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**PRODUCT QUALITY DEVELOPMENT IN GLOBAL  
OPERATIONS**

# PRODUCT QUALITY DEVELOPMENT IN GLOBAL OPERATIONS

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## **ABSTRACT**

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This work developed the quality standard for the PKCE, because the company got more locations across the world and sharing of information was not as good as before. The aim was to unify the quality regardless of the location of the office.

This work gathered information from the customers of the company and analyzed their quality requirements and standards, which served as the basis for the company's own standard, which fulfills the requirements but is not of too high quality.

This work resulted in the quality standard, from which the quality requirements for the products, materials, parts and packages can be found. The quality standard is stored in electronic form on the company's internal computer system, where it is accessible to all and can be read at the same time. In addition, instructions are taught for people working both inside and outside the company.

The instructions have also been translated into the English language due to the internationalization and could be translated into Chinese later. The standard will be updated regularly and the requirements are modified when necessary. Therefore, the standard has persons who are responsible for the contents and who make sure that only the relevant changes are made and all the important information is added.

Keywords: Total quality management, quality control, quality standard, quality, designing, mechanical project process, mechanical parts

# TABLE OF CONTENTS

1	INTRODUCTION .....	5
2	ABOUT QUALITY .....	6
	2.1 Quality in PKC .....	6
3	ORIGIN OF QUALITY .....	8
	3.1 Definition of quality .....	8
	3.2 Quality Company .....	9
	3.3 Quality Company's characteristics .....	10
4	QUALITY DEVELOPMENT .....	12
	4.1 Quality of products .....	13
	4.2 Quality of production chain .....	13
	4.3 Quality Functions .....	14
5	COMPREHENSIVE QUALITY MANAGEMENT .....	16
	5.2 Key elements of quality management .....	17
6	QUALITY SYSTEM IN PKC ELECTRONICS .....	19
	6.1 ISO standards in PKCE .....	19
	6.2 Quality requirements of PKC customers .....	20
7	STARTING POINT FOR PKCE QUALITY .....	21
	7.1 Problems before quality instructions .....	21
	7.2 Client Project .....	23
	7.3 PKCE's planning process .....	24
	7.4 Manufacturing process of a mechanics product .....	25
	7.5 Initial details of PKCE quality standard .....	27
8	PKCE QUALITY STANDARD .....	29
	8.1 Contents of the quality standard .....	29
	8.2 Deployment of the standard .....	30
	CONCLUSION .....	32
	REFERENCE .....	33

# 1 INTRODUCTION

PKC Electronics is a subsidiary of the PKC Group. PKCE produces electronics design and contract manufacturing services mainly to the automotive, industrial electronics and energy industries. Products designed and manufactured by PKCE are used in vehicles and in equipment for power regulation, as well as in testing electronics and in solutions for energy-saving. PKCE also provides strong testing and mechanical design expertise and efficient supply chain management. PKCE takes advantage of other transactions and cooperation between them, providing customers with product solutions, which combine electronics, mechanics and wiring harness expertise. (7.)

The objective is to find out what would be the best possible solution for the company, when the activities begin to expand all over the world, and the customers' needs are changing and expanding. Engineering is part of the development program, which is intended to improve the company's profitability, reliability, flexibility and provide the opportunity to be involved in changing customer requirements. PKCEs' business is expanding all over the world and this is why it is necessary to identify, develop and update the current approach.

The aim of this thesis is to develop a shared idea of quality, which will provide the company a harmonized quality. Another goal is to train all the workers according to the new guidelines. It is also important to keep the instructions updated as the requirements change.

## **2 ABOUT QUALITY**

The last ten years have brought forward the idea about quality in businesses. During the 1960s it was important how well the finished products reflect the drawings and the ideas presented in them. That was perceived as high quality and the goal was to have the final product resemble the original as closely as possible. The idea of quality changed over time, and during the 1980's brought focus to the customer's point of view, which meant that the idea of quality shifted from the final product towards service. This meant that the product centric idea of quality diminished over time. Nowadays the quality is much more than the technical features and services. Quality is all encompassing and includes the product, feeling of quality and customer satisfaction. (6.)

Various quality management systems have been developed and thousands of companies around the world follow their own business activity using different quality management systems. In the 1990's the general guideline was that the companies were trying to adapt to ideals specified in the corresponding systems, but recently the focus has been to adapt to change by being as agile as possible. (1.)

### **2.1 Quality in PKC**

The importance of quality, new customers and expansion of activities forced the PKCE management to review the old practices and they noticed that the old way of doing business was not satisfactory for the customers, so it was time to make changes. At that time there was an idea about a companywide guideline for quality. The design fault and effect analysis guide for the vehicle industry side was introduced to the electronics side at that time. There was a separate project in China to use Six Sigma, which contained the guidelines used in Kempele. The Total Quality philosophy led the company to modify the internal functions, in order to improve their skills, quality and responsiveness to changing customer needs. Also, the annual customer survey results supported the decision to improve the quality. (4.)

