'Process improvement of the change processes within the global Sensata Technologies organization'

Communication interface between the Netherlands and China

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PREFACE

In order to finish my bachelor study Business Administration at the University of Twente in Enschede I have ended up at the last phase, which is writing a bachelor thesis on a research assignment. A copy is lying in front of you.

Because of my interests in being and studying abroad I contacted Gerrit Borghuis, who is Electrical Protection Engineering Manager at Sensata Technologies in China (Changzhou). Together with two of his colleagues he came up with an assignment on reviewing the business process of change management, and understanding the bottlenecks in this process. I accepted the challenge and completed the project with some advice based on facts based on findings. The Production Part Approval Process and 8D procedures within Sensata Technologies will be reviewed alike. Before, all these things were managed locally in Almelo. As Sensata became a more globalised organization, activities had to be split and activities and responsibilities are settled in a new, less experienced organization. The aim for Sensata is to anchor the processes tasks and responsibilities clearly and unambiguously to facilitate continuity and improvement. I chose to participate in this project because of my interest in innovation, and my follow up master in Entrepreneurship and Innovation Management.

The assignment is supervised by Ir. A.J.H van der Kuij, Ing. G. Borghuis and Ir. Ing. W. Kleissen from Sensata Technologies, and Dr. R. Harms and Drs. J. Veldman from the University of Twente. I would like to thank them all for their ideas and support.

Enschede, 9 september 2009

Chantal G. S. Dekker

VOORWOORD

Voordat ik mijn bachelorstudie Bedrijfswetenschappen aan de Universiteit Twente in Enschede af kan ronden is er nog maar een laatste stap die genomen moet worden, het schrijven van bachelorscriptie over een onderzoeksopdracht. Een kopie van deze scriptie ligt op dit moment voor u.

Vanwege mijn interesses in het studeren in het buitenland, nam ik contact op met Gerrit Borghuis. Hij is Engineering Manager voor de afdeling Electrical Protection van Sensata Technologies in China (Changzhou). Tezamen met twee van zijn Nederlandse collega's in Almelo kwam hij met de opdracht om het bedrijfsproces van verandermanagement te bekijken. Hierbij is er tevens het doel om de bottlenecks van dit proces te begrijpen. Voor het afronden van het project zullen er dan ook adviezen worden uitgebracht voor procesverbetering die voornamelijk zijn gebaseerd op de feiten. Tegelijkertijd worden de Production Part Approval Process (PPAP) en 8D (klanten klachten) processen binnen Sensata Technologies op de zelfde manier geanalyseerd. Voorheen werden al deze processen lokaal in Almelo gemanaged. Maar als een meer geglobaliseerde organisatie, zijn de activiteiten gesplitst en zijn de verantwoordelijkheden verplaatst naar een relatief gezien nieuwe en onervaren organisatie. Het doel van Sensata is om de processen en bijbehorende taken en verantwoordelijkheden te verankeren, om zodoende meer duidelijkheid en minder ambiguïteit te creëren, om continuïteit en vooruitgang te faciliteren.

Ik heb ervoor gekozen om in dit project te participeren, vanwege mijn interesse voor innovatie en mijn toekomstige master in Innovatiemanagement. Het project is begeleid door Dr. R. Harms and Drs. J. Veldman vanuit de Universiteit Twente en Ir. A.J.H van der Kuij, Ing. G. Borghuis and Ir. Ing. W. Kleissen vanuit Sensata Technologies. Ik wil hen allen graag bedanken voor hun bijdrage aan dit project.

Enschede, 9 september 2009

Chantal G. S. Dekker

MANAGEMENT SUMMARY

This is a report of the research after the change management process of Sensata Technologies. Reason for this study is the communication problems that have become into existence after moving the product design, production, and supplies of the Electrical Protection products from Almelo to Changzhou. Sensata Technologies has procedures for all of her business processes, and in that way as well for change management. That is why the assignment was mainly meant to map the process in accordance with the existing procedures, as well to map the current process, and to find the bottlenecks in communication. The mean question that is answered in this report is: '*What does the process of change management at the moment look like, and how can this process be improved when looking at the communication streams?*'

Three steps have been taken two answer this question. First, the process as it should be, is mapped according Sensata's Change Management Procedure, which is set up after ISO and TS quality requirements. Secondly, the current Change Management processes have been described, and actual communication streams during the process have been described and mapped. Finally, the communication problems during the change have been described, using the outcomes of depth-interviews with Change team members. To collect all the necessary information I have been analyzing the process, and interviewed the participants in the process.

With the collected information in hands I should be able to give opportunities to improve the change management processes. What I found, were indeed a lot of communication issues and that they mostly have to do with the physical distance, cultural and lingual matters.

Although more important is that I found, that most of the communication problems are caused by other upper laying issues. These issues are to be divided in five categories: process, organization, knowledge measurement, (use of) technology, and performance measurement. For all of these categories points of improvements have been given, of which the technology part also covers points of improvement for communication.

SAMENVATTING

Dit rapport geeft de resultaten weer van een onderzoek naar de verandermanagement processen van Sensata Technologies. Reden voor deze studie is het communicatieprobleem die is ontstaan bij het verandermanagement proces, maar ook bij andere bedrijfsprocessen. Deze problemen zijn ontstaan toen het product design, de productie en leveranciers voor de Electrical Protection producten vanuit Almelo zijn verplaatst naar Changzhou. Sensata Technologies heeft voor al haar bedrijfsprocessen procedures en zo ook voor verandermanagement. Vanuit dat punt bezien was deze opdracht voornamelijk bedoeld om het veranderproces conform de procedures in kaart te brengen, als ook het huidige proces in kaart te brengen en om bottlenecks in de communicatie te vinden. De hoofdvraag die in dit rapport beantwoordt wordt is: '*Hoe ziet het proces van verandermanagement er op dit moment uit en hoe kan dit proces verbeterd worden met betrekking tot de communicatiestromen?*'

Om deze vraag te kunnen beantwoorden zijn er drie belangrijke stappen genomen. In de eerste plaats is het veranderproces in kaart gebracht zoals deze zou moeten zijn volgens Sensata's Change Management Procedure, welke is opgezet naar ISO en TS kwaliteitseisen. Daarna is het huidige verandermanagement proces in kaart gebracht en beschreven, ook zijn de bijbehorende communicatiestromen beschreven. Uiteindelijk zijn de communicatieproblemen die tijdens het verandermanagement proces optreden onderzocht, door middel van het gebruik van diepte interviews met teamleden uit het veranderteam. Om alle noodzakelijke informatie te vergaren is er gebruik gemaakt van diepte interviews en zijn er analyses gemaakt van de bestaande procedures en tools.

Door gebruik te maken van de informatie die daarbij vrij zou komen zou ik mogelijkheden moeten kunnen aangeven om het verandermanagement proces te verbeteren. Voornamelijk door de resultaten van de interviews kwam ik er achter dat er inderdaad een heel aantal communicatie problemen zijn en dat deze voornamelijk in de afstand tussen de verschillende teamleden, en culturele en talige oorzaken kunnen worden gevonden.

Maar wat belangrijker is, is dat de meeste communicatieproblemen voornamelijk voortkomen en/of in ieder geval de problemen versterken, uit bovenliggende oorzaken, welke voornamelijk van organisatorische aard zijn. Deze zaken kunnen worden onderverdeeld in vijf categorieën, namelijk proces, organisatie (omgeving), kennismanagement, (gebruik van) technologie en het meten van prestaties. Omdat deze punten belangrijker zijn dan de alleen communicatieproblemen, zijn ook hierbij verbeterpunten gegeven. Het punt technologie dekt dan tevens de lading communicatie.

CONTENTS

1. GLOSSARY

List of abbreviations

CS	Customer service
CQE	Customer quality engineer
DE	Design engineer
FAE	Field application engineer
FSE	Field sales engineer
MFG	Manufacturing
MKTG	Marketing
PE	Process engineer
PL	Planning
PM	Project manager/coordinator
PRO	Procurement (Purchase)
SQE	Supplier quality engineer
QRA	Quality and reliability assurance (Quality engineer)

List of definitions

8D	Problem solving process that is started when there is a customer complaint. The 8D Process is a problem solving method for product and process improvement. It is structured into 8 steps (the D's) and emphasizes team. This is often required in automotive industries.
BC	Business Center
CAD	Customer approval documentation:
CJF	Change Justification Form:
CM	Change Management:
CM Matrix	Change Management Matrix: technical support system for executing Change Management. This system enables sharing of change management features, like proposals for change management, uploading important files, sending e-mails when continuing to the next phase etc.
Communication interface	The points of interconnection between the Almelo and the Changzhou, Baoying or Shanghai organization.

CRB   Change Review Board: board of managers within Sensata that has to evaluate the impact of the change using the submitted change justification form (CJF). This board can approve, hold or reject the change.

ECN   Engineering Change Notice: simplified change management process, in most of the times only used in case of small text errors. ECN is also used in CM to update drawings.

FMEA   Failure Mode and Effect Analyses: methodology for analyzing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effect on the operation of the product, and identify actions to mitigate the failures.

GCM   Global Change Management: all changes which are identified as product, process or supplier-related that generally impact the customer requirements of fit, form, function, performance, durability, and/or capacity are to be coordinated and managed.

GNDP   Global New Product Development: the development of a new product platform. Change Management uses the shortened version of the NPD Checklist.

NCS   New Component Sourcing: This is one of the components (tools) of CM that is used for new components and/or new supplier sources.

OEM   Original Equipment Manufacturer. A producer that provides a product to its customers, who proceed to modify or bundle it before distributing it to their customers.

Oracle   Business planning system of Sensata

OTP   Operational Transfer Price: refers to the pricing of contributions transferred *within* an organization, used by Sensata to analyze the financial impact of a change.

PPD   Product Parent Documentation: part of the organization responsible for the design of products

PPAP   Production Part Approval Process: a process used in the automotive supply chain to establish confidence in component suppliers and their production processes, by demonstrating that: "....all customer engineering design record and specification requirements are properly understood by the supplier and that the process has the potential to produce product consistently meeting these requirements during an actual production run at the quoted production rate."

RA   Risk assessment / analyses, with parts like FMEA's or business risks.

RASCI   A model with a responsibility assignment methodology that is primarily used in project management particularly for identifying roles and responsibilities during the project implementation or the change management. Responsibilities are divided in Responsible, Accountable, Supportive, Consulted, and Informed.

2. INTRODUCTION

2.1 PROBLEM DESCRIPTION

In the first meeting with my supervisors from Sensata Technologies (after this: Sensata) the necessity for improving response time and quality in business processes, like change management, customer complaints (8D) and Product Part Approval Processes (PPAP), was expressed. Especially the communication between sites in different locations around the world is seen as a bottleneck. In the past these processes were managed under one local 'roof'. Customer needs identification, product design, production, and supplies were all completely managed in Almelo. Also the quality procedures according to ISO9001 (ISO14001) and TS16949 standards, important for Sensata for doing business, were managed in Almelo.

The change process has now become global, the customer relations and business plans are set up in Almelo, and the drawing of products and production is done in the Changzhou organization. The Changzhou organization is therefore responsible for some of the quality procedures. The communication lines between Almelo and Changzhou are thin due to different causes, for example language barriers, culture differences, resource constraints and level of expertise. However this communication is judged to be essential by Sensata in order to guide the process in the rapid changing business environment, avoiding big dips in business performance and keeping up high performance in the market place.

This assignment is mainly focused on the change processes and the communication interface between the Almelo and Changzhou organizations. Aligned to the change process, also the 8D and PPAP processes will be observed and mapped. The responsibilities, deliverables and expectations of both organizations seem to be unclear. That is why the business processes needs to be mapped, to improve the efficiency and the response quality and time internally (per location) and externally (over more locations, including suppliers and customers).

For Sensata changes are to be found in a broad category: all changes which are identified as product, process or supplier-related that generally impact the customer requirements of fit, form, function, performance, durability, and/or capacity are to be coordinated and managed. When it comes to change management there are also a lot of functions that have to be involved. There are a design engineer, quality engineer, process engineer, supplier quality engineer, customer service, planner, purchaser, marketer, manufacturing engineer, and sales engineer involved when it comes to a big change. All these functions have to communicate and work together in order the reach the best change results.

2.2 PRE-STORY

When changes had to be managed in one location (Almelo) this was relatively easy, when comparing this to the management of this same process over more locations. In Almelo, the customer brought in a new request for a change of an existing product, the design engineer made the drawing and went to the manufacturing lines (only a couple of meters away) to discuss with the process engineer or line operator how to realize the change. Samples could be made fast and easily, and all problems that appeared were solved directly in the lines. This was a fast communication process, with the biggest disadvantage that the knowledge about these changes were only 'stored' in the heads of the employees (see also figure 1).

In the middle of 2006 the manufacturing lines have been moved from Almelo to Hungary. For that reason the responsibility for process engineering and manufacturing moved to Hungary. Some of the employees in Almelo got fired, some are now working in a new function. Of course, some of the employees who were dismissed, took some important knowledge with them, since

most information was in the heads of the employees. With the movement of the manufacturing lines, the change management processes became harder. The design engineers were not able anymore to simply walk to the production lines to solve some problems if they appeared. The importance of storing knowledge came into sight, and some small communication issues were already visible. It was clear that managing everything in one location is a lot easier.

A couple of years after that, Sensata had to make the decision to make another 'line move' to China. In first place there was decided to do this in a slower and more structured way, but with sights on the economic crisis the production lines had to be moved quickly. During the second half of 2008, and the first half of 2009 the transfer took place, so since the beginning of this year Sensata Electrical Protection does not have production lines in Europe anymore. This was a way to reduce costs, and because of decreasing demands from customers an effective time to do so, since Sensata was still able to assemble what was ordered. With this second move there were more things that had to be changed. Besides the decrease in responsibility for the process and manufacturing, also responsibility for the design of the products had to be moved to China. For the Chinese location this meant that they gained these new responsibilities in a relatively small amount of time, and there was the need to hire and train a lot of new engineers. For the European organization this meant that the responsibility for design and quality engineering disappeared. Former design engineers became a field application engineer, which means that there role is now more related towards customers' application, to fulfill their needs at a high level. They are the internal voice of the customer (technical). They have to make the decision on conception (functional & constraints.
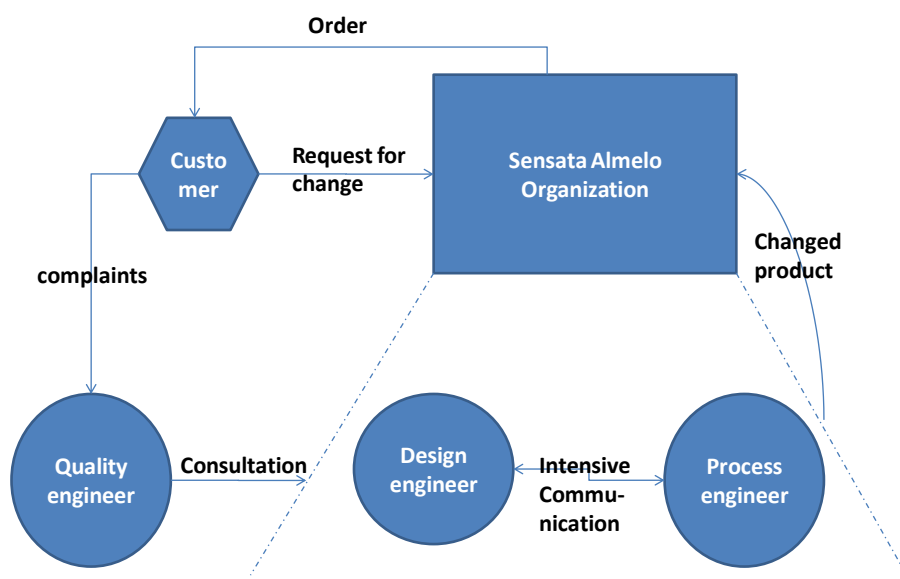
Figure 1: Managing changes in one location

With this last line move all business processes were more difficult to manage. Most of these difficulties are due to the fact that it was not possible anymore to just walk through the building, to see what was going on and what was going wrong. Next to this, there is the fact that the knowledge of products or changes in these products, processes or suppliers, were mostly not to be found in a computer database. Because of that, trainings mostly had to be given based on information that was left in the heads of the present employees in Almelo and Hungary. The engineers in China who had to take over the new responsibilities went over to the locations in Almelo and Hungary to get the training. After that only some engineers from Hungary went over

to China to control the production lines, and to provide some on-the-job training. At the moment all the employees in Hungary are already dismissed. For all the employees in Europe and China there are travel restrictions, and after the line moves too less people from the Almelo organization has been in China to see how the lines are working.

2.3 WHY CHANGE MANAGEMENT?

People may ask, why an organization wants to change, if it is such a difficult and time consuming activity. The reasons for Change Management (CM) can come from different causes. Sometimes changes are required when looking at the ISO-9001 and automotive ISO/TS 16949 quality requirements, that have to be followed in the industry Sensata is operating:
- change of a part depending on altered function or production requirements
- change in the application of a part
- introduction of a new part
- replacement of a part
- withdrawal of a part
- correction of errors on a document
- bringing an old document up-to-date

But in most of the times, the change management process within Sensata, is needed because of a product change due to the following reasons:
- changes in the customer specification
- faults in the interpretation of customer demands into technical requirements
- difficulties in parts fabrication or assembly
- weaknesses in the product identified during prototype
- quality problems with some subsystem or component
- development for future product revisions

In short, there are technical and commercial reasons to change products, processes and/or suppliers from time to time. In order to reduce the amount of changes, Sensata treats changes that do not hit the above conditions with a simplified process, named Engineering Change Notice (ECN). When a whole new product is set up, Sensata uses a New Product Development (NPD) process, which is also created along the ISO quality standards. This report is only about Change Management, not about Engineering Change Notice or New Product Development. But, ECN is always part of the Change Management Procedure.

Besides the difficulties that Sensata has due to the line moves from Europe to China, the Change Management process, and the Change Management process in particular, is in literature associated with some difficulties. In the first place there are *many departments affected* when documents have to be changed. To perform the change in the best way possible and fulfill the wishes of all parties, the process should be performed in a cross-functional environment. The difficulty in that is mostly that different departments have different goals (Malmqvist & Pikosz, 1998). For Sensata this becomes clear when looking at differences between Europe and China. In Europe the different departments are totally focused on customer satisfaction, in China everyone is paid off for the volume in products. This means that Europe is really change centered, were the Chinese organization does not like to change at all.

