.

4. Communicate the Vision

- A key goal of communicating the vision is to keep the project and change in the minds of people.
- Communicating it at several forums could help this.
  - For example, Monday morning meetings should have a small mention of progress or the current focus the project is on.
  - Communicate through global medium: product meetings and global operations meetings
- Send email updates to a targeted team:
  - Team composition could include:
    - International Champions such as the Heads of Power Conversion in the LECs
    - Champions with global responsibility such as the Head of Excitation Systems and the Head of Global Operations in Excitation Systems
- Important Users such as leaders of engineering and sales in the LECs
- Get the International champions to promote the project and talk about it positively

5. Remove Obstacles

- Project Team Burnout: Find ways to re-energize your core project team and not suffer from project fatigue. They are closest to the project and need to be the project's greatest advocates.
  - Examples: Associate tasks completed with a sense of achievement and celebrate them
- Turn Negative Into Positive: Listen for any pessimism about the project and try to address immediately

6. Create Short Term Wins

- Celebrate and communicate finishing configurator version RC1. Help people understand the complexity of defining the product logic that makes creating a configurator more than just creating an IT tool. Emphasize that it is a large exercise in defining product knowledge that happens with low frequency in a company (e.g. rewriting the black box).
- Define other items as wins and communicate these 'wins'.
  - Examples:
    - getting the appropriate server resources
    - successfully testing the cost and price calculation in Switzerland
    - training the initial key users in Switzerland
    - first quotation sent with the configurator
    - first order achieved through use of the configurator

7. Build on change

As previously mentioned, build on the longer term vision for the configurator.
- Speak actively of the plan and timelines for the 6800 and for configuration as a model of doing business.
- Create momentum by encouraging improvement ideas to be submitted
- Talk with STECO and project team about how to maintain the configurator and how it affects other aspect of operations

8. Anchor the Change in Corporate Culture

- Investigate how the configurator can affect other departments and changes how they do work.
- Ask the following groups to think about how the configurator impacts their organization:
  - Product Management
  - Engineering
  - Sales
  - Project Management and Manufacturing
  - Supply Chain
  - Service

7.4 Section Summary

In this section, an implementation plan for roll out was developed including timelines, an overview of specific steps in the timeline. Using the Three Lens framework and change management theory by Kotter, specific actions were recommended for enabling a smooth roll out.
8. Limitations

This research only looks at a small part of the problem for rolling out a configurator and thus has several limitations.

As mentioned in section 5.7, a cost vs. utility analysis using the functional priorities, the knowledge of the programmers and the actual cost benefits of implementation at each international subsidiary would enable the implementation manager to decide which country should be a priority, what level of functionality each country should have and what amount of customization should be done for a country.

A global roll out is synonymous with change. This research does not deal with the various needs of the individual countries for change management and does not go in depth to analyze their organizational structure.

In looking at creating customized version of tools or processes as a corporation seeks to expand internationally, structures for maintaining the tools, databases or processes that have to be both local and global at the same time are a vexing question. This question of maintainability is an area of future research.

Finally, implementing product configurators have potential impact and benefits on a much wider swath of the value chain then simply the order acquisition and order fulfillment processes. Research & development, product strategy, supply chain, marketing could all greatly benefit from being approached with product customization in mind. A further case study of interest would be how a company such as ABB in rolling out its configurator could use it to benefit other functions.
9. Conclusion

To conclude, the development of product configurators provide a benefit to multinational industrial good companies by streamlining their sales and engineering process and reducing costs of complexity. Each local subsidiary faces different requirements based on its market and operations. To develop a concept to introduce a new tool globally, the manager responsible for global roll out must focus first at the needs and design requirements that the specific conditions of the market require. Using the framework described in this paper, the manager can pinpoint the specific areas of the tool or process that will require a change. A major challenge of a new global product configurator is found to be the cultural and organizational differences between the headquarters and the local sites. M This study was done as action research within a power electronics industrial goods company. The methods and framework used could easily be applied to industries facing similar challenges in developing tools to help move from low volume high complexity engineer to order systems, to configure to order systems with reduced costs and equal product variety.
Bibliography


Appendix 1: Typical LEC Questionnaire

PERIMETER QUESTIONNAIRE – Detailed

Goal of Questionnaire:

The goal of this questionnaire is to gather information about your LEC related to the implementation of the new Excitation configurator. This information will be used to understand your requirements and include them into the plan for the global roll-out.
Thank you for your help with this information. Please contact me at alicia.lenis@ch.abb.com or at +41 58 589 35 43 if you have any questions.