The company also noticed that, although the company products would be of top quality, it would still not be enough, because the company's products include a great deal of know-how and work from to the suppliers. It was therefore important to begin to establish quality guidelines for everyone; raw material suppliers, subcontractors, suppliers as well as to the company's own workforce, thus the whole product chain would work optimally and the products would be of high quality. (4.)

### **3 ORIGIN OF QUALITY**

When speaking about quality, meaning about the customer satisfaction. Even if producing flawless quality in an efficient manor, it would not be regarded as high quality if the customer is not satisfied. Therefore when talking about the quality, talking about the customer's needs and expectations at the same time.

#### **3.1 Definition of quality**

Quality has many different interpretations, depending on the angle of view of the matter to be considered. In general, however, quality is the fulfillment of customer's requirements using the most cost effective means available. It is good to remember that the customer satisfaction must not be the only goal and should not drive up the costs to unhealthy levels. It should not be pursued without keeping an eye on the costs.

In order to maintain the company's high-quality and to produce high-quality merchandise the company must remain up-to-date and develop their performance to the top. Criticism comes from internal development projects, but often ideas come from outside: the proposal for a client, competitors, or even social change. Quality is monitored by the different sides, and, therefore, even the law changes, environmental objectives, or changes in society will lead to changes in the quality of the company. The company has to keep up with these changes to ensure continued good and quality products. Globalization also provides challenges to the quality of the company. It has national contracts, but also international agreements, which must be taken into account when talking about the company's high-quality products. (3.)

The most common definition of quality is the fact that it is done correctly at the first time and mistakes are not made. The motto could be inside the company, "Do what is right. Do not do wrong." One even more an important question which must be taken into account is doing things right and doing the right things. An example might be a



company's product, which the company is very proud of, and considers excellent, but the customer is not so enthusiastic about and regards it as too high quality and too expensive. Then it can be said that the company has failed because the customer does not want to pay for the higher quality. Quality should be considered holistically and not to center too much on small details because they do not necessarily guarantee a high quality and successful product for the company to achieve a competitive advantage. The Total Quality Management is the order of the day.

### **3.2 Quality Company**

Quality Company is flexible and nimble, and is kept up-to-date. The organization is light, there are not too many of managers and the staff is working in teams, and IT has a large role. Processes are streamlined and speed up all the time as far as possible. The Decision making process takes into account all stakeholders and its impact on the society.

The company comprises of, of course, success factors, whose activities affect the company's performance, either making it a success or a failure. Therefore consider the company's critical success factors. These include, for example:

- skilled workers
- low production costs
- rapid product development
- good customer satisfaction
- good marketing channels
- reliable sub-contractors
- competitive and high quality products
- environmentally conscious business.

In addition, it is important that the employees and the management team operate with the company's vision, and the teams are included in the decisions, and all are up-to-date and agree on abiding by company policy. In the long run, a good quality and functional organization is the key to the firm's survival and job security and that is why it is so

important to invest in good quality and doing the right things at all levels of the company. (3.)

### **3.3 Quality Company's characteristics**

Quality companies have some common characteristics that include the following: customer orientation, staff development, social responsibility, continuous improvement and quality management.

Customer orientation comes from understanding that without the customers there is no cash flow, and if the flow diminishes, the company fades away as well. The Japanese philosophy of quality is that the customer is God. Even if the customer is not always right, one must listen carefully to the customer, because the customer is a business sponsor. Every customer is not a buyer of the product and the payer, but customers include the sub-contractors, wholesalers and retailers, too. They, too, are important to the quality and success of the company, as few companies will no longer manufacture the product from start to finish. (5.)

Staff development helps to keep the company in the race, and it is people that make the company's quality. If a company wants a sustainable and good quality, it is necessary to develop and train competent staff and to view it as a company resource, even during challenging times. Through education and added responsibilities it is possible to increase the motivation of the staff to develop all the time, and to raise the quality of the company. (3.)

In modern times, the social responsibilities of the company are also a big challenge. Laws and regulations change, and become stricter all the time and the company must keep up with them, if they are planning to stay in the race. Societal responsibilities cannot be ignored when talking about safety, health question, pollution generation and resource waste prevention. These are very important factors today and many clients study and ponder about how much of the company's product waste a natural resource, polluted, and foremost, where it has been made. (3.)

Changes come every day, some bigger and some smaller, but even after modifications, one must not lay still and admire how great one is, because the world evolves constantly, and reforms and developmental projects should be continued as soon as the previous one ends. Ideas and topics for development projects and reforms come from feedback, audits, and through methods, but also from watching the competitors and the world brings fresh ideas and opportunities for development. Watching the world and competitors is the basis for development. (3.)