A second obstacle is that the Engineering Change Management processes are related to *long lead times*, caused by the following factors: the process requires extensive document management, and the process requires meetings with all affected functions, to satisfy all departments (Malmqvist & Pikosz, 1998). Also on this point we can find that especially the meetings are difficult, since there are travel restrictions, and time differences.

As a third difficulty there is a *long learning time* for new employees, since the change process can be very complex. This may cause a lack of knowledge and understanding, why employees might be unwilling to use the process.

The last thing that might bother the process is the nature of Engineering Change Management, which is also a *source of irritation*. This is because when the change is started, the When starting

an EC process, it means that designers have to redesign something they have already done before. The design engineer might feel accused of having done something wrong, which is something that can slow down the process (Malmqvist & Pikosz, 1998).

2.4 BACKGROUND

Sensata has two business units: Sensors Products and Control Products. The Control Products unit consists of Electrical Protection and some portfolios obtained during recent acquisitions. The assignment is carried out in the Electrical Protection part of the Sensata business. Sensata is a company with business centers, production locations and sales offices around the globe. The three business centers are situated in Attleboro (Headquarters near Boston, U.S.), Japan (covering the Asian market) and Almelo (taking care mainly for European market). Due to the rapid evolution of business in China, Sensata has manufacturing sites in Baoying and Changzhou. The latter location is becoming responsible for Product Parent Documentation (PPD), drafting and probably growing out towards a business center role as well.

The Electrical Protection portfolio contains mainly products having a sensing and switching bimetal part to control temperature and/or avoid fire in applications. The in the business well known 'Klixon' brand name, is referring to the rapid switch off and on of electricity. This also called snap function is needed to obtain high quality products. Switch of electricity can be initiated by over-temperature (thermostat), over-current (circuit breaker) or an overload of temperature in combination with current (motor protector). Sensata thermostats, circuit breakers and motor protectors can be found in a wide range of applications like household appliances (compressors of refrigerators, coffeemakers …), automotive electric motors (wiper motors, sun roofs, window lift motors …) and high end aerospace applications. Sensata customer portfolio contains for example Askoll (pumps), ACC (refrigerators), Danfoss (compressors) and Bosch (automotive electric motors).

Good communication between Europe and China is essential to sustain and to grow the European business of Sensata, during and after the transition (of manufacturing lines and PPD responsibilities) period. To do so ISO-9001 and automotive ISO/TS 16949 quality procedures, and responsibilities for the process and process steps have to be clear. Implementing this will positively impact response quality and time, resulting in high quality offerings to Sensata's customers.

2.5 GOAL & ACCCOUNTABILITY

The assignment is focused as well on business processes and the communication interface between China and Almelo, as on the responsibilities and the deliverables of both organizations to improve the efficiency and the response quality and time internally and externally. The business process which will be reviewed is Change Management. Sensata Technologies will map the PPAP and 8D processes by herself parallel to the mapping of the change process. The interface that will be reviewed during the assignment: Asia (Changzhou, Baoying, Shanghai) – Europe (Almelo). Out of scope are the interfaces Asia – Attleboro and Europe – Attleboro.
The relevance of this topic can be summarized in four major points:
1. The general importance and influence of change management within distributed organizations.
2. The importance for Sensata Technologies to have a clear procedure documentation of the process of change management within her organization.
3. The literature on change management can be strengthened with the outcomes of the research.
4. The findings of this research may give some new insights on change management, and the improvement of change management business processes.

3. PROBLEM DEFINITION & RESEARCH QUESTIONS

In the introduction the following problem definition is outlined: The processes of implementing changes for European products were all managed in Almelo. Based on experience and expertise built over the years, the Almelo organization was capable to cover gaps in procedures. These days, due to the split of activities and responsibilities to a new, less experienced organization; deliverables, responsibilities and expectations of both organizations are unclear. It is judged essential by the Sensata organization that processes, tasks and responsibilities are unambiguously anchored for continuity and improvement. According to my supervisors at Sensata most problems are to be found at the communication interface, which is why the assignment has to be focused on the communication streams.

From the above given problem definition the following Main Question (MQ) can be derived:

MQ: What does the process of change management at the moment look like, and how can this process be improved when looking at the communication streams?

This research question can be split up in the next three sub questions (SQ), in order to make it easier to give an answer to the main question:

SQ1: *What is the process of change according to the standard change procedures of the global Sensata Technologies organization?*

SQ2: *What does the change management process at this moment look like?*

SQ3: *What are the communication problems in the current change processes?*

Changes will in this report seen as followed:

- *Change*: All changes which are identified as product, process or supplier-related that generally impact the customer requirements of fit, form, function, performance, durability, and/or capacity are to be coordinated and managed. Within Sensata technologies there is given a kind of ranking to the different changes:

- *Examples of changes that belong to change management and so are of importance for this research*:

- Material
- Supplier (source, facility, process)
- Equipment/ tooling modification
- -Manufacturing line layout
- Process flow
- Test/inspection method
- New equipment/ tooling
- Validation of alternative cell (cell flexibility)
- Significant changes to customer drawing
- Error/ mistake proofing installation

4. THEORETICAL FRAMEWORK

This research is primarily focused on mapping the business process of change management, with focus on the communication streams. Besides the observation of what is done at the moment, the research is also focused on giving advice on how to improve the current processes. That is why this framework starts with an introduction on how business processes can be analyzed (4.1). Continued by an explanation for which technique is chosen, and how this technique can be applied to the assignment. After that some general information on change management, specific will be given (4.2). That will be followed by an outline of difficulties with distributed teams (4.3), and finally there is a brainstorm on how to apply all these theories (4.4).

4.1 BUSINESS PROCESS ANALYSES

There are four different ways in which processes can be analyzed (Biazzo 2000) (see appendix 1): (1) Action analysis; (2) Process mapping; (3) Coordination analysis; and (4) Social grammar analysis. The search for organization knowledge can be conducted from the outside and inside. When gathering data using information generated by the organization the research is done from the outside. In case that the researcher becomes part of the organization; which is characterized by the assumption that organizational phenomena must be understood through immersion within the flow of proceedings, research is conducted from the inside. There are two alternative strategies, representing the inside and outside approaches, for analyzing business processes: (1) rational reconstruction strategy; and (2) pragmatic reconstruction strategy. Both strategies include two forms of analyzing the current situation of business processes.

One of the forms of rational reconstruction of business processes is process mapping, which can help trying to understand a process by creating a map. In this map the relationships between activities, employees, information and objects involved are graphically drawn in a model. Process mapping methods are widely recognized for the reason that such models can offer useful, and relatively inexpensive, descriptions which can help towards improving and re-designing business processes (Colquhoun et al., 1996; In: Biazzo, 2000).
There are different kind of techniques for process mapping in existence, but independent of the technique there are couple of phases that always have to be proceeded: (see, for example Hunt, 1996):
- Define the boundaries and of the customers of the process, of the main inputs and outputs and of the actors involved in the workflow;
- Interview those who are responsible for the various activities within the process and study of available documentation;
- Create the model on the basis of the information acquired and step by step revision of the model following the logic of the `author-reader' cycle.
Creating a process map of the change management process within Sensata will help understanding the desired process and actual processes of change.

The other form to analyze business processes is the coordination analyses. As Malone (1988) recognized the activities of separate actors within a business process can be coordinated, where all communication and decision making tasks can be scaled as coordination tasks. When using this form for analyzing the change management process, the research will have to consist of identifying the actors involved, interviewing the individuals and examining documents that describe standard operating procedures in order to discover the following items:
(1) What kind of information the actors receive;
(2) From whom they receive it;
(3) How they receive it;
(4) How they process the different kinds of information; and

(5) To whom they sent messages as a result (Crowston, 1997; In Biazzo, 2000, p. 106).

The forms of the pragmatic reconstruction of business processes are social grammar analyses and action analyses. Pragmatic is the opposite of rational, where the pragmatic approach tries to go beyond the traditional idea of structure as a set of formal and abstract relations which restrict action. Where the rational analyses might make processes look like they are independent of human actions and interpretations, the pragmatic reconstruction seeks to subjectivist theoretical positions. The analysis of action needs to be the precursor to a further research after the sequence of actions, social grammars. The foundation of action analysis lies in the concept of `move' as defined by Pentland (1992; In Biazzo, 2000), which is a socially relevant activity of an actor. 'Move' is by other authors also described as 'action', that is also how we will call this in this report.

Action analysis means the identification of the actions within a given process and a thoroughly exploration of the structural conditions within which the individual actions take place. In that way, business processes are studied through explorations of the ``elementary cells''. This offers the idea of a conception of processes as a network of actions, as can be seen in appendix 2. When analyzing such a network the researcher should be questioning why some sequences appear, and others don't. Besides there should be given a thought to what dimensions create the set of sequences, and what effects they have. To make this analysis of the sequence of actions, the following points can be followed:
(1) Identify the lexicon that is of the set of `actions' - of the process being studied;
(2) Observe a large enough number of `instances';
(3) Explore the basic rules that underlie the existence of the varieties of assemblies found in practice.

Within the field of pragmatic reconstruction strategy, grammatical analysis shifts the emphasis of study from the actor to the system, that is, to the set of structural factors that regulate the assemblies of actions carried out by the individual actors (Biazzo, 2000, p. 109-110). Looking at the change management process at this way, might give another approach since it is more likely that Sensata usually will be more looking at the procedures themselves.

Process mapping

Process mapping is one of the above mentioned ways to analyze a business process. This is an important approach for this research, since a lot of Change Management process steps are unclear at the moment, and using this method can help understanding the process. There are several ways of process mapping and in this research there is a mix of two approaches used. Before process maps can be drawn information is be derived on how process maps can be made and how information of the business processes can be gathered.

Mapping a process can provide tools and a verified methodology for mapping the 'As-Is'business process, and is an option to design a 'To-Be' roadmap for reengineering business processes / organizations Hunt (1996, p. 1). It is a way to ensure that a reengineering team can understand and improve business processes. To be able to identify and to map the current process flow of change management process mapping will be used, and process mapping will also be used for advice on reengineering the change management process. The 'As-Is' and 'To-Be' process maps that have to be created will be made using the 11 key process mapping steps of Hunt (1996, p. 25-26):
1. Determine if you need a process roadmap (there are a couple of reasons why you would want to use a process roadmap: improve customer satisfaction, process understanding, quality goals, adoption of multifunctional teams, or continue to improve the process)
2. Assess your need to improve or reengineer your business processes
3. Define the role of process mapping in your reengineering strategy
4. Determine if you really understand your business processes

5. Understand the value of process mapping
6. Apply the process mapping methodology in your own business
7. Create a process mapping team
8. Find the right process mapping tools
9. Collect process map information and process details via focused interviews
10. Implementation of process mapping
11. Just 'Change it!'

'A process map consists of graphic hierarchical diagrams, supporting text, and a glossary of common terms and process definitions, all cross-referenced to one another. The major output of the process map is a workflow diagram (Hunt, 1996, p. 15).' Activities will be shown as boxes and arrows will represent data and interfaces. When the steps of Hunt will be followed this will lead to a current and a 'To-Be' map of the business process, in case of Sensata this will be a current map of the change management process and a 'To-Be' map of the procedures of that same process.

It is proven that many people failed in process understanding and improvement without a solid methodology for understanding the processes. A solution might be found in detail process charts that can provide the level of understanding that is essential for effective analysis (Graham, 2007a). These process charts provide the perfect foundation for improvement of business processes, and they are as well excellent training tools if they include enough detail to support common sense decisions (Graham, 2004b). The best results can be derived when using process maps that are used for improving effectiveness and efficiency of the business processes. Reasons for choosing such an improving project might be the generation of costly errors, long lead times, or audit fails etc. (Graham, 2004b).' According to Graham (2007a) the best process maps can be defined by asking six questions two all the involved people: what, why, when, how, where and who? He says when the why-question cannot be answered, that the recommendation should be that the process step should be eliminated. When all the questions are asked the final question can be addressed; "How is it done and why is it done that way?" (Graham, 2007a). What might help me answering sub questions two and three, finding the current deliverables and bottlenecks.

Both, Hunt and Graham focus on several forms flowcharting, with from basic flowcharting promoted by IBM in the 60s till IDEF (Hunt, 1996, p. 96-118; Graham, 2007b). Hunt promotes IDEF process mapping methodologies and Graham promotes Detail Process Charting methodology developed by Graham in the 1940s, with totally different symbols (Graham, 2007b). A combination of both methods is used to map the process as it should be according to the Global Change Management Procedure.

4.2 CHANGE MANAGEMENT

In this research there are lots of different changes that belong to the Change Management Process. We are talking about changes in products, processes or suppliers. Further, does this report focus on communication problems, which is why we also take a look at the people's side of change. Sensata's goal is in the end making benefits from her processes, what leads us to 'Best-in-Class' performances.

Change Management: the people side of change

Change management has grown out as a big body of knowledge, which is why there is a growing confusion about what change management really is. This can particularly bother business leaders in creating a clear picture of change management for their employees.

Understanding why changes are important for the organization, will help employees better at how to manage the change. Therefore it should be clear that Change Management is not a matter

of simply following steps. Given that no two changes are exactly alike, following a recipe for change management is not enough. For Sensata this means that only following the checklist for Global Change Management will not make a success of every change. There should be considered a specific approach in every situation. If employees do not understand why they are changing the products, processes, or suppliers; there is a big chance that the change will fail even when the standard procedures and processes are followed. Research with hundreds of project teams has shown that a "one size fits all" approach is not sufficient. To be effective at leading change, an organization will need to customize and scale her change management efforts based on the unique characteristics of the change (Creasey & Hiatt, 2003, p.14).

When it comes to change management there are some key principles; when the change Program Manager understands and applies these principles, it will be easier to apply the techniques and processes that belong to the specific change situation. These concepts are:
- Change agents must be conscious of both a sender's meaning and a receiver's interpretation.
- Employee resistance is the norm, not the exception.
- Visible and active sponsorship is not only desirable but necessary for success.
- Value systems and the culture of the organization have a direct impact on how employees react to change.
- The size and type of the change determines how much and what kind of change management is needed. Just because a change is small does not mean that change management is not required.
- The "right" answer is not enough to successfully implement change.
- Employees go through the change process in stages and go through these stages as individuals.

The employees' perspective, individual change management, and the managers' perspective, organizational change management, are two change management approaches to put these key principles into practice. The first approach, individual change management, is frequently overlooked by change management models. The approach consists of tools and processes that change leaders use with their employees to manage individual actions through change. This employee-oriented component of change management is the critical ingredient that allows a project team to:
1. Help employees through the change process
2. Create a feedback loop to business leaders and identify points of resistance
3. Diagnose gaps in communications and training
4. Implement corrective action (Creasey & Hiatt, 2003, p.40).

The managers' perspective, organizational change management, includes processes and tools for managing the people side of the change at an organizational level. These tools include a structured approach that can be used to effectively transition teams or organizations through change (Creasey & Hiatt, 2003, p. 53).

When both perspectives on change management are combined and understood, the tools provide a framework for managing the people side of change. The model that is proposed by Creasy and Hiatt (2003) describes five blocks that can help organizations to successfully realize change at the individual level. Awareness, Desire, Knowledge, Ability and Reinforcement. Predecessors also apply a linear, staged model for implementing change, for example Lewin (1951): Unfreeze-Change-Refreeze.

Best performance

To achieve the best performance and improve decision-making in change management there are also four other fundamentals that have to be addressed:
1. Get the right supporting product data to the right people in a timely manner

2. Formally analyze the impact of change on the product across the lifecycle and the supply chain, including technical and commercial considerations
3. Collaborate visually about product change with visualization and virtual meeting technology
4. Develop and execute formal change implementation plans to put the decision into action (Boucher & Brown, 2007, p.3).

As other organizations, Sensata has to recognize that change management in product development and engineering can drive top-line benefits, and that developing processes can improve speed to market. Good change management has always been a fundamental process, but in today's market it has even more importance – it is now being viewed as a competitive tool to increase product profitability through improved market responsiveness in addition to improving efficiency (Boucher & Brown, 2007). Especially the conditions of market conditions manufacturing companies like Sensata The market conditions that manufacturing companies are leading to high demands in terms of flexibility in production, and with that to engineering changes in production.

Quality issues and changing market requirements are also driving a focus on change. Once a product has been released, companies still need to get product updates to market quickly. Change management can help initial product launch, and also ongoing product management. Quality and product improvement changes seem to be critical to market success and profitability.

Managing changes is getting more difficult than before, because of increased complexity of the processes, the number of people and departments affected by the change, and the related costs to managing changes. The greatest benefits from change management can be found in the following six performance criteria:

- Meet change deadline targets
- Meet design product budgets
- Achieve product cost targets
- Achieve product lifecycle cost targets
- Achieve product performance objectives
- Achieve product quality goals (Boucher & Brown, 2007, p.6).
-

When looking at change management there are five key categories supporting change management: (1) process (how companies are executing change management in their business); (2) organization (corporate focus and collaboration among stakeholders); (3) knowledge management (contextualizing data and exposing it to key stakeholders); (4) technology (selection of appropriate tools and intelligent deployment of those tools); and (5) performance measurement (the ability of the organization to measure the efficiency and effectiveness of change management) 9(Boucher & Brown, 2007, p.9). For each category there will be outlined what kind of approaches in these categories will support the change management processes.

Best performers in change management take a more structured approach to change **processes** Companies good in change management have implemented two critical processes more frequently than their competitors: formal impact analysis and formal change implementation plans (Boucher & Brown, 2007, p10). A more structural approach helps understanding and managing changes more successfully (Cao et al, 2004, p. 123).

Commitment in order to create an **environment** that supports improved decision-making can also support change management. For that reason organizations that are good in change management use a cross-functional CRB in order to fully understand and evaluate the impact of change across all aspects of the product lifecycle. Besides they have separate meetings to make decisions on whether to approve a change, and how to develop change implementation plans. In addition it is important to ensure that a program manager has signoff to approve or reject change orders, giving decision-making authority to the "owner" of the product or project. Other research does also indicate associations between elements of the firms' corporate environment and the proficient execution of new product process activities (Dwyer & Mellor, 1991).

The Change management support can also be found in integrating **supporting information** to improve change decision-making on a change request. Further, implement centralized access to the status of change orders decisions can also be helpful. They also provide centralized access to the change history which creates more accountability on the decisions made. Finally, to be able to improve change management, companies must measure it.

Turning to **technology** to support the change processes might also be helpful. The technology enablers can be divided into two groups, knowledge and execution. Having the right information is the key to making better decisions. Frequently the information for engineering change is better communicated visually than verbally; use design visualization and markup technology. Document visualization is common among organizations good in change management performance.