Questions

General

How many sales staff working on excitation systems?
How many engineering working on excitation systems?
Average amount of quotations written per year for 6080?
Average amount of quotations written per year for 6800?

Market

What percentage of the above numbers are for newbuild and retrofit?

Tools

What CRM (Customer Relationship Management) tool and/or quotation tracking tool are you using?
What Project Management tool do you use?
What ERP software do you use?
What standard PRU documents do you use and which do you not?
What customization do you do on drawings or documents provided by the PRU?

Product architecture

How many systems of your orders do you customize? (Less than 25%, 25%-75%, more than 75%?)
What is the typical extent of your configuration?
  • Cabinet layout
  • Small details
  • Large amount of mechanical work
  • Electronics

Is customization: customer driven or local regulation driven? If the latter, what regulations are these and what typical type of customization do they lead to?

Cost calculation

How is your calculation derived:
Historical data? Bottom up Calculation?
How often is it updated?
What are some aspects of your cost calculation that are pretty unique to your LEC? (e.g. third party manufacturer, unique tax situation,

**Price Calculation**

What aspects of your pricing do you add on that you believe are specific to your markets?
E.g.:  

<table>
<thead>
<tr>
<th>Description of Pricing Impact</th>
<th>Range of amount of pricing impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import Duties</td>
<td>[x% - y%]</td>
</tr>
<tr>
<td>Hedging</td>
<td></td>
</tr>
<tr>
<td>Sales Commission</td>
<td></td>
</tr>
</tbody>
</table>

Other aspects?

**Manufacturing and purchasing process**

Do you currently use the output of ERRSys as an input into your ERP systems?

What part of production do you outsource? Is all final assembly done in-house?

Can you describe your process for building your BOM?

**Potential Users**

Potential users of the configurator will be the Excitation sales team, engineering team, project management team and management.

Can you identify any LEC specific user management requirements?

**Measuring**

Do you track OPQ related to sales, quotation accuracy and/or sales to engineering handoffs?
On average how much time does it take for a sales engineer in your organization to create an offer?

----Continues on next page-----

86
Prioritizing Functionality

The configurator will over time have amongst others the functionalities described in the table below

Priority:
On a scale of 1-5, with 1 as lowest priority and 5 as highest priority, please rate the following functionality based on how much help (e.g. making the task easier or faster, reducing mistakes, etc.) it would be to your organization to have this as part of a configurator.

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate system parameters and noble parts for standard configuration (as defined by configuration table and including standard options)</td>
<td>Base functionality</td>
</tr>
<tr>
<td>Storage and easy transfer of data about configuration from sales to engineering</td>
<td>Base functionality</td>
</tr>
<tr>
<td>Add in non-standard options</td>
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<tr>
<td>Calculate cost of system</td>
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<tr>
<td>Calculate price of system</td>
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<tr>
<td>Determine available spare parts and add to quotation</td>
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<tr>
<td>Automatically create required transformer spec</td>
<td></td>
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<tr>
<td>Create System Losses Report based on configuration</td>
<td></td>
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<tr>
<td>Create Braking Transformer Spec</td>
<td></td>
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<tr>
<td>Create Load List</td>
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<tr>
<td>Create System Calculations Report</td>
<td></td>
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<tr>
<td>Automatically create Technical Proposal</td>
<td></td>
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<tr>
<td>Automatically create Commercial Proposal</td>
<td></td>
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<tr>
<td>Output documents associated with chosen configuration such as single line diagram, layout, and user manual</td>
<td></td>
</tr>
<tr>
<td>Interface with ERP software through Manufacturing Key (a.k.a Config Code)</td>
<td></td>
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<tr>
<td>Interface with other software (E3, service database, etc.)</td>
<td></td>
</tr>
<tr>
<td>Require user to go through the required review and approval process for the system in question</td>
<td></td>
</tr>
</tbody>
</table>

Other:

Please add any additional comments here you think would be useful for us to know regarding the product configurator in your organization. We are particularly interested in aspects of your operations that are complex and unique to your LEC.