## 4 QUALITY DEVELOPMENT

In order for the company to achieve the highest possible quality and reliability, the company must spread the concept of quality beyond the walls of the company. The whole production chain must embrace the concept of quality: raw material manufacturers, subcontractors, manufacturers of the final product and customer care. Thus, it is not enough that the company improves the quality within its walls, but it must be extended beyond the walls of the company. The quality instruction must be, therefore, taught and instructed to the raw material manufacturers and suppliers to guarantying an all-encompassing, functional and quality production chain. (8.)

One of the most important factors that must be emphasized is the understanding of the product and the work needed to manufacture it. When talking about the product, meaning the quality of the final product, and when talking about the work, talking about the quality of the production chain. These terms are often confused and must be fully explained and made clear in the company's quality policy. The company should put much effort into understanding the concept of quality and make sure that each and every person understands it because it will affect the following:

- The company's product and the functional objectives may conflict with each other and when that happens, each person should know the priority of products.
- Quality Control function requires clear metrics and they cannot be created until the priorities are understood in the same way everywhere.
- Distinguishing between the quality indicators of products and operations.
- Rapid changes in customer demand which company must be able to respond quickly.
- It is not possible to rapidly change the priorities of the process if the concepts are not clearly defined.
- Development of the quality of the production chain requires effective leadership. If the concepts are lost, then the development is difficult. (8.)

## **4.1 Quality of products**

When talking about the quality of the product, can be talk about all of the features and characteristics of the products. Quality includes the goals and needs set to the product. In the end, the quality is assessed by the customer but the people involved in the development can also set their own requirements. Depending on the product, the authorities can add requirements for the product, thus adding their own touch to the quality of the product and, therefore, the quality requirements are many and varied.

Quality can be divided into the following parts:

- The expected quality, reliability, durability, safety and consistency.
- Expected quality means the expectations from the product. These expectations are created by the markets, previous products of the company and the image of the company.
- Reliability should be something that one can calculate, measure and evaluate.
- Durability of the product can have different opinions, but in general, when talking about the durability of the product for the life of well-known operating conditions and the intended use of the product.
- Product security refers to security risks the product poses to users and the environment.
- The compatibility refers to the comparison of the possible standards and other similar products.

These may be affected by their design, but even manufacturing and production methods affect the quality of the product in different parts. The quality of the product is the result of many factors, and therefore it is important to emphasize the totality of relates and affects the quality of the product. (8.)

## **4.2 Quality of production chain**

Looking at the product design and manufacturing errors that may occur, or the economic efficiency of the manufacturing, it can be said that it is looking at the quality. All of these elements affect the quality of the production chain. The quality of

operations may be extended to the whole of the company and to all of the activities inside the company. In this way, each individual process and task is viewed.

The quality of production chain affects many parts because the errors in the operation of the product causes unnecessary inspection and repair work, which wastes effort and hours. They also affect customer relationships and the quality of the product. The errors in the production will cause the company's brand image to suffer. The quality of the production chain also affects the working atmosphere if there is no uniform sense of quality and one department can do whatever they please. It is therefore important to develop the product chain and to keep the quality control active at all times, in order to timely intervene even on small defects. The concepts should be clarified in detail to all staff and, where appropriate, to educate and inform the staff. (8.)

In this case, it is important to expand the quality of the production chain beyond the company and educate the partners in order for the quality of the production chain and the products reach the desired levels of quality. This will help the company to maintain and even improve their own image and to produce good and effective products within the given time. The company's internal core principle is "Do what is right, do not do wrong."

### **4.3 Quality Functions**

Every company strives to provide each customer a flawless product as rationally as possible. The quality is kept at a level where each product can be done right at the first time at a reasonable price. But because each customer's needs are different, and the quality depends on so many elements it is, unfortunately, rarely possible to make an entirely "error-free" product. It is necessary to make corrections and modifications to the product throughout its life cycle. Although there are a number of different methods and techniques in use, the world and the requirements for the product are changing, and the company must be able to respond to this.

For example, when one buys a cell phone, it is loaded with all the basic programs with the latest updates. Because the world is changing and the time goes by, there must be updates and new products are needed. These programs are repairs and modifications. Sometimes the product does not notice the error until sometime later, when the client is trying to reach the device or the company has discovered an internal error that affects the product. Sometimes an error in a product is found only after some time, when the customer uses the product or a flaw that company is internally discovered. Then the errors must be corrected in order to keep the customers happy and to make them stay as customers of the company.

Sure, the aim is for the products to always be error-free, and there is a variety of functions to discover flaws. Quality control is one of the most important factors and the aim is to find the quality variations and irregularities before the product reaches the market place. Quality inspection is performed to the final products, product components and documents in order to discover errors and deviations in time. Quality guidance utilizes the information gathered on quality problems and tries to discover the root cause for the problems and solve those.