To improve change management, organizations have to **measure** it, to do so, organizations can use formal metrics to track the effectiveness of the change control process (Boucher & Brown, 2007, pp.10-12).

The organizations that are good in Change Management are more likely to use a more structured approach to their change processes, to facilitate that they incorporate technology tools into the change management process. To ensure that the information reaches the right decision makers promptly, companies can use workflows. This allows them to ensure they are involving the right people to make the decisions (Boucher & Brown, 2007).

4.3 CHANGE AND DISTRIBUTED TEAMS

The Sensata Change Management team members are geographically distributed, and must often communicate via technology. Research points out that geographically distributed teams operate differently, and experience different outcomes than traditional teams. The distribution of teams might have an important impact on the Change Management processes, which is why the possible consequences are analyzed over here. In literature a distributive and collaborative engineering process, like the change process within Sensata is also called concurrent engineering , where individuals in various disciplines from differing corporations cooperate to design a product and develop related processes.

There are two main characteristics that distinguish distributed teams from traditional(collocated) ones. Namely, being distant from team members *and* relying on technology to mediate communication and collaborative work. Both, distance and technological mediation can lead to conflicts (Hinds & Bailey, 2003). Research points at precursors to conflict that are unique to distributed teams. All conflict types, task, affective, and process, are proven to be harmful to the performance of distributed teams. *Task conflict* refers to disagreements focused on work content. Affective refers to team disagreements that are characterized by anger or hostility among group members. *Process conflict* refers to disagreements over the team's approach to the task, its methods, and its group processes. *Affective conflict* has been differentiated from task conflict, and from process conflict, partly in an effort to explain contradictory findings regarding the impact of conflict on team performance (Hinds & Bailey, 2003).

Advantages of distributed teams are: expertise around the globe, continue work around the clock, and create a closer relationship with oversees customers. These benefits can be diminished by the conflict caused by distance and technology mediation. For both causes the reasons will be outlined below.

Distance can have a negative impact on team members' shared context, familiarity, and friendship, and it also has an impact on heterogeneity, which will increase because of distance; of all these issues the reasons why they may cause conflict in teams will be given (Hinds & Bailey, 2003). Boucher & Brown (2007) agree on that point, and they have solutions in terms of

technology, through which team members for example can share their information on working times and holidays. It might be difficult for teams, when they are at distance, to develop a *shared understanding* because of the lack in common behavioral norms, the difficulty in establish a shared temporal rhythm, or to become entrained. These kinds of difficulties may lead to conflicts as team members find their expectations of others unmet and their work processes incompatible. Normally, *familiarity* can develop if teams are co present. Lack of familiarity increases conflict about roles and responsibilities (Hinds & Bailey, 2003, pp. 617-618). It becomes more difficult to coordinate teams if work habits of other team members are unknown. Research on *friendship* suggests that distributed teams will experience less friendship and, thus, less affective conflict. Distance is likely to reduce *homogeneity* among team members might lead to more task and affective conflict. Increased heterogeneity, particularly cultural differences, that will reduce the similarity of team members (Hinds & Bailey, 2003, p. 618).

Technology mediates both communication and collaborative work for distributed teams. The effects of technology mediation can be categorized according to their impact on relational outcomes, information transfer, and coordination. Technology mediation has negative *relational outcomes*, and will lead affective conflict. The effects of this, for example reduced cohesion and group identity, may cause lower trust, familiarity, and a sense of belonging on the team. Effects of information transfer may also cause affective conflict. Uneven distribution of information, which can lead to frustration and misplaced blame, increases the potential for affective conflict. The *coordination problems* imposed by technology mediation may precipitate conflict of all types. Process conflict, because of for example difficulties in the coordination of shared resources. Task conflict, can be expected when individuals have not examined the same materials as their colleagues or when they work on the basis of different information. And affective conflict can be caused by frustration and misconceptions, because coordination work is as good as impossible (Hinds & Bailey, 2003, pp. 619-622).

Teams may be able to moderate the negative effects of distance and use of mediating technologies in at least five ways:
- 'To dislodge distance: increase the frequency and length of face-to-face meetings. This promotes interpersonal relationships, and so, more familiarity and friendship.
- Purposely conveying contextual information: for example by sharing information about vacation schedules or office politics. By understanding each other's background, the opportunities to build familiarity and friendship increases.
- Creating similar contexts at different sites: some standardization of work processes, tools, and systems can help mitigate conflict in distributed teams .
- Particular structure of technology use: as teams learn more about the technologies they use, they will be better able to communicate, share information, and coordinate.
- Adapt communication technologies: When team members elect to use technologies that more effectively convey the affect and information demanded at the time, they may mitigate the effect of mediating technologies' (Hinds & Bailey, 2003, pp. 625-626)

Teams may be able to mitigate many of the negative effects of distance and reliance on mediating technologies using the above options, other researchers (Chen et al, 2001) offer other solutions to the practice of concurrent engineering by providing a system, that will increase product development capability and quality, reduce the lead time and cost, and increase product marketability. Since these systems are complex, take some time to implement in the organization, and expensive this research will not focus on that. Because there is already a system in place (CM Matrix) to support the process, and the improvements need to be aligned to the current Change Management Procedure of Sensata.

4.4 BRAINSTORM ON RESEARCH

When choosing between the two approaches for analyzing business processes, the rational and the pragmatic reconstruction strategy, according to Biazzo (2000) one key condition must be

taken into account: 'the analysis must concentrate on factors that can be modified over a reasonable time period and must use simple research methods, since change projects are obviously characterized by tight constraints both on time and financial resources'. That makes clear that, in the context of a change initiative, 'pragmatic reconstruction cannot be an alternative to rational reconstruction; (re)engineers need first to know and understand all the ``hard'' elements of the process (work flows and information flows) before they can decide which activities to eliminate, which to combine and which to overlap (Biazzo, 2000).'

For this research I will make use of a combination of both strategies for analyzing the change management process. For rational reconstruction process mapping is used, for a good understanding of the current process, but also for creating a 'Should-Be' map according the Global Change Management Besides the action analyses is used for creating a network of actions. That is especially meant to see the communication streams. Only a simplified version is given in the report, the action analyses model and description of it can be found in the appendices, and is especially created for Sensata.

For process mapping I will use both given sights on process mapping, the eleven steps of Hunt and the six questions of Graham, which can also help me setting up good interview questions, drawing process maps and giving advice on how the process change flow should be. The process map might also be needed for the understanding of the process for the team members of change management, and for continuity of process improvement. Not all the key process mapping steps of Hunt can be followed, because the process mapping will not be done in a team and the implementation of the 'To-Be' map and changing the present process is not part of the assignment, but will be part of the advice that will be given on the overall change processes. The literature on communication and implementing product changes will in the end be used for giving advice on improvements of the change process.

When analyzing the communication streams, also the communication tools can be taken into account, and team members' problems with communication can be reported. Other literature mentioned in the framework is to keep in mind other factors that might influence the communication and change management processes. Since the research pointed to other 'variables' then communication, disturbing the change management process, there is also literature added on categories that influence Change Management, and what kind of solutions can be found for improving those categories.

5. METHODOLOGY

Between May 2009 and August 2009 the use of the Change Management procedure and belonging tools is examined in the Sensata Technologies organization. During the research in-depth interviews are used to examine the following:
- Opinions and definitions of Change Management
- Communication streams, methods and struggles
- Team feeling and conflicts

Besides the existing procedure of Global Change Management, the Change Management Matrix, and all other belong tools are analyzed via Sensata's intranet. The following things are determined:
- Number of Change Management programs started up in Matrix
- Percentage of Change Management programs finished in Matrix
- Availability of CRB boards
- Sort of changes (product, process, supplier) in Matrix
- Other tools for processing a specific change, like a line move or supplier change.

The in-depth interviews are a qualitative analysis; social research data is analyzed without converting them to a numerical format (Babbie, 2007). The biggest part of this research is based on qualitative information, which is linked to existing literature. The questions that need to be answered in this research were not easily Field research can be divided in a couple of categories; Table 1 gives an overview (Van der Zee, 2004).

1)	Observation	as outsider	unaware	(1)
			aware	(2)
		participating	unaware	(3)
			Aware	(4)
2)	Inquiry	face-to-face	Open	(1)
			Closed	(2)
		telephonically	Open	(3)
			Closed	(4)
		by letter	Open	(5)
			Closed	(6)
		world-wide-web	Open	(7)
			Closed	(8)
3)	Intervene			(1)

Table 1: Different categories in field research (Van der Zee, 2004).

During the whole research I participated within the organization as an insider and I will make unaware (1.1) and aware (1.2) observations. When participating, I was critical to what is said by colleagues, how they are communicating and what kind of company culture they have. Besides I have been doing as many face-to-face interviews as possible with everyone who is involved in the change managment teams. These interviews were open (2.1) to get as much qualitative information as possible. I have also participated in some teleconferences, especially oversees (Almelo – Changzhou) to test whether this is a good means of communication or not, and whether this can influence the processes in a negative way. Some interviews were done by phone, since the people of the sales departments are most of the times located in Italy.

All the interviews are worked out en compared. Other kinds of observations are recorded by making a diary every day. In this diary all the outstanding and remarkable things I will be seeing

and hearing are noted. In the last chapter of this report my personal opinion will be given based on experiences and diary notes.

The interview questions and background can be found in Appendix 12.1.

Sub question one (procedure)

For the first sub question I have done some desk research. Standard documents and procedures for the global change processes within Sensata have been investigated. When analyzing these documents a process flow of the desired change process by the global Sensata Technologies organization has been set up. This flow chart has been used to understand the responsibilities of the team members and the different organizations; it is used for setting up the in-depth interview questions.

Sub question two (actual process)

It might have been the case that the responsibilities of all functions were very clear, but that deliverables did not point to that. It is important to know whether that is the case or not. There might be a communication problem or tasks may not be clear for the employees. For the second question I had to find out which organization is delivering which parts of the product change process at this moment. To do that I have made a segmentation of the process. Using the process flow of the desired process (together with the checklist) of change the deliverables of the different team members were assigned to the different process steps. The following functions were found in Sensata's product development/change process teams:
- Program manager/coordinator
- Field application engineer
- Design engineer
- Process engineer
- Quality engineer
- Supplier quality engineer
- Customer service
- Planning
- Procurement (Purchasing)
- Marketing
- Manufacturing

When answering this second sub question the deliverables were allocated to the different functions as given, and after that these deliverables and functions were assigned to the Almelo or the Changzhou organization. The main objective of this sub question was mapping the present flow chart in terms of deliverables of the different functions. This map includes all the process steps, who delivers what to whom and when is it delivered. The map is made based on the conducted interviews with all team members, only a simplified version is given.

Sub question three (communication problems)

When the current process flow of change and responsibilities of the team members were clear, the difficulties could be explored. It is important to know why the current process of change is differs from standard procedures, and why people do not use these standard procedures. Using the change process according to the standard Sensata Technologies procedures and the current way change is processed a questionnaire was set up to find out where are bottlenecks in the current way of processing change. Also by just analyzing the process flows some difficulties can be found.

6. PROCESS OF CHANGE ACCORDING THE GLOBAL PROCEDURES

Sensata Technologies has standard procedures for the global organization. Reasons for having these procedures are smoothening business processes and ensure that information will be stored properly. The change process is adapted from the norms that can be found in ISO9001 (ISO14001) and TS16949, so quality requirements can be easily met. For change management the most important document for Sensata should be the Global Change Management Procedure, belonging to this procedure there is a checklist (see appendix 3) that needs to be followed by a program manager for good change management practices. It is recommended that changes made to automotive parts are managed using this checklist. This checklist is made for the different Business Centers, PPD and Make sites; and all sites should use this checklist as a lead for change management.

Even though there is a checklist, this desired process of change management has not been mapped by the organization and that will be done in this report by using the global change management checklist. The three phases and thirty-five steps will be placed in a process flow, which will be called the change process according to the global procedures. There must be said that the steps in the original checklist are not numbered. According to a change management expert within Sensata (Personal communication, May 5, 2009) this is done on purpose, because the list is just a guideline and not all these steps have to be processed in this exact sequence. The checklist of change management according to the global change management and procedure is mapped.

6.1 GLOBAL CHANGE MANAGEMENT PROCESS FLOW

When all the steps of the global change management checklist are followed, and if the procedure is held beside these steps, we can come to a process map. This map can be found in Appendix 5. Before starting this change management process, there is a selection upfront, for selecting the right process, more about this can be found in chapter 8.

We have to look at the responsibilities that belong to the change procedure and checklist. For the Business Center site in Almelo the following functions are of importance: Program Manager BC, Design Engineer (FAE), Quality Engineer, Planning/Customer Service, and Marketing. For the PPD site there is only one team member that should be involved, the Design engineer. At the Make site the following team members are involved: Program Manager Make, Process engineer, Quality engineer, Supplier quality engineer, Customer service, Planning, Procurement (Purchasing), Marketing, Manufacturing, and Mechanization. In the table below the responsibilities are listed per function.

Program manager BC	Selecting the appropriate change management checklist (CCL) for the change management (CM) program, generally this would be the based on the industry where the product will be used (automotive/commercial or aerospace/commercial),
	Initiating and preparing the Change Justification Form (CJF) for each change (BC for BC site changes),
	Defining the Change Management Team,
	Ensuring the use of the Global Change Management Checklist as a guide to identify and monitor the tasks and team responsibilities for each change, and
	Inactivation of program due to circumstances that result in the termination of the program. (Examples such as; mfg capacity, supplier selection concerns, customer approval denied, financial, etc).

	Establish program schedule, prepare risk assessment and mitigation plan, establish capital expense requirements
Design Engineer (FAE)	Is responsible for coordinating and implementing changes related to the product design using the Engineering Change Notice ECN process
Quality Engineer BC	Together with Make QRA and Customer Contacts responsible for coordinating the change notification with the customer and following the required submission instructions as deemed by the customer for approval.
	Submit customer approval documentation to customer.
Planning (and CS)	Manage inventory disposition.
Marketing	Review commercial impact of change
Design Engineer PPD	Complete testing to validate change, release production drawings, complete oracle set ups.
Program Manager Make	The same first five responsibilities as BC Program manager
	Define production process, order equipment and tooling, establish Operational Transfer Price (OTP), review pre-production operations checklist
	Verify capacity and confirm readiness, assess financial performance, complete lessons learned, hold program exit review
Process Engineer	Responsible for coordinating and implementing changes related to the process.
	Process FMEA's.
Quality Engineer Make	Together with BC QRA and Customer Contacts responsible for coordinating the change notification with the customer and following the required submission instructions as deemed by the customer for approval.
	Review customer quality requirements, identify and flow down customer special characteristics,
	Complete production control plan and flow down characteristics, identify and launch controls and verify capacity, review customer approval documentation, conduct internal process audit and formal safety audit, log date of change, exit launch controls
Supplier Quality Engineer	No direct responsibilities according to the procedure and checklist.
Planning	Manage inventory disposition
Procurement (Purchase)	Complete New Component Sourcing (NCS) checklist.
Manufacturing	No direct responsibilities according to the procedure and checklist.
Mechanization	No direct responsibilities according to the procedure and checklist.

Table 2. 'Should-Be' responsibilities

* The original role of the design engineer at the business center is changed. That is why in reality there is a new role, the field application engineer. The function of the field application engineer is not yet described clearly, but is related to all technical requirements in the application concerning Sensata's product portfolio; which can spread out from quality and changes till new product development. The field application role is more related towards customers' application, to fulfill their needs at a high level.

6.2 PRODUCT REALIZATION PROCESS

In appendix 4 the product realization process map can be found, this map has to assure the quality and reliability for new product orders. When there is an order from the business center, this order can be an existing product or a new or a derivative product. When it is an existing product the order will be forwarded to the make site, and in the end it will be delivered by the logistic department to the customer. If there is a whole new product the New Product Development procedure will be applied. If there is a request for a derivative product the Change Management procedure will have to be used as can be seen in the picture. At the business center the request (requirements) will come in via marketing or sales, the field application engineer will manage the technical requirements, and the quality engineer will specify the special quality requirements that belong to different customer orders. The field application engineer translates these requirements to the PPD engineer. The PPD engineer is subsequently responsible for the product design and together with the process engineer he will look after the manufacturing process. If the product design is there, the supplier quality engineers and purchasers will look for new purchasers and raw materials if needed. The quality engineers will have to check if the new product can meet the quality requirements (in terms of IS9001,TS16949 or what is agreed with the customer). If everything is settled and the quality and reliability requirements can be meet, the PPD engineer will take care of the first samples and testing. After that the process engineer will test the machines; if all tests are done the order can be delivered. The business center will have to take care of the shipment and logistics. All complaints of the customers will first come in at the business center, and business center and the make site will together take care of the corrective action response process in order to satisfy the customers.

6.3 COMMUNICATION LINES ACCORDING PROCEDURE

In order to determine how the communication lines should be according Sensata Procedures (ISO/TS norms can be reviewed the standard to this procedure), the Change Management procedure and belonging checklist, and the product realization process map are investigated. In the diagram below is given how the communication would be, if the procedures will be followed. There is focused on the 'actions' that actually have to be made by several individuals (functions). The diagram of all the 'prescribed' communications is too complex to display over here, which is why a simplified version is given. The diagram with the communication lines according to the procedures can be found, attended with belonging text and explanations, in Appendix 6.

In the two diagrams below, there is made a distinction between the Design site, the processing of information, for changes, and the Make site, the processing of materials, for changes. For both, design and make, there will be given an example description of the 'action' streams during a change process.

When looking at design in the value stream of change management, we can start at the site of the customer. For example a customer need of a product is not met, which is why there is a need for change for improvement. Together with the field application engineer and quality engineer in the business center, the customer will specify her needs in terms of technical (functional) and quality (reliability) requirements for the product that has to be changed. It is important to find mutual agreement amongst both kind of requirements. The field application engineer also communicates to the customer whether Sensata has the capabilities to produce the specific product or not (sFMEA). When requirements are clear, the program manager, which is mostly the field application engineer at the business center; will do a risk assessment, a Net Present Value (NPV) calculation, and some other steps in order to be able to fill in the Change Justification Form (CJF). This will have to be delivered to the management (Change Review Board). The Management uses the risk assessment, financial analyses, and commercial analyses as an input for the decision on whether to spend their resources or not. The management can

approve or reject the change. If the change is approved, the management will have to deliver the resources to the design team. During the change process, design is mainly giving support to the make site, so they can realize the change. Therefore, marketing, sales, field application engineering, and quality engineering should be working close together. Communication with design engineering has to be done via the field application engineers, who are responsible for translating the technical requirements to the designers. The design engineers receive technical requirements for the products that have to be changed, they validate the change, and they complete the risk analyses of the technical side of the design (dFMEA).

Energy that is put in the process can be divided in man power and tools. 'Man' are the employees working at the design project for the change process, who have to follow the Global Change Management procedure. Some tools, like the Change Management Checklist and Change Management Matrix, should help the employees to process the. Change.
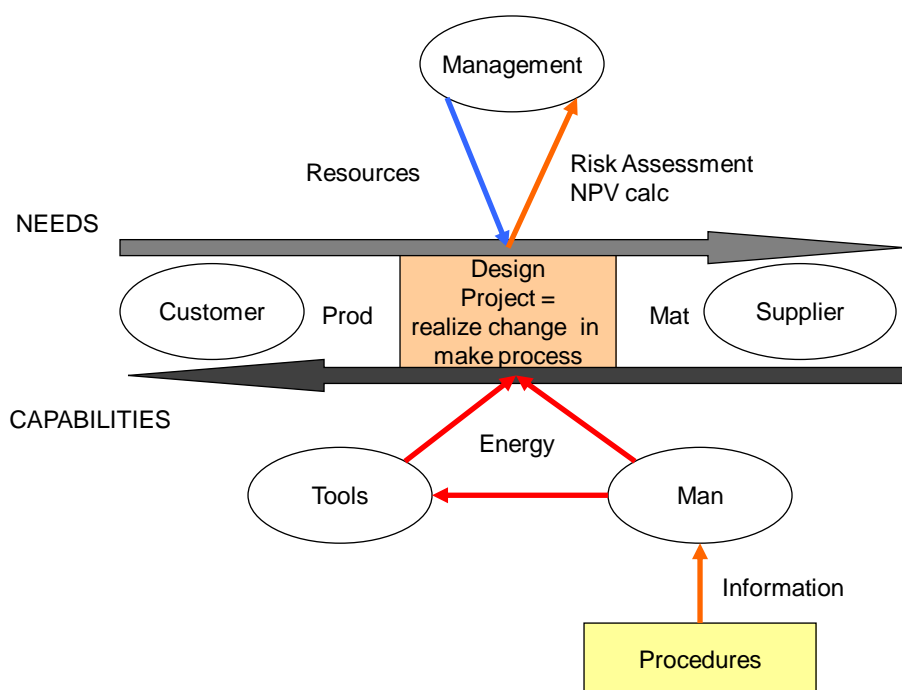
Figure 2: Design in the value chain of Change Management

When looking at make in the value stream of change management, we can first look at the same example for change management as is given above. The make site will also have to be incorporated at the start of the change process. The process engineer has to find out if the production lines have to be adapted to the change in the product, and is responsible for the completed analyses of process risks (pFMEA). The quality engineer, supplier quality engineer, and purchasers work together to see which components changes, if the needed component is already in stock or that there is the need to order new materials (of that they need to find a new supplier). If the prices of materials for the changed product are known, the Operational Transfer Price (OTP) can be calculated, and customer approval needs to be obtained before the process can be continued. In summary: The quality engineer is responsible for all the customer documentations; the process engineer is responsible for the production lines; the planners are responsible for delivering the products in time; the supplier quality engineers are responsible for high quality materias.

When there is another sort of change the following items in the picture: can be replaced:
- Supplier can also be an agency to servicing certification for products
- Customer can also be legislation
- Application can also be a process at customer.

Differences in the kind of change (product, process, or supplier) do not have a big impact on the communication processes within the organization. When there is a product change, the design site, mostly the field application engineer with the marketing team, has to have closer communications with the customers. When there is a process change, the make site has more intensive communication internally, because it doesn't impact the customers or suppliers; when there is a supplier change communication from the make site with suppliers has to be more intensive.

Figure 3: Make in the value chain of Change Management
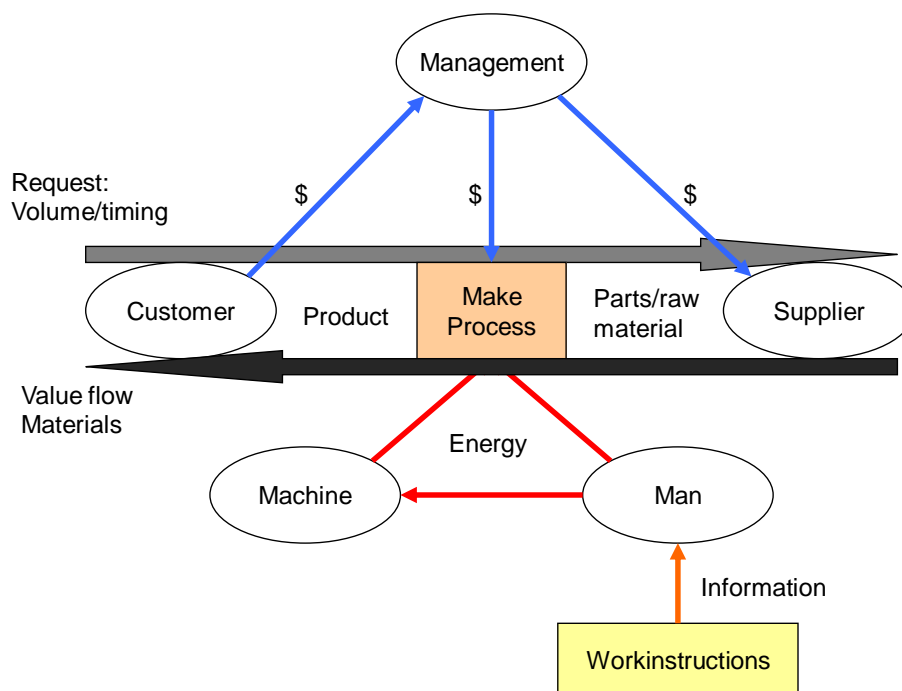
The value chain can also be described by: The communication of needs and capabilities between FAE and DE/PPD (system need vs. product capabilities), DE/PPD and PE (product need vs. process method capabilities), PE and Make (process method need vs line capabilities). Where the capabilities can be divided in materials/machine/man and controls (filters to remove errors made).

7. ACTUAL CHANGE MANAGEMENT PROCESS

The actual change management process has been analyzed using the Change Management procedure, checklist and the process map during the interviews with Change Management team members. First, the execution of the several change management process steps will be discussed. After that the several communication streams during the change management processes.

7.1 FOCUS ON THE CHANGE MANAGEMENT PROCESS STEPS

With all interviewed employees the separate steps on the Change Management checklist have been discussed, using the checklist and the map of the Change Management process (Appendix 5). When reviewing the separate steps their own actions have been analyzed. The positive thing on the outcomes of the interviews is that even though the change team members do not use the procedures and checklist, they do use the several tools and steps belonging to change management. Besides, everyone involved expresses the opinion that all the steps on the checklist are necessary to be able to complete the change process. Still, it seems to be that almost no one uses the procedure. The most important *reasons for not using the procedure* are:

1. *Documentation work*: the people who tried to use the change management matrix concluded that it was mostly bureaucratically paperwork of documentations. It costs a lot of time to upload the files that are needed, and everyone feels that they do not have so much time.
2. *Involvement of global change team:* when a new change has to be initiated in the change management matrix there are also a lot of people of the global organization, for example Japan, Mexico and the United States, who have to be notified or approved. In that case some of the employees in other sites might not understand the change or they might not give approval for the change. Because of that the project will never succeed the justification phase. For that reason some project initiators do not use the change management matrix in order to safe time.
3. *Training:* in a lot cases new hires are not trained in change management. If others will use the system, those new people will not receive the information that is needed.

The second and third factor are also confirmed in other research. Malmqvist & Pikosz (1998) state that, amongst others, 'the involvement of many departments' and 'long learning times' are difficulties that are often found in engineering change processes. Reasons for these facts are that it is difficult to agree with many departments on one point without the disadvantage of at least one department, and since Change Management is such is complex process it is difficult to learn fast.

If the employees do try to use the procedure the following checklist steps might cause some difficulties:

- *Select team and establish CRB (Change Review Board)*. The CRB is a board of managers who have to judge whether a change can be approved to the pre-launch phase or not. For the Electrical Protection business there is no standard CRB. This is sometimes causing some difficulties, since the program managers do not know who has to give approval for the project. What might happen in that case is that the program manager either manages it to find the right team through adding a lot of 'possible' CRB members; or, when the program manager is choosing the easiest way, he will add some people to the CRB who will for sure agree with the program. Of course, this second way is not doing good to the organization, because it might be that this CRB does not have a good overview of what impact the change will have across all aspects of the change.
  There is also no overview of which people are responsible for what kind of products (families) and tasks, so program managers also find it difficult sometimes, to find out who has to be in the change team.

- *Submit Change Justification Form*. The program managers try to fill in this justification form completely, but in this early stadium of change there is in most of the times not yet a complete team; so for example the program schedule and capital and expense requirements are not completely finished. In most of the time the form contains some milestones and estimates for the project. This is also how most interviewees feel that it actually should be; the CJF, it should contain the big steps and a raw estimate of the risks (Personal communication, June 4, 2009).
  On the other hand the problem of not being able to set up a team should get some attention. Sensata is not a project organization, but a matrix organization: the organization is divided in several departments who work together and have their own goals, but if there is a project like change management people across several departments have to work together in one team. Because of this matrix situation it is sometimes difficult for the program managers to work with the team, since they have no genuine control over the team members.
- *Identify launch controls and verify capacity*. If it is right, there is agreed to verify metrics established after a determined time of production. At a certain moment there can be decided if some items have to be in the Control Plan or not. Verify capacity is about analyzing the numbers of products coming from the lines, and how to define better programs for improving the capacity. For the quality engineers (Personal communication, June 4, 2009) this is a difficult step, because for this step they need to understand all the requirements of the specific product and customer, which is sometimes very difficult for them. They need to understand the specifications concerning what is needed in the application. Quality engineers find this complex because they are not the designers of the project and not involved in each step of the development of the products. Besides they are young, not experienced enough, and some of them do not have a technical background.
- *Review customer approval documentation with BC*. In this step the customer approval documentation should be reviewed internally before it is submitted to the customer. The checklists states that the make quality engineer is responsible for this, but in reality this is not what is happening; the process engineer or PPD engineer will coordinate this with the business center.
- *Obtain customer approval*. Sometimes this is a difficult step, because for example the sample making is too slow. The sample making is mostly a weak point in the process at the production lines, were people are afraid to make the decision for producing a first 'trial' order of the customer, which is under the minimum amount of production (set at this amount, so there won't be any losses). It is important that the employees at the manufacturing site are more confidential in making such decisions, because in most of the cases a bigger order will follow in less than a week (Personal communication, June 8, 2009). Over here we can see three things affecting the process in a negative way: culture, obsession of finances, and personal priorities. The culture has this affect, because the Chinese people on the work floor are not used to, but also do not like, to make decisions by themselves; normally this is up to their mangers. Because the organization is so interested in reducing costs and setting priorities and lowest costs, people do not feel anything for sample making because this contains some risks and it is also not their priority to make changes. There is no business management, but only output management what has a negative impact in that case.
- *Complete lessons learned/design documentation*. This point at the checklist is well thought, but the fact is that this is not always done, and when it is done, the lessons are not used properly. It is important that these lessons are reported to all the team members. Besides one of the first steps in the first phase should be that the lessons learned of similar projects are reviewed.
- *Hold program exit review*. A step that is never taken, according to all interviewees. It is seen as an unnecessary and time consuming step.

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Besides the difficulties with following the normal steps, there are also some things missing in the checklist according the interviewees. The following items are all steps that should be integrated in the Change Management Procedure and checklist according the interviewees in Almelo. Remarkable is that the people from the business center focus on knowledge based information, where the make sites focus on operational aspects.

After each phase, when having approval to move on to the next phase, the program manager should review the checklist with team members (Personal communication, May 5, 2009); or at least inform all the team members about moving on to the next phase, the informed people should include marketing, sales and planning (Personal communication, May 6, 2009). When something changes in the design, quality or planning, the whole team should be updated as soon as possible (Personal communication, May 5, 12, 2009).

Another thing that has to be reviewed is the financial impact of change, according to the change team members in Almelo this should be done in every phase of the process. At the moment the checklist only requires to do this in the first phase, which is not sufficient. According the interviewees there are several ways to review the financial impact: NPV analyses (cash flow analysis), keep on updating the operational transfer price (OTP), or update the financial analyses in all phases (first phase estimation, second and third phase feasibility estimations) (Personal communication, May 5, 12, 2009). There should be a good strategy, before this is going to be implemented in the change processes (Personal communication, May 11, 2009). When it comes to finances there is some kind of unbalance in the organization. On the one hand Sensata is really focused on making profit, where on the other hand this focus does not become clear at all when it comes to her procedures and practices (Personal communication, May 14, 2009).

Besides the financial review, a commercial review in each phase is considered important. About fifty percent of all changes come from Sensata, looking at Best Cost Sourcing (BCS). In the first phase the marketers are responsible for reviewing the commercial impact, but after that first review there are no steps in the other phases that review the actual commercial impact.

Most interviewees do also agree upon the fact that the risk analysis (FMEA's and RA's) should be reviewed at the end of the third phase of the change process. Consequently, all the team members can learn from these estimations; when they were totally wrong with their estimations in the beginning they can do it in another way the next time.

Research on Change Management acknowledges the importance of the last three mentioned points: reviewing financial impact, commercial impact and risk analyses. If an organization wants to ensure that the right decisions are taken, performances have to be measures; only then strong and weak points can be recognized, so the next time decision making can be improved (Personal communication, June 8, 2009).

China PPD and China Make

In China the interviewees also experience that the procedure is not complete, but the checklist does contain everything that is needed for a good change. In contradiction to the interviewees in Almelo, the employees working at the make site are much more focused on the operational site of the process instead of knowledge based information.

One of the most important improvements discussed at the Make site is informing team members; process engineers (Personal communication, May 27, 2009), would like to add a step early in the second phase in which they will be informed by the design engineers (PPD) about the products, so she will be able to understand the product and can think for their selves when it comes to changing the process. The Quality engineers (Personal communication, June 4, 2009) would also like to be informed earlier, especially when it is about a supplier change. Sometimes they get that information when the components are already there, and then it is too late to react on raw materials that sometimes don't meet the quality standards. Also sales has to be informed and involved earlier in the process, so they can obtain customer approvals for changes in time (Personal communication, June 16, 2009). In conclusion, all change team members want to be

informed in an early stage; too many people are 'surprised' in a too late stadium, so they feel pressed to work at certain items.

Before there is a new design concept, the design engineer has to communicate with the process engineer and quality engineer to see if the planned design is practical for mass production, because sometimes it is really difficult to make a large number of the products, since they are really complicated (Personal communication, June 5, 2009).

The checklist is build for many different changes, and not for example for supplier changes. The supplier quality engineers would like to see more detailed activities in their area. The scope is too large. The change management procedure should be so that it can be combined with other procedures, in this case for example with the supplier process management (Personal communication, June 9, 2009). The checklist should be more adaptable.

Both sites mention that it is important that all team members are well informed, research on Change Management brings this even a step further by stating that all departments should be integrated from the beginning of the change. This also means that for example sales and marketing also have to be trained in the Change Management procedure and belonging tools. Reason for that is the fact that only in that way the 'absolute' right decision can be taken on the change, since everything will be considered. From ISO requirements till how the new product will have to be marketed (Boucher & Brown, 2007, p. 13).

7.2 ACTUAL COMMUNICATION LINES

In reality the communication lines during the change management process are not precisely the same as they are described in chapter 6; the communication lines that can be expected when everyone follows the procedure. Besides these communications streams, there are also some interactions between functions that are not expected. All the actions of the change management process have been identified, and we will discuss over here what sequences appear, and why they appear. In the figure below, a schematic overview is given of the actual communication lines. The smaller lines between the field application engineers, design engineers, and process engineer are needed according to the change management procedure. The other lines between the different sites are explained below the picture.
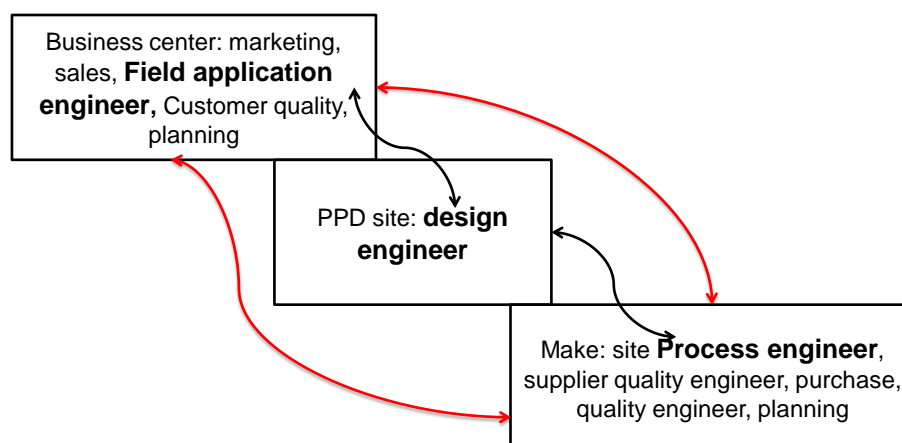

Figure 4: Actual communication lines within Sensata Technologies.

The field application engineer sometimes communicates with the process engineer or quality engineer. There are several reasons for this communication stream. For example the field application engineer is responsible for delivering the documentations like PPAP to the customers. The quality engineers have to realize this at the make site in the process, if these documentations are causing difficulties, or if they are delayed, it seems to be easier to contact the responsible person at the make site directly. For the 1NT product the field sales engineers will contact the quality engineers to discuss customer complaints and requirements. Another example is that the field application engineer contacts the process engineer, about for example the tuning of the machines. It is the responsibility of the process engineer in cooperation with the design engineers to do this properly. The field application engineers try to make decisions for the process engineer, which is not their responsibility anymore. Reason for this action is the communication with process engineers when production was still located in Almelo.

Some of the field application engineers also interact with manufacturing, for the same reason they have contact with the process engineers. It is up to the Make site to make decisions about the process and manufacturing.

There are also some communication streams that are considered important when looking at the procedure, that are facing some difficulties.