Quality guidance involves each employee and task of the company. Everyone must understand their own role in it, and each person must be fully involved in the action. It is especially important to tell each employee that each input has an impact on the quality and operations of the company. Each employee must be trained and made motivated to maintain quality because only then the company has succeeded in their own quality control. The quality assurance processes ensure that the company processes work and are complete. The goal of the quality management is to keep the quality of products at the desired level both in the short term and in the long term. In addition, another goal is that the quality meets the expectations set by the company.

## 5 COMPREHENSIVE QUALITY MANAGEMENT

Figure 1 shows the John Oakland model, which describes the total quality management generally. Comprehensive quality thinking is based on a corporate culture that emphasizes quality work, effective communication of goals at all levels of the company and commitment to continuous improvement. In the heart of The Quality Management model are customer-supplier interfaces, which are included in the company's business processes. These include the inner and the outer interfaces where the maker of the next phase is the customer of the previous stage and where the customer is an outside company or the end customer respectively. Customer-supplier interfaces are brought to the center stage, as the client determines the ultimate quality of the company's operations.

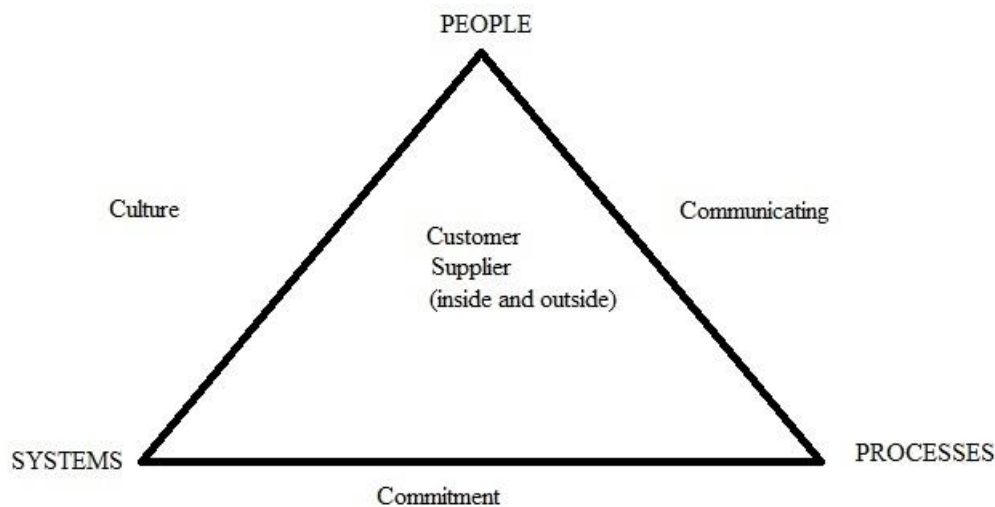


FIGURE 1: Total quality management system (2)



## 5.2 Key elements of quality management

Table 1 lists the key factors and methods in comprehensive quality thinking. Tools, practices, and techniques have been mentioned as an example of how they can be implemented in practice.

Table 1: Key factors of quality management (2)

The key factors	Methods (practices, tools, and techniques)
<b>Customer-oriented approach</b>	<ul style="list-style-type: none"> <li>• Channels for handling the customer feedback</li> <li>• Identifying customer needs (surveys, market research and supplier reports)</li> <li>• Customer satisfaction surveys</li> <li>• Post-Marketing</li> </ul>
<b>Commitment of the management</b>	<ul style="list-style-type: none"> <li>• Support for development</li> <li>• Top management involvement and the positive attitude of middle management</li> </ul>
<b>Quality Planning</b>	<ul style="list-style-type: none"> <li>• Mission and Vision</li> <li>• Quality Policy</li> <li>• Quality Objectives</li> <li>• Communication strategy</li> <li>• Project monitoring and improvement of</li> </ul>
<b>Fact-based management</b>	<ul style="list-style-type: none"> <li>• Quality audits</li> <li>• Employee satisfaction surveys</li> <li>• Quality Monitoring of cost</li> <li>• Performance metrics</li> <li>• Risk management and prevention of problems</li> </ul>
<b>Continuous Improvement</b>	<ul style="list-style-type: none"> <li>• PDCA circle</li> <li>• Self-evaluations (ISI 9000, EFQM, etc.)</li> <li>• The seven quality tools</li> <li>• The seven management tools</li> <li>• Other tools and techniques</li> </ul>