- BCS Team to marketing and sales: Sometimes marketing/sales are informed to late about a change in materials or something like that. These functions need to be informed early in the process, so they can obtain approval.
- Field application engineer and customers: Difficult to get customer verification, or contract; before production can get started. Customer wants to do this as late as possible, because they don't want to have too many risks, they don't like to invest a lot of money in a new product, and they might be looking for the product in other organizations at the same time. Sensata wants to do this as early as possible, so they share the risks with the customer, and they are already investing money in the product that has to be changed.
- Customer to quality engineer: Most of the complaints on the changed products, come afterwards, when the products are already produced. Due to the reorganizations at the business center, it has been difficult to manage all the complaints with less people, and at the same time more changes due to supplier changes, because of Best Cost Sourcing team efforts.
- Supplier quality engineers and purchasers: The checklist is not clear for a supplier change, in that case other functions are involved. The checklist should be more adaptable and relevant steps have to be chosen by the program manager.
- BCS Team and supplier quality engineers: The BCS team only wants to reduce costs, and they want to change as much suppliers as possible. The supplier quality engineers do not want to change, since the current contact with the suppliers is good. The local suppliers sometimes cannot deliver the same high quality components as the original supplier, but if they still can meet the requirements set by for example ISO-norms, they supplier change will be proceeded. This can cause a lot of quality issues, because customers do not receive the same high quality products anymore. Internal discussions are about the investments versus the results; poor results can lead to additional investments, and the point is that financial results of the supplier changes are not structurally reviewed.

8. COMMUNICATION PROBLEMS IN THE CHANGE MANAGEMENT PROCEDURE

We will now look at the communication problems in the change management processes that are mentioned by the interviewees, as can be read below. The different problems are to be found at three kinds of communication. The first is internal communication, which includes all communication streams within one business site. External communication is the second, and refers to all communication streams with external organizations like customers and suppliers. The third stream are the communications at the interface between Almelo and China.

Almelo Business Centre

- *Internal communication*: At the moment things go wrong with informing planning, the program manager is responsible and the input for planning should come from him. He also has to inform material management; this also is in a lot of times to late. Also the change management checklist is often not updated and it is not a checklist for the whole team (Personal communication, April 21, 2009). In some cases people would like to receive some information / deliverables in another way, but they do not communicate about this. For example: marketing and sales do not know about the preference of the field application engineer, so he receives everything by e-mail; a reason why a lot of information can get lost (Personal communication, May 11, 2009).
  For the planners it is important to receive the information of the finance department about payments of the customers in time. In 'these times' customers have to pay in time, if they do not do that the finance department will put these customers on hold. Planning receives this information from finance. Sometimes very late, that causes customer complaints which cost a lot of time and energy (Personal communication, May 14, 2009).

- Interface communication: There are a lot of cultural differences within the global Sensata organization. In the Netherlands there is a very direct way of communicating. In China this is different, for Chinese people it seems to be more difficult if they cannot make a requirement or appointment, because they see this as a personal failure. For that reason it is difficult for the European employees to decide whether the Chinese will be able to deliver in time or not. Besides, normally the communication between Chinese companies seems to be more flexible, when there are problems they will talk it through, with Europe this is different. They are less flexible and want to stick to appointments and contracts.
  The employees in Europe experience that there is a little or no initiative for new things and you should not ask the Chinese for any plans. Almelo has to bring up the plans and ideas. (Personal communication, April 21, 2009).
  Since Sensata has travel restrictions her employees are now communicating a lot with people they have never seen, this sometimes lead to a trust problem (Personal communication, May 5, 2009). Something that might aggravate this problem is the fact that Almelo and China do not know what way of communicating is preferred. Right now they don't know if this is via e-mail or maybe via a new form that has to be set up for specific changes (Personal communication, May 5, 2009).
  In addition the people in Almelo feel that the level of English of a lot of people in China is not good enough, with some of the Chinese people it is impossible to have a telephone conversation. However, the Chinese people criticize preparations before meetings of the Almelo site; teleconferences should be prepared in a sense that e-mails have been read and agenda's have been prepared.

- *External communication*: Communications with customers about the quantities of products they will receive is sometimes communicated badly. Planning communicates this together with sales; they receive via 'oracle' information on how many products will be made

(Personal communications, April 21, 2009). The communication about what quantities of products will be delivered at what time to the customers, Sensata Almelo is to optimistic with fixing deadlines; it is impossible to fix very hard deadlines when there is for example a component that has to be changed. Planning, marketing and sales are frequently forgotten and should be in the change teams. Planning receives information way too late and marketing and sales do not here about whether production will be possible or not (Personal communication, April 21, 2009).

China PPD & Make Site

- *Internal communication*: When walking through the halls of the Changzhou plant the engineering manager points at all the large posters. One of these posters is about operational excellence, the global organization has her priorities for 2009; linked to the global priorities to the Make site has her own priorities, one step lower comes China Make, after that the Changzhou plant has her own priorities, which are all falling under the global Sensata priorities. In Changzhou (and in the rest of China), these priorities are coupled to objectives per function. Behind these objectives we can find the names of the persons who are responsible for these objectives. Those are also the points on which the employees will be accounted at the end of the year. These objectives are totally focused on customers, costs and operational excellence. There is nothing said about carrying through changes, so that is not what they are responsible for, and so they do not like to do things like changing products. Two other posters are about Lean Manufacturing and Six Sigma. In Changzhou they use these tools to optimalize the processes. Almelo (Europe) brings this further, where they would like to optimalize the products when it comes to these tools. This is why the product changes are coming a lot more from Almelo, where China does not think that it is useful to change. This is a conflicting situation, which disturbs communicating, because there is no mutual understanding.
Sensata has a lot of different departments. In a case that someone wants to change a supplier, because there is only one supplier for a sudden component; this can be really difficult, because in that case that person needs to communicate with a lot of different departments, who all have their own priorities. In that case the employees want to have more authority to make those kinds of decisions (Personal communication, June 11, 2009). The employees might see this as a communication problem, and the easiest way to solve this problem would be giving more authority, but that is not a solution. It is indeed important that all departments are involved, so decisions can be supported. Solutions to this problem have to be found in an improved way of communicating through a Change Management system.
A bottleneck in the current change processes is that it is difficult to find the team. Because there are lots of different representatives, with different tasks. Sometimes it is too late for the customers or the change cannot be completed (Personal communication, June 9, 2009). When a program managers starts with a new change, they do not know who should be involved in the project. The only way to organize the team, is based on experience. It is difficult to know who should approve the new ECN. There should be something in the system, giving examples of which departments should be involved for what kind of changes (Personal communication, June 10, 2009). What is missing is a clear project organization; the vertical stream of decision making is very clear, the horizontal stream is not, which is why program managers might not have the abilities to make decisions and choose the right team members.
Sometimes the planners do not receive the information in time, so the inventory cannot be checked, the planners are mostly waiting for the program managers to contact them about checking their inventory; but if the program managers are not doing this in time, the planners should ask them about the situation of a project, so there will not be such a big impact on continuous production. There can be concluded that some departments are always excluded from changes.

- Interface communication: The engineering manager in Changzhou (Personal communication, May 25, 2009) also acknowledges that the teleconferences with Europe are not going very smoothly. In Almelo they are still reading their e-mails while having the conversation. In China it can be very noisy and when having the conversation the people in Almelo can still hear this background noise. It is important that everyone is prepared for a meeting, so it will be easier to understand what is said.

When there are samples of a product, they should be sent to PPD for analyses and testing as soon as possible. There is no better way than using samples for communication. This can help making a lot of things clearer (Personal communication, June 1, 2009). The biggest bottleneck in the change management procedure might be that the sample making is too slow. There are a lot of 'S.O.S.' sample requests from the business center in Almelo, but in a lot of cases we cannot meet the requirements, because the samples are made too slow (Personal communication, June 8, 2009). An effect of that, is that other organizations were faster on that point, so customers will switch of the supplier.

There are also some finance issues sometimes. For example the field application engineer in Almelo and the process engineer in Changzhou do not agree on the use of materials, then there will be a discussion about who is taking the costs of the more expensive materials that is required in Europe; sometimes the Changzhou finance team will hold the payments in that case. ('Our manager does not want to talk about these problems to the business center.') (Personal communication, June 9, 2009).

9. OBSERVATIONS

For this assignment I was supposed to look at the change management processes within Sensata Technologies. I had to find out how change management is processed at the moment, and how the change management process can be improved in relation to the communication interface. The latter focus on the communication interface was applied, because the initiators thought that the difficulties in the change management process were caused by communication problems.

During my research and after having conducted more and more interviews I found that there are profound problems causing the communication problems, which is also supported by literature on change management. That is why the several change types with their similarities and differences will be described below, and after that the effects of the procedures will be given.

9.1 THREE CHANGE TYPES

For her business processes Sensata has her own procedures, covering ISO and TS requirements, which can all be found at the server by all employees, and to which in most of the cases an automatically system is attached. For the Global Change Management Procedure this is the CM Matrix. This system is set up to ensure that everyone who has to be involved or notified will be automatically informed and notified, and that there will not be any loss of information. For changes there are three kinds of procedures, in sequence from small to big changes (definitions to be found in chapter 2): Engineering Change Notice, Change Management, and New Product Development. A picture of the selection process can be found in appendix 8.

The Engineering Change Notice processing procedure is set up for small text error or changes that have no technical impact; they can be seen as administrative changes. An example might be that someone made a small mistake in the drawing that has to be covered up. This procedure exists of three phases: (1) Start Work Phase, (2) Work Completion Phase, and (3) Incorporate Notice Phase. When looking at the procedure one can see that there is a clear flow chart and process, the responsibilities of the involved people are also clear, and there are even functions with names of the people that have to be required or approved. There are also lists for the Change Control Boards (CCB), the people who have to approve the ECN.

On the other end of changes Sensata has a New Product Development processing procedure. In that case they will start from scratch, and after the 'change' there is a whole new product. This kind of change is not occurring a lot of times, and especially not at the moment due to the economical crisis. This process is existing of five phases: (1) Concept, (2) Experimental, (3) Pilot, (4) Pre-launch, and (5) Production. To clarify the responsibilities of the involved functions, there is a RASCI besides all the process steps.

In between these small administrative and new product developments there is the Change Management procedure, which is meant for bigger changes than administrative and smaller than new products. 'All changes which are identified as product, process, or supplier related that generally impact the customer requirements of form, fit, function, performance, durability and/or capacity are to be coordinated and managed using the Global CM Matrix Program Central System.' When looking at this procedure with incorporated checklist the responsibilities of the people that have to be involved are not clear; there is no standard list for the Change Review Boards (CRB); there is also no standard process that can be followed. There are suggested four phases: (1) Justification, (2) Pre-Launch, (3) Launch, and (4) Complete.

Similarities & Differences

The three processes have a lot in common. All processes start when there is an idea, or customer/market demand, or yield improvement, etc. The initiator of the change (mostly program manager as well) will have to raise an ECN or deliver a Change Justification Form (CJF). In all cases there is a Control Board that has to approve the ECN or CJF. There will be looked for

a team by the program manager (for ECN not always needed), and lots of new drawings will be made for CM and NPD. First some experimental drawings, the final drawing will go through ECN. Also 8D customer complaints and PPAP is managed through all three changes.

For ECN there is only need for the initiator of the change, and the person who executes the job; when the change is processed everyone who has to know about the change will automatically be notified. If those people need to approve or read the document this will attached in the e-mail. For change management and new product development this is different; the people that will have to be notified or approved have to be filled in manually by the program manager into matrix.

The differences with Change Management are that ECN and NPD are prescribed processes with clear objectives and responsibilities for the different functions. Change management only has this unnumbered checklist. To start the Change Management procedure in the way it should be according the procedure; is for those reasons a lot more difficult. The Program Manager does not know who to involve, and who has to approve. There is no list of CRB members, so that also has to be find out. The involved people do not exactly know what their own responsibilities are, and what others are supposed to do. Besides, there is not an organization chart available which says who has which function, in which site he is working, and at what telephone number and e-mail address this person can be reached.

9.2 ORGANIZATIONAL UPPER LAYING PROBLEMS

When people are not aware of the way the organization works, where to find people, and what their responsibilities are; there possibly will also occur communication problems, but in that case the real problem is on another level. Pointing out these problems will be good to surface roadblock problems, but it is important to keep in mind that the whole setting in which change management is placed is a difficult one to work in. Solutions on those communication problems might help a little bit, but an improved procedure (and process) for change management will take care of most of the problems at once. In order to keep these points conveniently arranged, the problems are scaled under the following items: process, organization, knowledge management, technology, and performance measurement (Boucher & Brown, 2007).

Bottlenecks in Business Center

1. *Process*: Change management has never been used completely by Electrical Protection, it always went in a way of 'common sense'. The change management checklist could be a great support for Almelo to know what China exactly does; some kind of monitoring. We need to go from 'common sense' to more formalization, because it is about global processes (Personal Interview, May 5, 2009). Lucy Scot in Attleboro is responsible for all the procedures. Not everyone knows about these procedures and there is not enough or otherwise insufficient training (Personal Interview, April 21, 2009). When there are procedures everyone should get a training session about change management. At the moment not everyone is involved in these training sessions. Also Marketing, Sales and Planning should get trained; so they do know about the procedures, documents and responsibilities of everyone involved (Personal interview, May 6, 2009). They should also be involved by the program manager.

2. *Organization*: Sensata has to create the right environment for Change Management. It is important to know who is responsible for what kind of job and who can be approached at the PPD-or make site. Even though a lot of people have left the organization and changed functions; these things are not made clear in for example the outlook application, in which telephone numbers and managers can be found. Right now these things are not up to date and that costs us a lot of time (Personal communication, May 12, 2009). Besides the wrong people may be informed or approved for a change, and important people who are needed to be involved may be left out.

Another way in creating a right environment is use of the Change Review Board, if changes are justified by a cross-functional board managers can show their priority to Change Management. When the first phase of change is completed there is an engineering change notice (ECN) and the change review board has to check and approve or reject the program. There is no standard CRB for the electrical protection change management procedure, but at Sensors they do have standard CRB lists per product family, maybe it is a good idea to have a standard list for EP as well (Personal communication, April 21, 2009). One of the biggest instabilities in the change management process is that the CRB is only required in the first phase, after the first approval it is al up to the program managers and the only thing they have is the global change checklist; the next things are missing: (1) Clear guidelines, (2) Management involvement, and (3) Good resource planning (Personal communication, April 21, 2009).

3. *Knowledge Management*: Almelo used to be knowledgeable of the products and production lines, but since the movements of all the production lines, China is responsible and needs to have the knowledge for all of these lines. The field application engineer in Almelo is now about technical marketing, before this he was the design engineer, with PPD responsibility, but this responsibility resides now in China. At this moment the field application engineers still do the PPD design engineering tasks of before, but these tasks are being transferred to China. The field application engineers still like to take their own decisions (Personal communication, April 21, 2009), but it is important that they learn how to make use of the new organization. If one of the employees feel that their knowledge is essential for the Change Management process to make the right decisions, they should share this. For that they can use the CM Matrix or set up a share point for Change Management.

4. *Technology* (communication): By providing the right technologies, Sensata can help the execution and storage of knowledge on Change Management. But without the right training, the system will not have any applied value.
   In a short time total PPD ownership moved from Europe to China. A couple of design, quality, and process engineers from China went over to Almelo (and Hungary) for training and where totally overwhelmed with information. This is how some information was not transferred completely, and this is also why it is so important that Almelo still supports the Chinese organization. Chinese people are really open, they want to learn and work hard, but they got too much information and too many responsibilities in a short time period. (Personal communication, May 5). Another field application engineer (Personal communication, May 11, 2009) agrees on that point: the structure of change management was and still is unclear. There has been insufficient training, especially for the team members at the PPD and Make sites. Besides there was never stored any Change Management related information, because this was in the 'heads' of the employees, which makes it even more important to store the knowledge in the system, so in the future, expectations of changes can be based on changes in the past.

5. *Performance Measurement*: As is already mentioned before, performances of changes are not reviewed within Sensata. What is the reason that strong and weak points are unknown and why the wrong decisions might be made.

Besides these points there is 'Changing': 'People experience change as something annoying'. This is mostly because of all the procedures and 'unnecessary' actions. The question is how the processes can be made easier and how these processes can be better integrated in the system (Personal communication, April 21, 2009). This is also what Beckhard and Harris already said in 1977; they stated that for change to happen successfully, the following statement must be true:
Dissatisfaction x Desirability x Practicality > Resistance to Change
The team has to be dissatisfied about the current change process, the proposed solution must be attractive, to be desirable, and the team must also be convinced that the change is realistic. When creating these three conditions it is possible for the organization to over win the simple statement, can be surprisingly powerful, and can be used by Sensata. Malmqvist & Pikosz (1998) also found that Change is a 'source of irritation' that have to be overcome.

Bottlenecks in PPD and Make sites

1. *Process*: Also for China can be applied that no Change Management project for Electrical Protection have fully processed according to the Change Management Procedure.

2. *Organization*: And once more, the organization should look for an environment in which it is easy to change. At the moment there is no alignment in priority setting: The engineering manager in Changzhou, (Personal communication, May 25, 2009) says that there are huge differences in priorities between the business center in Almelo and the make site in China. In China the employees see the business center as a customer, to whom they have to deliver their products. And the employees in China would only like to have orders and no changes. The products they make for Europe are only a minor part (15 till 20%) of the production and in their eyes a part on which they do not make a lot of profit, since these products (for example the BRL products) are difficult to make when comparing them to some other products for the Asian market. When it comes to Almelo these products are their number one priority in Electrical Protection and they want China to make, to change and to deliver the products as fast as possible. This gap in priorities between both sites does disturb the processes, especially when it comes to changes.

   Several other interviewees in China acknowledge that their priority of production is for Asia, and besides that they have no priority on using the procedures. For every employee there are set some goals that they have to reach in one year, at the end of the year they will be paid off on those specific goals. Of course these goals do not say that it is important to use all the formal procedures, so they won't get bonuses for using them. An easy thing to do is, to align the priorities at top management level, so design and make can easier collaborate together.

   An example of change management is the localization of suppliers. To reduce costs Sensata is looking for new (local) suppliers. In some cases the raw material of these suppliers is not exactly the same as the materials before. For example the hardness of those materials might not be the same, and in that case Sensata will have serious quality problems. When a supplier is changed in most of the times something goes wrong. There is a high need to ask the suppliers to deliver their raw materials more stable, and otherwise we need to reject the defect parts. A solution might be that the quality engineers join the supplier quality engineer when they visit the potential new supplier, to check raw materials (Personal communication, June 4, 2009).

   According to the process engineer of the 1NT lines it is important to compare the local components with the components that are imported. There should be analyzed whether the local parts have a good or better performance. When using new suppliers costs can be saved, and product performance can be improved (Personal communication, June 1, 2009).

   As we can see there are different opinions about the local suppliers. The quality and purchase people do not like to change so much, since they have a good contact with the current suppliers. The best cost sourcing team and for example finance wants to reduce as many costs as possible. It is important that Sensata is aware of the fact that they might force cost reduction under circumstances that product quality decreases. It is significant to find out what amount of money they will win with changing the change of supplier, and what will be lost because of quality decrease. A suggestion might be to analyze one supplier change, and to make detailed finance reportage. And again, priorities should be the same in Europe and China in order to create the best 'changing environment'.

3. *Knowledge Management*: A problem is that not all the engineers have the authority to access change management in the system; in that case Change Management is only the formal communication tool. It would be a lot better if they could also access the system, so everyone will be informed in time (Personal communication, June 9, 2009). An example of not having authority to access for example the change management matrix is that a change management project was set up in Almelo. After a while this project had to be taken over by a new program manager in Changzhou. The old program manager was able to upload files to the matrix; the new one in Changzhou was not. That is why the program manager in Changzhou had to set up a new project in matrix to be able to upload the files personally.

(Example is about the transfer of the program manager responsibility of the BRL product, from Almelo to Changzhou.) If Sensata wants to manage the knowledge of employees, everyone should have the ability to share and obtain data.

4. ***Technology*** (communication): Sensata needs a more 'user-friendly' system for all the procedures, at least, that is what a majority of the interviewees say. Right now it is really hard to understand the procedures or to find them. It is important that everyone knows how the procedure works, so they will also able to see the bigger picture when a change is processed (Personal communication, June 3, 2009). At the moment the procedures are not going perfect, but it seems to be that Sensata does have very good procedures; the employees only do not know how to follow them. This asks for more training and a lot of discipline. Also a BCS team member (Personal communication, June 16, 2009) agrees on that. Only if the people know how to use it, and actually make use of the system, they will get more and more familiarized.

   There are some employees, who are not so sure about having all the knowledge to do their jobs properly. They did not receive much training from Sensata, and generally they only way to learn is doing the job (Personal communication, June 8, 2009). This is what a lot of interviewees, and especially the planners, process-, and quality engineers confirm. They want to have more training from internal and external experts to be able to do their jobs better. At the moment training is only given by internal experts. In Almelo the training on Change Management is not structurally determined per function. Only the people who were interested got the training during the shortening in working time ('werktijd verkorting'). In China all managers and engineers get a yearly Change Management training.

   Chinese culture: The Chinese local managers seems to have a problem in creating an open atmosphere. For all Chinese people it is difficult to say that there is a problem; this is a difficult thing to overcome. But if a manager is foreign, this is not such a big problem, but no one dares to tell the same things to the local (Chinese) managers. At least it is important that the local managers know this, so they can open up a little bit more (Personal communication, June 8, 2009). Another thing the managers have to be aware of is the fact that whatever the assignment is that they give to their subordinates, they will be followed up even if that will be bothering some other processes. A good example is that one manager said to his subordinate that all change projects should have high priority. For that matter there were 200 projects and the subordinate does not know what to do with it, because it is impossible to use the change management procedure (and belonging Matrix) for every small change. Still, this person is trying to do it, which causes that he is totally overwhelmed and will never be able to finish his work.

5. ***Performance Measurement***: At the make site only the benefit per product is calculated at the end of the process. Other impacts like financial, commercial or risks are not analyzed.

10. CONCLUSION

Now the three sub question have been answered, the answer on the main question 'What does the process of change management at the moment look like, and how can this process be improved when looking at the communication streams?' can be given. Because the research is pointing on some other variables influencing the change process, on those point improvements points will be given. Points of improvement in terms of communication are to be found under technology.

10.1 CURRENT CHANGE MANAGEMENT PROCESS

It is as good as impossible to map the current change management processes. This is caused by the fact that in the Business Center no one has ever finished the Change Management Procedure, and the fact that the changes at the Make site are processed in a different way by different people, departments, or product groups. For some of the change management processes there can be described that they process according the Engineering Change Management process. For other change processes there can be said that the only structure is that the people who are involved, use e-mail as a way of communicating and as a resource for the storage of knowledge. Sometimes a change project is started up in the Change Management Matrix, and never completed in the Matrix, but then the change is completed in reality. And in that way there are a lot more descriptions that can be given on how 'a' current change management process looks like. With that given, we can only conclude that the change management process within Sensata Technologies is ambiguous, unstructured, and unpredictable at the moment.

There can be said that the positive thing on the outcomes of the interviews is that even though the change team members do not use the procedures and checklist, they do use the several tools belonging to change management. For example the several steps of the Change Management Checklist are known by most of the interviewees, FMEA's are started up, and Change Justification Forms are submitted. Negative things on the outcomes of the interviews are for example that the Change Management Matrix, the system that can support to process the changes is only used at a minimum amount of times. After the notifications and approvals for the change, there is in general not one common place were all the documents will be uploaded to share the information. And some departments, like marketing, sales, and planning are in most of the times excluded from changes.

There are a lot of factors that influence the Change Management process. Also for Sensata these factors are to be divided in five categories (Boucher & Brown, 2007, p.9):
(1) **process**
(2) **organization**
(3) **knowledge management**
(4) **technology** (communication)
(5) **performance measurement**

10.2 OPPORTUNITIES FOR IMPROVEMENT

Why improving?

Before there will be outlined what can be improved in the Change Management process, it is important to focus on the question why Sensata should want to improve her Change Management process.
- Change management in product development and engineering can drive *top-line benefits* (Boucher & Brown, 2007).
- Change Management can be *a competitive tool* to increase product profitability through improved market responsiveness in addition to improving efficiency (Boucher & Brown, 2007).
- A good Change management process can assist to *achieve the best performance* and *improve decision-making* in change management(Boucher & Brown, 2007, p.3).
- A good Change management process can *improve speed to market* (Boucher & Brown, 2007).
- An Change process that is fast and reliable can even improve the customer relations (Malmqvist & Pikosz, 2003, p.2).

The goals of implementing Change Management within Sensata, 'to improve the efficiency and the response quality and time internally externally, resulting in high quality offerings to customers ', will be achievable after improving the Change Management process. In addition, product profitability can increase, and decision making can be improved.

Opportunities

The opportunities for improving the Change Management Procedure of Sensata are to be found in the same categories that can influence the Change Management process. In each category there will be outlined on what points Sensata can improve. In the end, a short implementation plan will be given.

Process

This category is on how Sensata executes Change Management. Execution doesn't seem to be Sensata's strongest point, everyone is focused on the goal, the way it is processed is not experienced as relevant. The process, in the way it can be found in Sensata's Global Change Management Checklist, cannot be changed easily since it is bounded at ISO9001 and TS16949 quality requirements. But there is also no need for changing the process the way it is meant to be, the execution of it on the other hand have to be improved.

What is really important to carry out is the *impact analysis*. It will allow Sensata to make more informed decisions and approach change with greater consideration of the overall implications of the proposed change. At the moment the Change Justification form is serving this factor. This step should be taken seriously, and the following criteria can be taken in consideration to put in the Change Justification Form: Impact on product requirements, Change in manufacturing tooling/equipment, current supply/purchase orders, current demand/sales orders, Change in manufacturing processes, related documentation, impact of change on related components or assemblies, part obsolescence (Boucher & Brown, 2007, p. 11).

To make sure that Sensata will take the absolute right decisions about changes, not only engineering should be involved, but also other *affected departments* like marketing, sales, and customer service. If those departments will also be included, everything from regulatory compliance to how the product will be marketed, will be considered.

Organization

The environment has an important impact on the Change Management process. Two important pillars on that point are (1) the *focus of the corporate organization*, do the top managers see Change Management as an important aspect of her business, and (2) the *collaboration among*

stakeholders, are there separate meetings and who gives the approval for change. There is no pressure from the managers to use the Global Change Management Procedure or the Change Management Matrix as far as it flows from the interviews. Besides is the collaboration among the several stakeholders difficult, because they are separated, and departments like marketing and sales are not included.

The management can show their priority by developing a *cross-functional CRB.* If Electrical Protection would like to have standard Change Review Boards like Sensors, there should be more than eighty boards, because there are so many product families. This is practically impossible and at the same time unrealistic. Instead they can set up a small 'pre-CRB' that will receive the Change Justification Forms. This board can point at a change facilitator for each location; for example the quality manager. In consultation with the pre-CRB the facilitator can decide about the functions that should be in the change management team.

By providing good organization charts Sensata can enhance good collaboration, especially between the different centers. If Sensata will *provide clear organization charts*, it will be easier for everyone to understand the way the organization works. As soon as the employees know the way the organization works, they can also find other peoples roles and responsibilities. In that way it is easier to approach people in other sites, and to find change team members. An easy way to realize this, is using the existing outlook application.

Knowledge Management

To improve this category, Sensata only has to expand the resources she already has. The Change Management Matrix is a system that can help integrate supporting information to improve change decision-making on a change request, centralize access to the status of change orders decisions.

It is just a case of demand and supply: when there is raised a new change project, without using the *CM Matrix* it is important that other people who are involved ask for using the system. If there is no demand for using the system, no one will. It should be pushed by the people who do know more about change management to use it, only in that case it will become a habit. Only if it is a habit, to process will be more structured and formalized. Managers can help this process by prioritizing the use of the CM Matrix.

Technology

Technology can help the Change Management execution, and the storage of knowledge. The interviewees see the current system, CM Matrix, as time consuming and not user-friendly. The selection of suitable tools and intelligent deployment of those tools can actually help the Change Management process to be more efficient.

When looking for a *new system* Sensata has to consider whether the system provides the use of the following items: workflow, configuration management, manufacturing execution system (to monitor and lead production processes), product lifecycle management, design visualization and markup technology, Product Data Management (to keep centralized data). Organizations that have systems that support Change Management, mostly have the given items integrated in their systems; to ensure that decisions are being made and that the information reaches all the stakeholders.

The Change Management teams can also have to use technology to moderate *the negative effects of distance*. Standardization of work processes and tools is already done, but the following ways can help them as well:

- *To dislodge distance*: increase the frequency and length of face-to-face meetings. This promotes interpersonal relationships, and so, more familiarity and friendship.
- *Purposely conveying contextual information*: for example by sharing information about vacation schedules or office politics. By understanding each other's background, the opportunities to build familiarity and friendship increases. Trainings on each other's culture can also contribute to understanding.
- *Particular structure of technology use*: as teams learn more about the technologies they use, they will be better able to communicate, share information, and coordinate. For that reason

CM should be incorporated into the competencies and training plan for different positions in the organization. Most of the interviewed people did not have sufficient training for change management. When providing training in change management everyone in the chain should be included; from the field sales engineers till the manufacturing engineers.

- *Adapt communication technologies*: When team members elect to use technologies that more effectively convey the affect and information demanded at the time, they may mitigate the effect of mediating technologies (Hinds & Bailey, 2003).

Performance measurement

For continuous improvement of the Change Management processes Sensata has to measure the efficiency and effectiveness of her Change Management processes. For those measures she can use formal metrics. The metrics will allow Sensata to track what works and what doesn't work. Metrics allow companies to track what works and what doesn't work. With that kind of measures Sensata will be able to make better informed decisions in the future (Boucher & Brown, 2007, p. 12).

This is also a point suggested by interviewees. They would like to see *Metrics at the top management level of both organizations* (Europe and China), so the differences in priorities can be better aligned in that way. Metrics that are suggested by them are:

- Product profitability,
- Financial impact of change,
- Commercial impact of change,
- Cost of quality,
- Risk analysis.

10.3 IMPLEMENATION PLAN

Sensata likes to work with list, this is the reason why Benefits of a good Changing Process, and Main improvement points are summarized over here. This list can be used for implementing the improvements into the organization.

Benefits of a good changing process

1. It can drive top line growth; react faster to market request;
2. It can drive bottom line growth; better efficiency through the organization;
3. It can improve decision making and at the right level;
4. It can improve speed to market; react efficient to requests;
5. It can improve customer relations; clear and efficient customer request handling.

What to change to improve the Change Management Process

The following three pillar cover all five categories that influence the Change Management process within Sensata.

1. *Train Change Management in all departments*
   - Create training materials
   - Make training materials available on the net
   - Assign Change Management facilitators in every site
2. *Involve all departments/functions at the right moment and right information*
   - Have organization schemes / charts available for all departments (also globally)
   - Develop the right CRB and communication list (like ECN); install an administrator who verifies the correctness of the CRB and communication lists
   - Clear justification for the change (to get understanding at all functions) and benefits for Sensata.
   - Train and explain to the organization the cultural differences of involved people.

- Create an official kick-off meeting with if possible face to face meeting (minimum video conference).
3. *Explore the CM Matrix (or other system) in a better way for Change Management*
    - Train all participants in CM in Matrix, it possibilities and the benefits of it.
    - Managers regular review if entries are made
    - Managers regular review progress of CM's
    - Managers regular check if CM's are closed
    - Develop score card (F.I.: # Opened, # Closed, # Open, % documents entered in Matrix, throughput time, etc.)

What is already happening to improve?

The Changzhou and Almelo organization are already busy with the following points of improvement:

- Assign Change Management facilitators in every site,
- Have organization schemes / charts available for all departments (also globally),
- Develop the right CRB and communication list (like ECN); install an administrator who verifies the correctness of the CRB and communication lists,
- In Almelo there is set up one new Change project, all the steps are recorded and shared with the team in Almelo. This is a way to find strengths and weaknesses in the process,
- In Almelo important cultural Chinese aspects are presented and discussed with the team members (this was done by me).
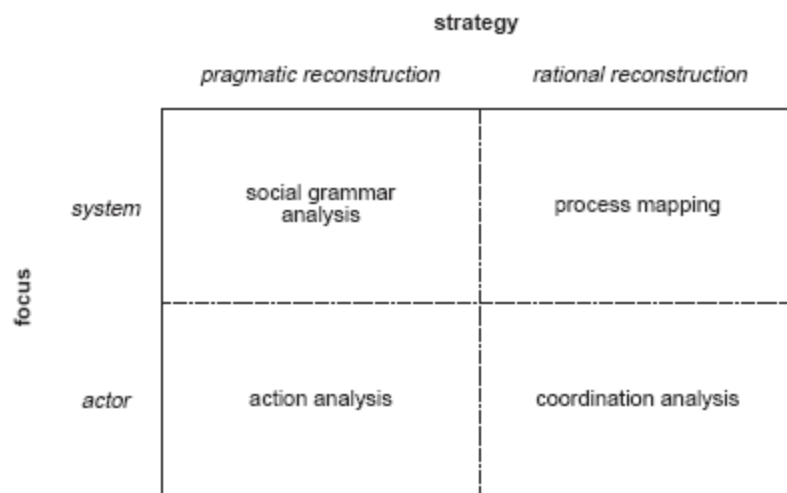
11. LITERATURE

Allen, T. J. 1971. *Communications, technology transfer, and the role of technical gatekeeper*. R&D Management, 1: 14-21.

Allen, T. J. ,1977. *Managing the flow of technology,*. Cambridge, MA, MIT Press.

Ancona, D. G., & Caldwell, D. F. 1992b. *Bridging the boundary: External process and performance in organizational teams*. Administrative Science Quarterly, 37: 634-665.

Backlund,G. & Rönnbäck, A.O. ,1999. *Managing complexity in collaborative development: modeling requirements and enhancing communication.* Microprocessors and Microsystems, Vol. 23, pp. 409-416.

Berger, L.A., 1994. *The management change handbook: a road map to corporate transformation*. McGraw-Hill, US of America.

Biazzo, S., 2000. *Approaches to business process analysis: a review*. Business Process Management Journal, Vol. 6 No. 2, pp. 99-112.

Boucher, M. & Brown, J., 2007. *Engineering Change Management: Better Business Decisions from Intelligent Change Management.* Boston: Aberdeen Group, September 2007.

Brown, S.L. & Eisenhardt, K.M., 1995. *Product development: past research, present findings, and future directions.* Academy of Management Review, Vol. 20, No.2, pp. 343-378.

Cao, G., Clark, S. & Lehaney, B., 2004. *The Need for a Systemic Approach to Change Management— A Case Study.* Systemic Practice and Action Research, Vol. 17, No. 2, April 2004.

Creasey, T.J., & Hiatt, J.M., 2003. *Change Management: the People Side of Change*. Prosci Research; Loveland, Colorado, U.S.A.

Dwyer, L., & Mellor, R. 1991. *Organizational environment, New product process activities, and project outcomes*. Journal of Product Innovation & Management, 8: 39-48.

Graham, B.B., 2004 a. *Detail Process Charting: Speaking the Language of Process.* John Wiley & Sons.

Graham, B.,B., 2004 b. *Understanding Business Processes.* John Wiley & Sons.

Graham, B.,B., 2007a. *Business Process Analysis, Using Detail Process Maps and the Questioning Method*. John Wiley & Sons

Graham, B.,B., 2007 b. *Business Process Improvement: The Devil's in the Detail.* John Wiley & Sons.

Hunt, V.D., 1993. *Process mapping: how to Reengineer Your Business Processes*. New York: John Wiley & Sons, Inc.

Lewin, K. (1951). *Field theory in social science*. Chicago: Univ. of Chicago Pr.

Malmqvist, J. & Pikosz, P., 1998. *A comparative study of engineering change management in three Swedish engineering companies.* Machine and Vehicle Design Chalmers University of Technology, Göteborg.

Tidd,J., Bessant,J. & Pavitt, 2005. *Managing innovation; Integrating technological, market and organizational change.*

Zee, van der, F., 2004. *Kennisverwerving in de empirische wetenschappen: de methodologie van wetenschappelijk onderzoek.* BMOOO, Groningen.

12. APPENDIXES

strategy

	pragmatic reconstruction	rational reconstruction
system	social grammar analysis	process mapping
actor	action analysis	coordination analysis

focus

Appendix 1. Alternative approaches to business process analysis (Biazzo, 2000).
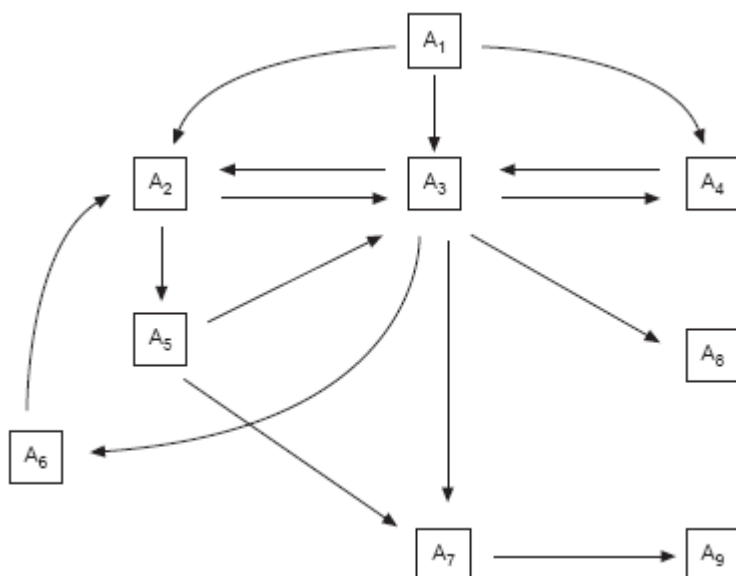
Appendix 2. Business process as a network of actions (Biazzo, 2000).