<b>Participation of entire personnel</b>	<ul style="list-style-type: none"> <li>• Information</li> <li>• Feedback Systems</li> <li>• Working Groups</li> <li>• Reward systems</li> <li>• Empowerment</li> </ul>
<b>Education</b>	<ul style="list-style-type: none"> <li>• Personal Education Plans</li> <li>• Education Plan for the Company</li> <li>• Gathering and transferring of the silent knowledge</li> </ul>
<b>Working groups and co-operation</b>	<ul style="list-style-type: none"> <li>• Cross-organizational teams</li> <li>• Quality Circuits</li> </ul>
<b>Communication systems</b>	<ul style="list-style-type: none"> <li>• "Top-down" and "bottom-up" as well as horizontal communication</li> <li>• Up to date guidelines</li> </ul>
<b>Learning</b>	<ul style="list-style-type: none"> <li>• Continuous training and coaching</li> </ul>
<b>Process management</b>	<ul style="list-style-type: none"> <li>• The quality manual documentation as a link</li> <li>• the quality management practices</li> <li>• Operating instructions</li> <li>• ISO 9001 certification</li> <li>• Process ownership</li> </ul>
<b>Supplier Collaboration</b>	<ul style="list-style-type: none"> <li>• Supplier audits</li> <li>• Supplier Training</li> <li>• The agreed quality objectives</li> </ul>
<b>Respect for the environment</b>	<ul style="list-style-type: none"> <li>• Environmental Handbook</li> <li>• The environmental management system procedures</li> <li>• ISO 14001 certification</li> </ul>

## **6 QUALITY SYSTEM IN PKC ELECTRONICS**

Quality department has built an internal quality system that transmits information across the organization. When talking about quality system, can be also talking about quality leadership, as they are very closely related to each other. A quality system is needed, and it aims to achieve, for example:

- customer satisfaction
- high quality of products, services and processes
- training for staff
- shared practices throughout the company.

The quality system also includes different standards, which are updated all the time. Certificates are awarded by different organizations and each of these has its own letter combinations. The most commonly used are the ISO standards, which are internationally established but there are also SFS and EN certifications. SFS-standards were adopted in Finland and EN standards were established in Europe. (3.)

### **6.1 ISO standards in PKCE**

With new products and customers, a company needs new ISO standards to keep up with the competition and with the quality standards. Also, expansion into new markets creates new demand levels. PKCE has an ISO 9000 and 9001, ISO 14001, ISO 18000, and 18001, and ISO / TS 16949, which help to determine certain quality requirements. The ISO/TS 16949 is very strict with the quality requirements and the compliance to them, especially in the vehicle industry. (7.)

## **6.2 Quality requirements of PKC customers**

Each client has their own quality standards, but they are often closely related and the internal standard is based on those. Customers often have general requirements applicable for every product but each product also has some requirements for that specific product. The lifetime of the product is not usually specified as long as it fulfills the needs and requirements set for the use of the product.

Research and development tools are usually in use only for the duration of the product development phase, which is usually a period of six to 18 months, depending on the lifecycle of the product that is being developed. The actual requirements, such as the amount of uses, but there are some specific requirement for the use conditions. As the tools are used all over the world and within various types of climates, there is a special weather cabinet in which the tools are tested, and of course, they will have to fit into them. Again, there are exceptions, that is, sometimes the customer can demand a bigger unit to be built than what the maximum size of the cabinet is. Each client has their own weather chamber and the size and volume of the cabinet varies. (4)

## **7 STARTING POINT FOR PKCE QUALITY**

All employees were sitting in the same room when the company started their operations. This allowed effective sharing of information. As the number of locations and personnel increased, the sharing of information became more difficult, and the idea arose of the company's internal guideline and so did the need for it. There was a need for a uniform operating way, especially when the business started to expand around the world, the example in Kostamus Russia and China in Suzhou. Each country has their own way of working and the company felt the need for a uniform way of working. They wanted Finnish quality from all locations. (4.)

When talking about a standard, talk about the company's internal quality guidelines. The purpose of the standard is to be the company's quality manual. It is intended to ensure the quality of the products of the company and to guarantee that the quality remains high from start to finish. Standard is a global document that guarantees that each location produces uniform quality that, for example, the Finnish product has. The standard also defines the baseline for the quality required from the suppliers in order for them to become suppliers for the company.

### **7.1 Problems before quality instructions**

The company had a number of problems with the product through the process, when there was no real quality instruction. The design process was negligent, ignorant and careless. When the suppliers delivered the products to PKCS, the acceptance control inspected the products whether they matched the agreed rules, measurement and instructions. The agreed rules were the flip side of the drawings and possibly issues agreed within an order. If there was a defect in a product, first they needed to find out whose fault it was, if it could be repaired in house, who would pay for the cost, and if the product could still be used regardless. All these problems take time, resources, and create additional costs of quality.

Problems cause phones ringing and e-mails flying to designers, product leaders, and suppliers and checking. Pictures are sent to buyers, suppliers and to the designers and questions are being asked whether this product or part can still use. What the problem is and why this has happened. If there are extra measurements in the drawing, then those must be measured from the product and checked if they pass the tolerance in the drawings. The time it takes to finalize the design process eats up precious time and will cause stress for the rest of the production chain to ship the final product to the customers. Once the problems in acceptance control have been resolved, the components are moved to production, where the products are assembled. The problems in assembly are caused by clarity and difficulties to read drawings, wrong components, and in a hurry to pack and send.

The designer is responsible for many parts, and usually the designer is the first to be contacted about the problems. The supplier inquires possible improvements and defects to the drawings and inspects the tolerances, roughness of the surfaces, and other possible aspects that the designer regards as implied general rules. Acceptance control announces the discovery of the errors, changes, or variations that are found, and of possibly unclear images or dimensions. The production requires assistance in the assembly and notifies of a missing part. All of these problems cannot be removed even with the best quality of instruction, but a good set of guidelines reduces the amount of these types of problem. A guideline that is written in the first language of the reader and a large enough font size help the reader understand what is expected of them.

There are also problems when a product is designed in Finland but manufactured in China and vice versa. There are great differences between the Finnish and Chinese suppliers in not only the culture and the time zone but also in quality, measurements and opportunities. The Chinese designers might use too small tolerances in products that were expensive to manufacture in Finland at a reasonable price, and the Finnish designers had different measurement standards as to what the Chinese suppliers were used to. These caused problems, delays and extra costs. Also, the quality of the product did not meet the expectations of the customer. Products with too small tolerances are expensive and take time to produce. The quality is also higher than what is required of the product, making the final product more expensive. Another extreme is the bad quality and the problems caused by it.

## 7.2 Customer Project

A customer project usually follows the pattern which is described in section 7.3. Figure 2 illustrates an offering process, from which can be seen how the process progresses. In this case, an old customer contacts the previously known sales representative. In the case of a new customer, the process progresses likewise but it is usually the sales representative that initiates the contact to discuss the possible needs. A salesman presents his/her own company and its proposed solutions to the customer problems. If the customer is willing to try the solution presented by the salesman, they make a preliminary agreement, after which the process proceeds in the same way as with the old customer.

Depending on the customer, the process starts to advance, either directly through the salesman, who will continue the process from beginning to end, or a salesman directs the customer to the project manager, who will continue to move forward and take care of every tender until the end. For longer client relationships the client can be directly linked to the project manager, who manages the customer from start to finish and prepares the actual offer. These are cases in which the business relationship has lasted for years and there is a preliminary agreement with the client. The preliminary agreement contains the basic prices and the time it takes to deliver them. And, of course, all specialties and additional requirements will affect the final price.

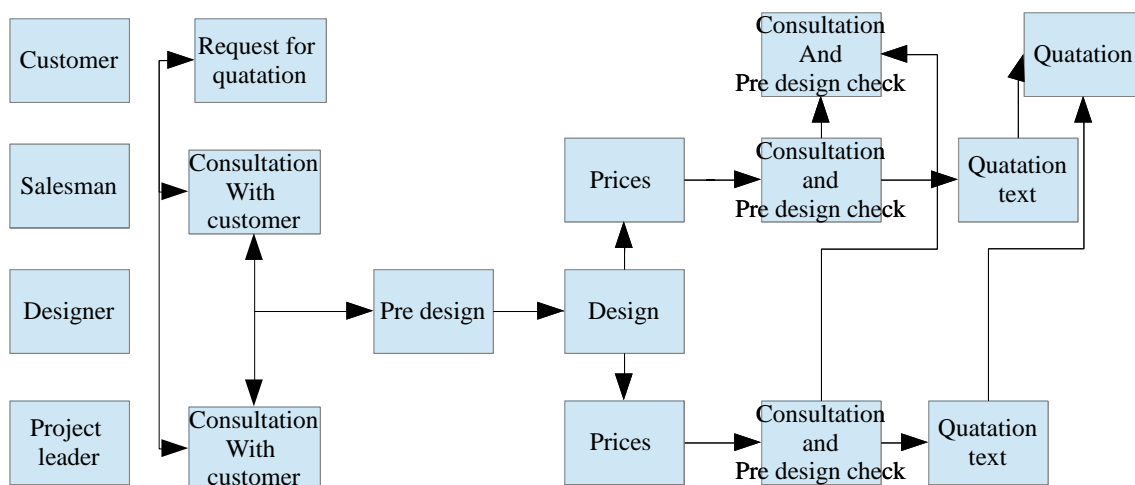


FIGURE2: The bidding process of PKCE (4)

Figure 2 shows that the designers will be included in the process from early on and help with the pricing of the offer and with the product choice, after which the designers wait in the background for the completion of the deal. The project manager or salesman negotiates with the client, and seeks an agreement on the prices and the details of the product, which is the basis for the offer. If the customer accepts the offer, a contract for supplying the product is made and this will start the design process.