Appendix 3: Global change management checklist.

Sensata Technologies — GLOBAL CHANGE MANAGEMENT CHECKLIST

It is the recommended that changes made to automotive parts are managed using this checklist format.
Comments describing each element in this checklist are attached to the title of that element.
Elements can be completed simultaneously within a phase, and are not listed in sequential order within a phase.
The minimum required records are defined in G-CM-8 (Doc. #1006005). However the Program Manager may choose to retain additional program documentation within the CM Matrix system.
Line items that are not applicable to the project will be marked "N/A" in the columns "target date" and "complete date"

PROGRAM DESCRIPTION

Program Number :
Last Updated :
Program Description:

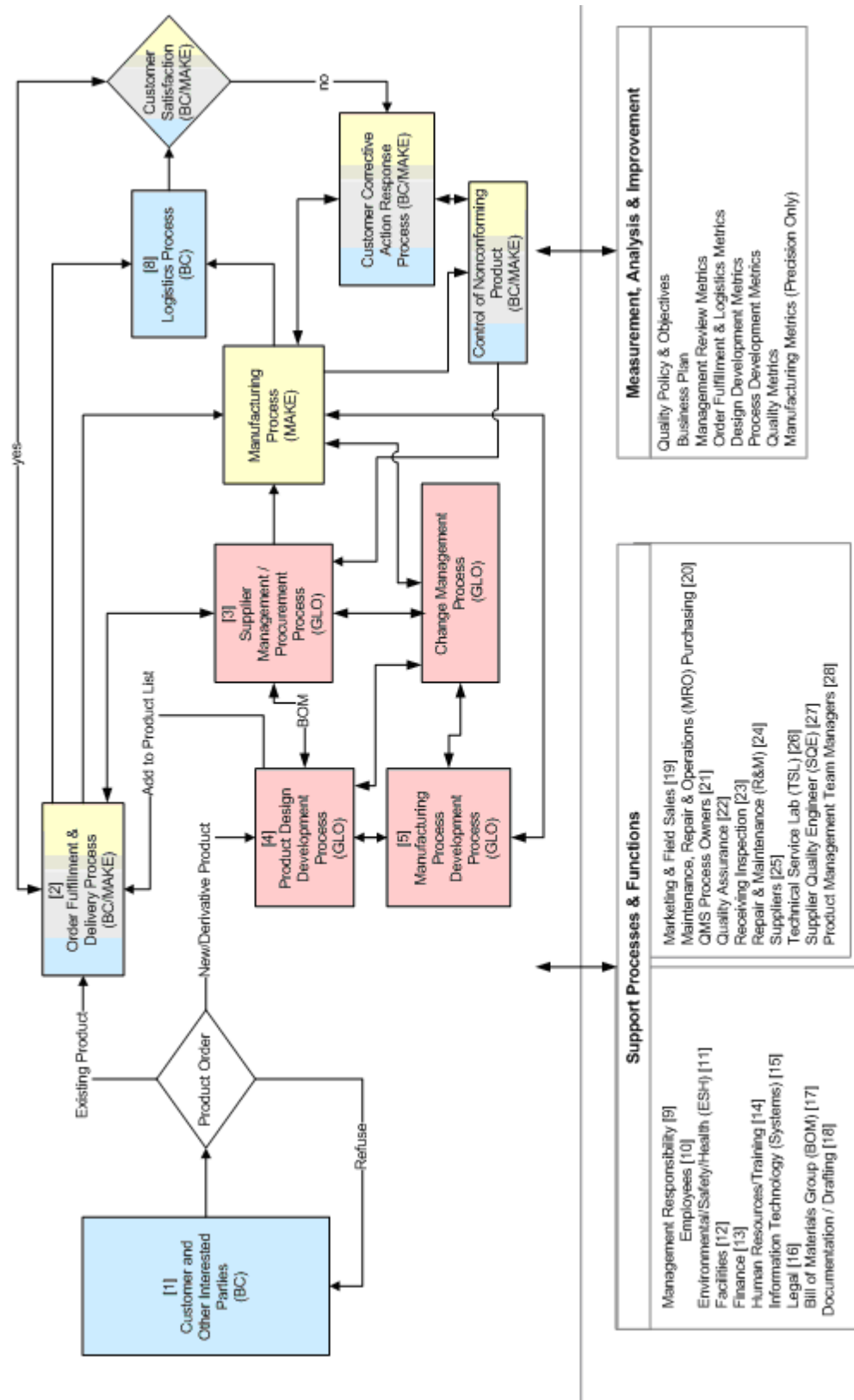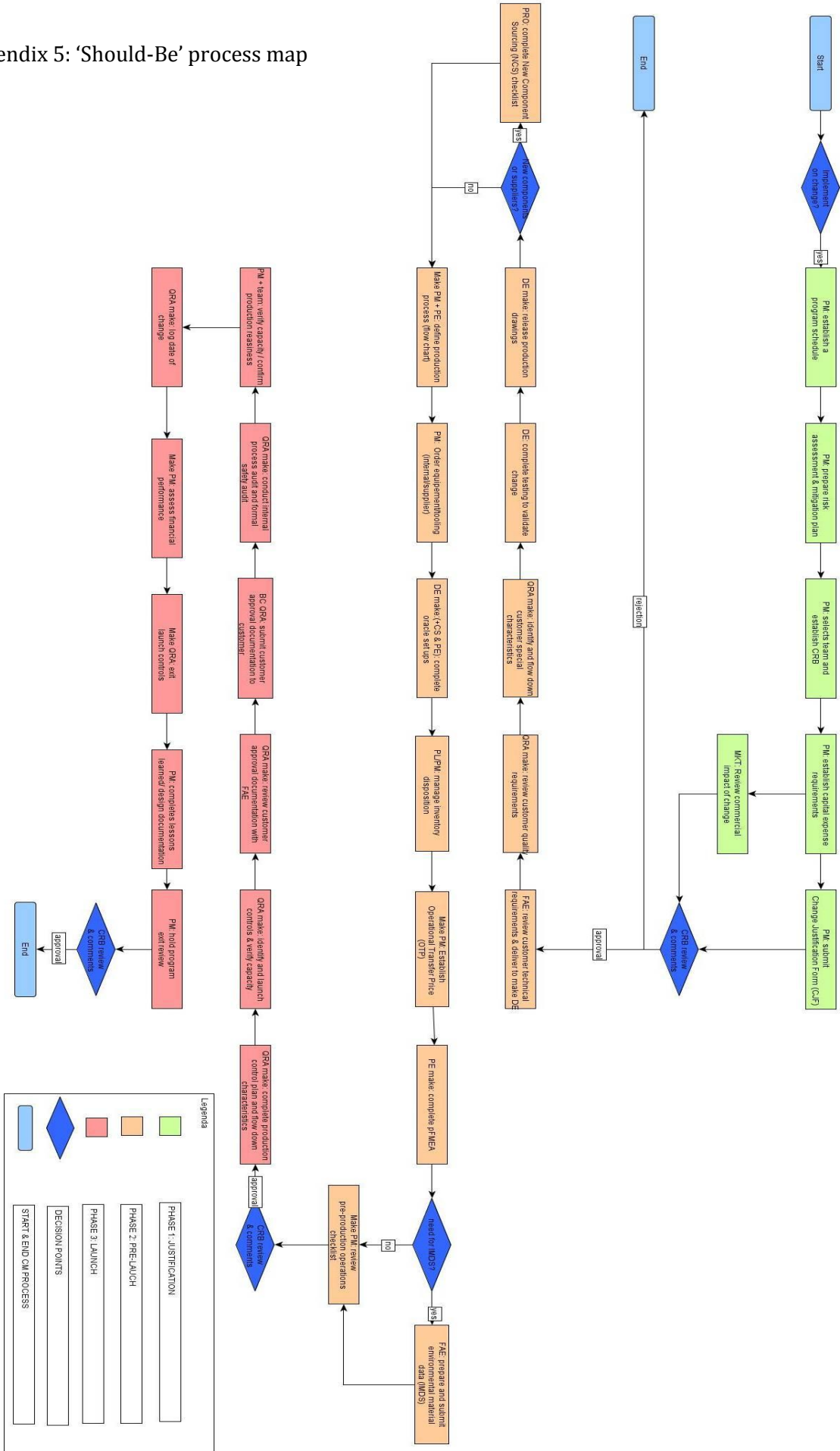| TEAM	BC	MAKE 1	MAKE 2 (if applicable)
Program Manager/ Coordinator	BC PM	Make PM	Make PM
Design Engineer	BC DE	NA	NA
Process Engineer	BC PE	Make PE	Make PE
Quality Engineer	BC QRA	Make QRA	Make QRA
Supplier Quality Engineer	BC SQE	Make SQE	Make SQE
Customer Service	BC CS	Make CS	Make CS
Planning	BC PL	Make PL	Make PL
Procurement	BC PRO	Make PRO	Make PRO
Marketing	BC MKTG	NA	NA
Manufacturing	NA	Make MFG	Make MFG
Mechanization	BC MECH	NA	NA

ELEMENT	RESP.	COMMENTS	TARGET DATE	COMPL. DATE	REQUIRED IN SYSTEM
PHASE I: JUSTIFICATION					
Establish a **program schedule**	PM				
Prepare **risk assessment & mitigation plan**	PM				
Select **Team** and establish **CRB**	PM				
Establish Capital & Expense Requirements	PM				
Review **commercial impact** of change	BC MKTG				
Submit **Change Justification Form (CJF)**	PM				CM Matrix
PHASE II: PRE-LAUNCH					
Design & Quality Preparation					
Review **customer technical requirements**	BC DE				
Review **customer quality requirements**	BC QRA				
Identify and flow down **customer special characteristics**	BC QRA				
Complete **testing** to validate change	BC DE				PDL
Complete/Update **Design DFMEA**	BC DE				Doc workflow
Notify customer of change	BC QRA				CM Matrix
Release **production drawings**	BC DE				Matrix
Component Supplier Preparation					
Complete **New Component Sourcing (NCS) Checklist**	PRO				
Preparation & Debug					
Define production **process flow chart**	Make PE				Doc workflow
Order **equipment/tooling** (internal/ supplier)	PM				
Complete all **Oracle setups**	BC DE				
Manage **inventory disposition**	PM/ PL				
Establish **Operational Transfer Price (OTP)**	Make PM				
Complete **Process PFMEA**	Make PE				Doc workflow
Prepare and submit **Environmental Material Data** (as applicable)	BC DE				CM Matrix
Review **Pre-Production Operations** Checklist	Make PM				
PHASE III: LAUNCH					
Process / Quality System Validation & Approval					
Complete **production control plan & flowdown** of characteristics	Make QRA				Doc workflow
Identify **launch controls** and verify capacity	Make QRA				CM Matrix
Review **customer approval documentation** with BC	Make QRA				
Submit **customer approval documentation** to customer	BC QRA				CM Matrix
Conduct internal **process audit**	Make QRA				CM Matrix
Conduct formal **safety audit**	Make QRA				CM Matrix
Obtain **customer approval**	BC QRA				
Verify **capacity** / Confirm **Production Readiness**	Make PM				CM Matrix
Start of Production & Exit					
Log effective **date of change** / initial lot number	Make QRA				
Assess **financial performance**	Make PM				
Exit **launch controls**	Make QRA				
Complete **lessons learned / design documentation**	PM				
Hold **program exit review**	PM				
COMPLETE					

Global Change Management Checklist   G-CM-4   Doc# 1003034 Rev G

Appendix 4: product realization process map (Sensata Technologies processes).

Appendix 5: 'Should-Be' process map

Start

Implement or change?

yes

PM: establish a program schedule

PM: prepare risk assessment & mitigation plan

PM: selects team and establish CRB

PM: establish capital expense requirements

Change Justification Form (CJF)

MKT: Review commercial impact of change

CRB review & comments

approval

FAE: review customer technical requirements & deliver to make DE

QRA: make: review customer quality requirements

QRA: make: review customer special characteristics

QRA: make: identify and flow down customer special characteristics

DE: complete testing to validate change

DE: make: release production drawings

New component or supplier?

no

yes

PRO: complete New Component Sourcing (NCS) checklist

Make PM + PE: define production process (flow chart)

PM: Order equipement/tooling (internal/supplier)

DE: make: +CS & PE: complete oracle setups

PL/PM: manage inventory disposition

Make PM: Establish Operational Transfer Price (OTP)

PE: make: complete pFMEA

need for IMDS?

yes

FAE: prepare and submit environmental material data (IMDS)

no

Make PM: review pre-production operations checklist

CRB review & comments

approval

QRA: make: complete production control plan and flow down characteristics

QRA: make: identify and launch controls & verify capacity

QRA: make: review customer approval documentation with FAE

BC QRA: submit customer approval documentation to customer

QRA: make: conduct internal process audit and formal safety audit

PM + team: verify capacity / confirm production readiness

QRA make: log date of change

Make PM: assess financial performance

Make QRA: exit launch controls

PM: completes lessons learned design documentation

PM: hold program exit review

CRB review & comments

approval

End

End

rejection

Legenda

START & END CM PROCESS

DECISION POINTS

PHASE 3: LAUNCH

PHASE 2: PRE-LAUCH

PHASE 1: JUSTIFICATION

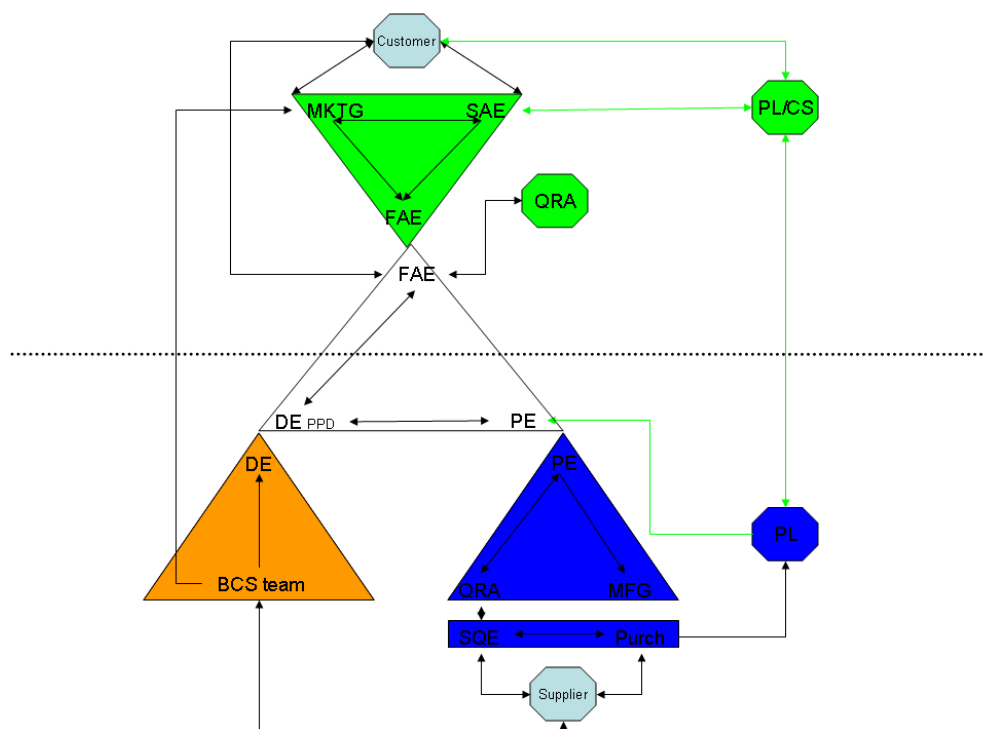Appendix 6: Communication lines according CM procedure

Figure 2: 'Should-Be' communication lines

The green lines represent the communication that the Business Center would have in the normal case (running production), when there is nothing about the product, process or supplier that has to be changed. At the site of the Business Center the Field Sales Engineer together with Customer service and Planning will receive orders for existing products from customers. Customer service and planning will communicate this with the make site, which normally will be Planning. The planning department will make the schedule for production of the product and will update the schedule to the process engineers. As you can see, there is no need for the business center or PPD site design engineers for this kind of communication.

The black lines represent the communication lines that the different sites will have to have, when there is something non-standard, like change in the organization (ECN, CM or NPD). The communication will include a lot more functions, of course depending on the difficulty or risks of the change. When there is a special requirement from a customer the Field Application Engineer is used to specify the technical requirements and the Quality Engineer is there to specify and flow down the quality requirements. Besides, Marketing will be involved when it comes to the financial 'game'. The Field Application Engineer will in this case also be responsible for the communication with the Make-Site. The Design Engineers at the PPD-site will be involved, and through that window all the specific requirements (technical and quality) will be flown down. The PPD Design engineer is responsible to present to the team the previously identified customer technical requirements; the team will have to review and familiarize with the customer specifications in order to help prepare for a successful launch. This may include, but is not limited to:

- Regulatory requirements, and/or
- Restricted substances, which may result in obsolete designs as restricted substances become prohibited.

Official communication reporting should go through the Change Management Matrix system*. Examples:

- -Special characteristics should be identified early in the program, and flowed down by the quality engineer through drawings, DFMEA, Process Flow, PFMEA, Control Plan, and Work Instructions. They should also be flowed down through the supply chain, which is to be found in the change management system.
- -Summary of the evaluation testing placed in the CJF form and/or a separate PVD&R or similar test summary placed in the matrix CM system as a support document.
- -Completed DFMEA in the Matrix Workflow system; where necessary, also include a summary and action plan in the Matrix CM system
- -Summary of the customers/agencies contacted, with details of the approval stored in the Matrix CM system.
- -Production Drawings stored through the Matrix ECN system.
- -With information provided by MAKE Process Engineering and BC/MAKE Procurement, the site BOM group will create or update the site BOM for the device. This information includes: product code for manufacturing, sub-inventory assignments, and verification of cost of finished devices. The final deliverable of this is: Completion of set-up in the Oracle system. BOM must exist in local, global, and any ship to/from locations.
- -Environmental Material Data (per the customer required format) stored in the Matrix CM system.
- -Completed production part approval, per the customer requirements [PPAP (Automotive only), FAI, or equivalent], stored at the Make Site files.