### **7.3 PKCE's planning process**

An accepted offer leads to the design process. If necessary, the designer requests additional information from the customer and refines the requirements. The design process initially produces a list of parts for both the mechanics and for the electronics because especially for the electronics the time of delivery for the parts can be quite long. This gives time for the purchase department to procure the required parts with good time and to include multiple suppliers in the process. The same part list is also sent to the production planning. Thus there is a correct time slot preserved for the product and there are manufacturers for the assembly and time for it as well as time for testing, packaging and delivery.

Mechanical Designer works closely with the designer for electronics throughout the process. Cooperation is important because the changes in the electronics design affect the mechanical design work, and vice versa. It is not possible to get a working product without proper co-operation. Especially at the beginning when making a prototype or trial versions of the product, with the intention of doing experiments before the final product, it is important the cooperation works between the designers and the customer. Therefore, it is important to communicate about any potential changes as soon as they arise so that the process can react to them in time.

In the last stages of the design process a plan is sent to the customer for inspection and approval. After the plan is approved, the document is finalized and the process to procure individual parts begins. An order is made using an email that contains the details of the product, time of delivery and the parts needed. This email is sent to the



project manager, other designer, to documentation, to purchase sections, testing, production planning and to production. The order contains the latest documents, which replace any previously used documents.

### 7.4 Manufacturing process of a mechanics product

Figure 3 shows the manufacturing process of the product. The process shows that cooperation between the designers and within a company is needed in many parts of the process. The preferred method of communication is email and it is easy to spread around information to many persons at the same time. Designers play a key role, together with the project manager and keep the control of the manufacturing process, and they are the persons to be contacted if problems arise in the process.

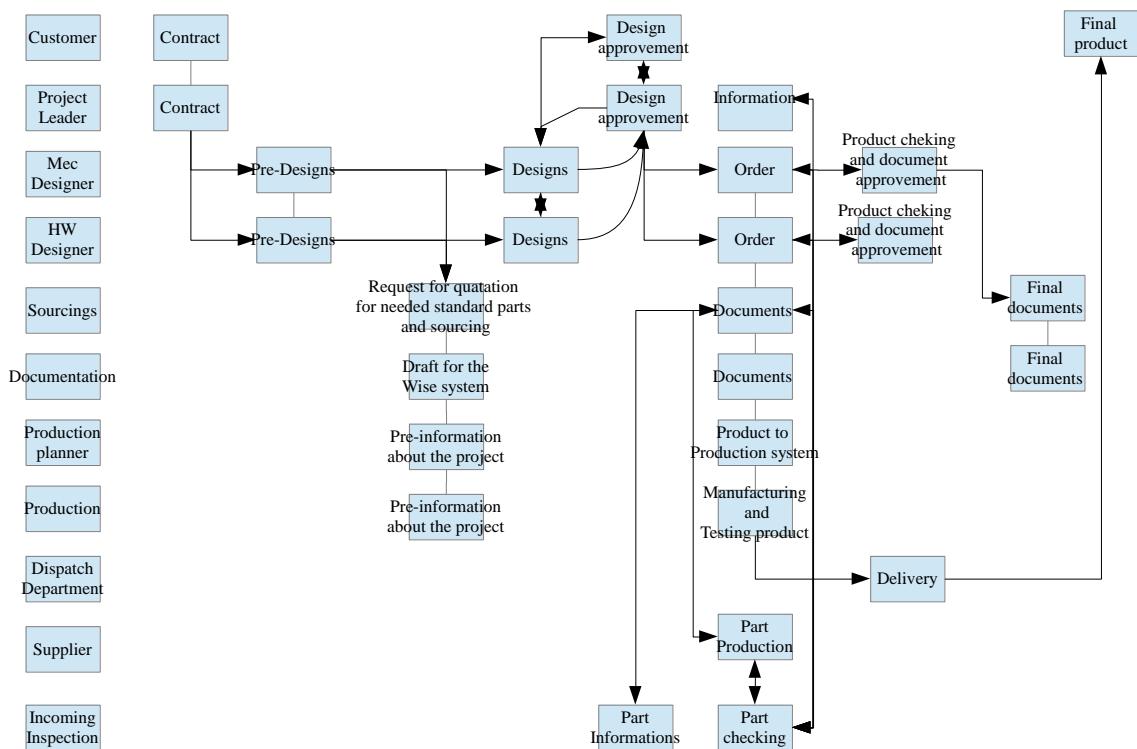


FIGURE 3: The design process (4)

The project manager is the contact person between the designer and the customer. Longer client relationships often work in such a way that the client is independently in

contact with the mechanics designers and the HW designers, contacting them directly about the changes. The project manager is kept within the loop by including him/her in the emails so that he/she knows about the changes and the information passed between the designers and the customer. The Mechanical Designer works in conjunction with the HW designer in production support. Should there be a problem in the assembly, then the production asks the designers for help to solve the problems.