* When describing Matrix as a communicating system, it should be given the thought if you can really communicate through that system.

When this information is put into the CM system, everyone involved will be notified, since they are all able to log on into the system. Besides the communication through the system there also have to be some other communications:

- The area sales managers and marketers will communicate with the clients about the quantities of products and about financial matters.
- Customer service/planning will work narrowly together with the area sales managers, and they will also have contact with the customers.
- The quality engineers and field application engineers from the business center will discuss the specific quality and technical side of the product with the clients.
- The field application engineers will have to communicate with the PPD design engineers to clarify the technical requirements.
- PPD design engineers will flow down these customer characteristics and requirements to the make team; mostly he will communicate this to the process engineer.
- The process engineer will lead the rest of the team at the make site. Who is in this team depends on the kind of change. There will always be involved a quality engineer, manufacturing supervisor, planner and a purchaser (procurement). If there is a change of component needed, also the supplier quality engineer and the BCS team will be involved.
- In case there is no need for a supplier change the purchaser will order new components at the supplier, before this can be done the quantities will be determined in consultation with planning.
- If there is need for a supplier change the BCS team will be looking for the cheapest supplier and the supplier quality engineer will be looking for the supplier which delivers qualitatively the best materials. In the case of a supplier change the BCS team should communicate this to the marketers and area sales managers, so they can verify this with the customers.
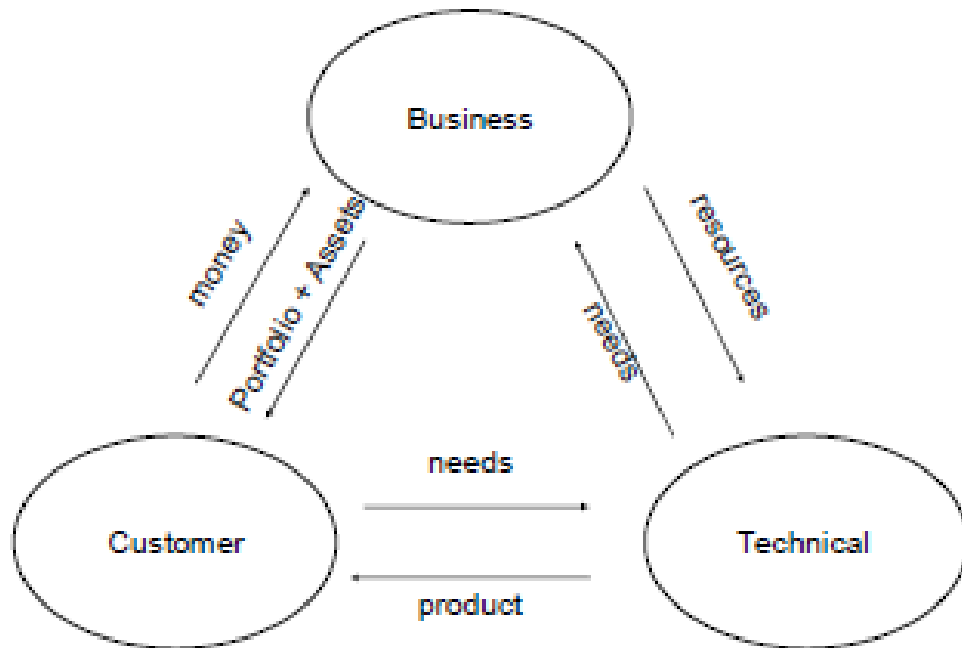
Appendix 7: Actual change management process as a process of action
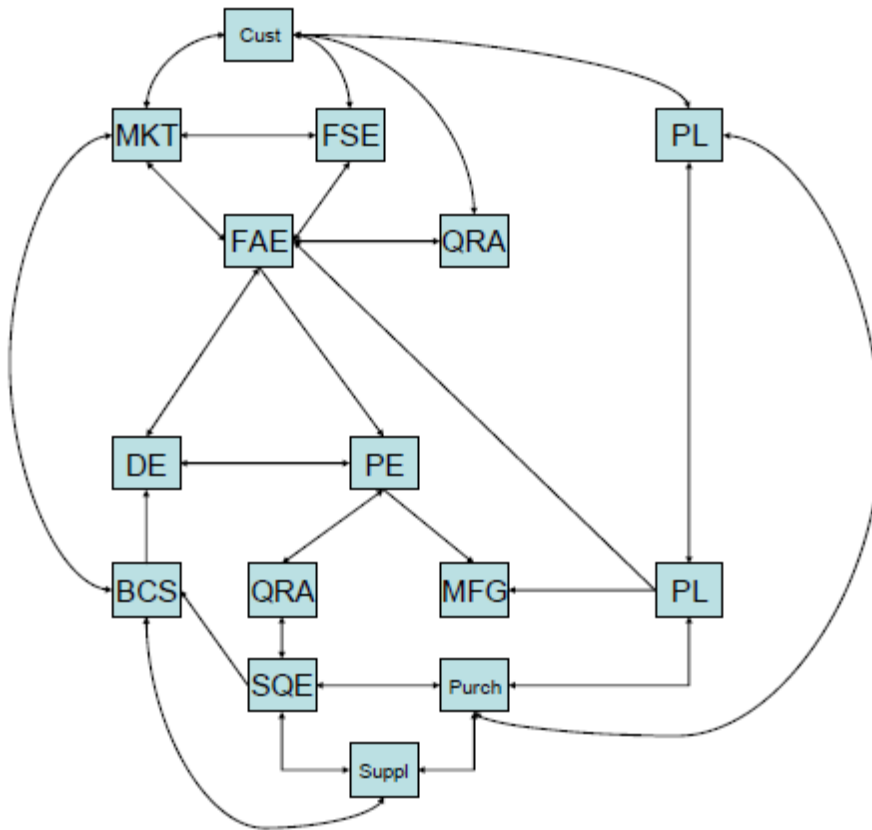
Appendix 8: Selection process for changes.
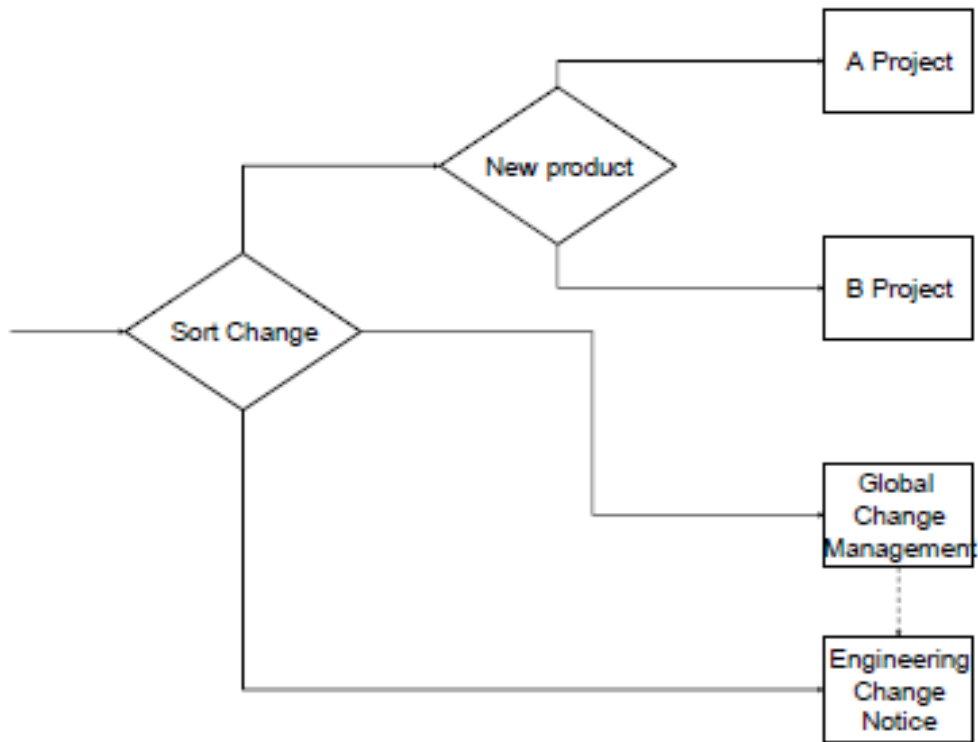
Appendix 9: Communication with customers.

12.1 INTERVIEWS

As is discussed by Hunt (1996, p. 184) it is not useful to define exact questions to ask during an interview, but it is possible to identify guidelines that should be considered during the interview when it comes to process mapping. I will use some standard interview questions that can be questioned to every team member. Additional questions can be asked belonging to the different functions these team members have. For recording the several interviews that will be conducted I will use a 'Standard Interview Kit' in order to organize the process mapping interviews. This kit will be used so fundamental data-gathering elements can be applied to each process mapping effort in order to provide a degree of consistent data collection. This is also recommended by Hunt (1996, p. 179-190).

Interview kit

The interview kit will contain the following elements:

1. Cover Page (Kit cover)
2. Interview and Record Follow-up

    - Interview Date (Process Map Diagram Date)
    - Interview Duration (Start time, End time)
    - Respondent Name
    - Respondent Title and Organizational Responsibility
    - Additional Sources of Information Identified
        1. Documents – Title and Location
        2. Other Suggested Interviewees – Name, Title, Organizational Responsibility, Address, Telephone number
        3. Collection of all paper data

    - Essential Elements of Information – a summary of the key points covered in the interview.
        1. Follow-up questions and/or areas of concern either not covered during the interview, or postponed
3. Activity and process data lists
4. Interview Agenda (Developed in preparation of Interview)
5. Interview Notes and Rough Process Maps

Interviewees

In order to create a good process map I conducted interviews with at least one person of all the different functions in the change process team(s). As Graham (2004a, p. 23-29) promotes: 'If you want to know how a job is done, look for the person or people who really know how to do it. You don't want someone who has to guess their way through the process. New hires, people who did the job years ago, people in adjacent departments, these are wrong people and this is not a criticism of their personal experience.'

To make the process map as reliable as possible it is important that especially the lower levels will be used for detail process information, where as higher levels can be used for the 'big picture strategy' (Hunt, 1996, p. 182). In Sensata Technologies Almelo the following people will hopefully be interviewed in order to be able to create at least process map of the responsibilities and deliverables that the Almelo organization is providing at this moment.

Both, managers and people who are 'really doing the job' will be interviewed, with keeping in mind that it might be so that managers are guessing their way through the process. When it comes to the process flow the descriptions of the people who are really doing the job should receive priority.

The interview questions are tested on reliability and workability by interviewing Tom Dekker, who is responsible for change management (according the same global standards) in the business unit of Sensor Products where they do work according to the global Sensata procedures and checklists.

After the interviews in Almelo, interviews in Changzhou will be conducted with the 'missing' team members at the make-site: design engineers, process engineers, quality engineers, procurement, manufacturing and mechanization. Names and actual functions of people that will be interviewed are at this moment still unknown.

Interview questions

Questions that should be asked during the interviews should stay close to the main goal of the assignment, which is drawing a process flow of the change process in terms of responsibilities, deliverables and expectations. That is why the interviewees should be asked for their responsibilities, deliverables and expectations.

Sensata expects that most of the problems or points of improvement can be found at the communication interface between Almelo and Changzhou, so communication and information questions are important to be able to profile the problems the employees at those interfaces experience themselves. General communication and information questions will be asked to see whether communication streams that support the change process can be improved, by supporting good or other ways of communication.

A short introduction of myself and the project ...	
General questions	
1. Name:	
2. How many years are you working at Sensata/PE/functions:	
3. What is your present function?	
4. What are the most important responsibilities in your recent position?	
5. Can you tell me about a typical day in your job?	
Change management	
I would first like to know what you consider to be 'change management'. So, the next couple of questions are to be able to formulate a proper formulation of what is considered as change management by al interviewees..	
6. What is change management according to you?	
7. When are products changed? (Who initiates change? Complaints	

customers or own initiative?)	

The manufacturing plant has been moved to Changzhou and this might have affected the change processes, because these where before captured in Europe and now have to be managed over two organizations.

8. Do you have all the knowledge to accomplish your tasks? (Did you have enough and sufficient training?)	

Deliverables & expectations

I would like to talk to you about the ..... line. Over the past few years there have been some changes with notches and wires. I would like to know from you what your share is when it comes to these kinds of changes.

9. From who do you receive deliverables that have to be processed by you during these kinds of change? (Deliverables: in this case inputs like requirements, documents, forms, drawings, records, emails etc.)	
10. What were your expectations of these deliverables of your team members? (Telephone, simple e-mail, a specific document etc.)	
11. Do they know how you would like to receive these deliverables? (In what manner, what kinds of documents, through which communication type)	
12. Who (function) receives deliverables from you?	
13. What is the product/deliverable (business plan, customer requirements, drawings, etc.) you distribute to them?	
14. Do you know how *exactly* (in what manner, what kinds of documents, through which communication type) they want to receive your deliverables?	
15. What went well during these change processes?	
16. What do you want to improve or the next time or what could have been better during the last change?	

Team (composition)

When processing these changes in the ..... products you worked in a team.

17. Who do you consider to be in your team when it comes to processing changes?	
18. What do you do to be an effective team member?	
19. How far ahead do you plan? Do your team members know about your planning?	

20. What role plays management in the product change process?	
21. Do you know who the external costumer is and what his demand is?	
22. Do you think that the organizational borders and geographical borders do influence the process in a negative way? How can the organization better deal with this?	

Communication & information

23. How do you communicate with the business centre in Europe, what kinds of communication do you use?	
24. Which type of communication do you use most?	
25. What percentage of time do you spend on the phone?	
26. How do you ensure that you communicate clearly and effectively?	
27. Do you sometimes have trouble communicating with your team members? (For example: do you always understand the requirements your colleagues are talking about)	
28. What is the worst communication problem you have experienced?	
29. Are there any barriers for communication that the organization can and should overcome? (Can you describe these barriers?)	
30. How do you think that the overall process of product change can be improved in terms of communication improvements among team members?	
31. How can the communication struggles between Europe and the Changzhou organization be better aligned?	

Process Change Map

I have made a map of the change process according to the global change management checklist. Can we walk through this map to see which steps are normally taken by you and other team members. So I can draw a map of how the change process is taking place at this moment.

32. Do you think that the map I made can be useful when processing the changes?	
33. What would you like to change about these global procedures to make it more/better workable? (What should be left out and what	

should be added; and in what sequence?)	

"I have six honest serving men (they taught me all I knew); their names are What and Why and When and How and Where and Who." (Rudyard Kipling, in: Graham, 2007a).

Literary support for interview questions

To make the questionnaires as reliable as possible a literary support will be given to the questions.

The most important questions that have to be asked in order to be able to describe and to map the 'As-Is' process are:

(1) What kind of information the actors received;
(2) From whom they received it;
(3) How they received it;
(4) How they processed the different kinds of information; and
(5) To whom they sent messages as a result (Crowston, 1997; In Biazzo, 2000).

These questions are a little bit different formulated under question 9 till 16.

Besides the following questions are asked, for the belonging reasons:

How many years are you working at Sensata/PE/function? As is described in the Communication Web Model (Brown & Eisenhardt, 1995) increases the performance with increasing mean tenure, but this performance drops after five years. It is important to know the average time team exists, to see whether team performances can be improved in that area.

What are the most important responsibilities in your recent position? Not described in literature, but this is a need, because responsibilities have to be mapped. Formal responsibilities can be extracted from the global procedures and checklist, but it is important to see whether the formal responsibilities and actual responsibilities differ from each other.

What is change management? How does that happen? Who changes (who does make it happen)? Where does the change take place? When are products changed? This are the five questions that need to lead to the 'As-Is' map of the change process. 'When walking through the process steps and drawing the process map the six question, what, why, when, how, where and who will be kept in mind, in a way that is described by Graham (2007).' 'In defining a process, the objective is to capture reality; to paint a realistic picture of what the process does. We ask what is happening at every step along the way. We also capture where the work is done, who does the work and when the work is done. We don't ask why, because it doesn't matter…yet. With a good process story in front of a team of people who represent the process (and really understand their piece of it), it is time to ask why. Now we ask the same questions that we asked to define the process…but, this time we ask why to every answer (Graham, 2007).'

Did this change have a big impact on your function and responsibilities? Do you feel that this change has moved too fast? Were the strategy and plan for the change management process clear communicated to everyone? The meetings with Tom Dekker and Niels Krakers made clear that the movement from the manufacturing from Almelo to Changzhou has been going really fast, without having all the employees up to date about the business processes and their new responsibilities. It is important to take this information within the interview questions, because people cannot absorb an unlimited amount of change. When their absorption maximums are exceeded, people begin to display sign of dysfunction, such as fatigue, emotional burnout,

inefficiency, sickness etc., which also might lead to poor communication and reduced trust (Berger, 1994). It is essential to find out whether these problems play a role in the change management processes, to see if improvements can be made.

Who do you consider to be in your team when it comes to processing changes? When people in Almelo believe that they only have team members in Almelo and when this is the same in Changzhou, both organizations should be seen like that. In that case we are talking about collaborative development. This brings a lot of advantages and disadvantages, but for sure it causes some extra communication difficulties (Backlund& Rönnbäck, 1999).

What do you do to be an effective team member? How far ahead do you plan? Do your team members know about your planning? What is the average time that team members stay within the team? (How long does the change process actually take?)What role plays management in the product change process? Do you know who the external costumer is and what his demand is? Do you think that the organizational borders and geographical borders do influence the process in a negative way? How can the organization better deal with this? All these questions are about (the formatting of) teams. These questions can be linked to the Communication Web model, the Disciplined Problem Solving Model and collaborative product developments. When knowing more about the teams, advice can be given on how to improve team performance or how to improve internal team communications (Brown & Eisenhardt, 1995; Backlund& Rönnbäck, 1999).

How do you communicate with your team members, what kinds of communication do you use? Which type of communication do you use most? What percentage of time do you spend on the phone with change team members? It is important to find out where communications lead to break downs, because it is easy to track those kinds of breakdowns, and simple solutions can be found for such kind of issues.

Do you sometimes have trouble communicating with your team members? What is the worst communication problem you have experienced? Are there any barriers for communication that the organization can and should overcome? How do you think that the overall process of product change can be improved in terms of communication improvements among team members? How can the communication struggles between Europe and the Changzhou organization be better aligned? These questions are not really to be supported by literature. I feel that is important what the employees feel about the communication; whether they think about it or not, in what ways they feel that the communication can be improved, etcetera. Of course this gives this some subjective influence onto the subject, but it is a good way to find out what is important for Sensata's employees.