Therefore, the designers have a great responsibility for the assembly process and for the quality for the product; because he/she is the person who makes the call as to whether the product can be sent to the customer if there is a problem. This is one more reason as to why the PKC standard was required because not all designers were aware and experienced in the various processes and materials. Some of the requirements of the customer were stricter than others and this fact showed the lack of experience in the designers. Products were made with too high precision and this caused losses for the company. This was also a goal to be solved with the PKC standard.

The designers are contacted when suppliers ask for more information or when they want to confirm aspects of the design. Suppliers receive parts of the standard on the flip side of the design, but that is usually not enough to answer all of the questions that arise about the parts in question. The supplier is then in contact with the buyers who in turn contact the designer. Sometimes there is a delay in the reading of the emails and this causes further delays in the process. There have been problems in specifications for the quality and this means that the supplied product cannot be evaluated without proper limits.

In the beginning the suppliers and products were few and only an oral agreement was sufficient to manufacture a product in a certain way using the materials needed. But nowadays products are more complex and there are more of them with various material requirements, as same agreements are not sufficient any more. The same rules do not apply when time is money, and the standard is needed for the suppliers so that they have the same knowledge and the opportunity to produce the product as needed.

## 7.5 Initial details of PKCE quality standard

PKCE has been using a reduced set of quality standard for a long time. The flip side of the drawings was used as a standard, and it had all the necessary data to manufacture the product. The rest was implied and expected of the supplier but not written down. This system worked for a few years when the products were simple, made from common materials, and the batches were small. With the increase in the quantity of products and with more challenging materials, the flip side was becoming too crowded and difficult to read.

<p>NOTES:</p> <ol style="list-style-type: none"> <li>All surfaces must be free of burrs. No sharp edges allowed (for aluminium / steel / copper alloys) unless otherwise specified. All sharp edges must be removed with a chamfer max 0.2x0.2 or rounding max R=0.2.</li> <li>General tolerance is <math>\pm 0.10</math> unless otherwise specified. Diameter tolerance for holes is 0.05 unless otherwise specified.</li> <li>All threads 6H unless otherwise specified.</li> <li>No splits or cracks allowed.</li> <li>All machined surfaces Ra: 1.6 unless otherwise specified.</li> <li>Concentricity for holes <math>\pm 0.1</math> unless otherwise specified.</li> <li>Planarity tolerances:             <ul style="list-style-type: none"> <li>&lt; 50 mm: <math>\pm 0.1</math></li> <li>&lt; 150 mm: <math>\pm 0.2</math></li> <li>&lt; 500 mm: <math>\pm 0.3</math></li> <li>&gt; 500 mm: <math>\pm 0.5</math></li> </ul> </li> <li>Plating thickness for silver / copper plating 5 <math>\mu\text{m}</math> unless otherwise specified. No blisters allowed. Plating measurement according to AGI, 0.65. Field book for plating thickness measurement must be provided subsequently if required.</li> <li>Product must be packed in a manner that will provide protection against damaging during shipment, handling and storage.</li> <li>Ending semi threads:             <ul style="list-style-type: none"> <li>Unthreaded part of semi threads max. 3x screw pitch</li> </ul> </li> <li>CD = Critical Dimension:             <ul style="list-style-type: none"> <li>Manufacturer has to maintain measuring register for each critical dimension and they have to deliver measuring register when requested</li> </ul> </li> <li>If plating is defined at drawing, it is included in dimensions.</li> <li>Other dimensions and drafts from 3-D file.</li> </ol>																													
<p>(14.) For molded parts:</p> <ol style="list-style-type: none"> <li>Material ABS+10GF (Pre-Elec ESD 7140 50%+Toyolac 100G20 50%, colour 76701 black or Pre-Elec ESD 7140 50%+H.G. DP2200 KA07 50%) Unless otherwise specified</li> <li>Surface quality demands:             <ul style="list-style-type: none"> <li>Zone1 (Z1): VDI 3400 nr. 50 (Ra3.2) or SPI D-1 No scratches, Burn/Draft marks or cracks allowed. Flash 0,1mm. Unless otherwise specified</li> <li>Zone2 (Z2): No texture demands No cracks allowed. Flash 0,3mm. Unless otherwise specified</li> </ul> </li> <li>Concentricity for holes <math>\pm 0.02</math> Unless otherwise specified.</li> <li>Tolerance ISO 2768-F unless otherwise specified.</li> </ol>		<p>(15.) For sheet metal parts:</p> <ol style="list-style-type: none"> <li>Surface quality demands:             <ul style="list-style-type: none"> <li>Zone1 (Z1): No blisters or cracks allowed. Bubbles, scratches, droppings or grains are not allowed as seen at a 0.5m distance.</li> <li>Zone2 (Z2): No blisters or cracks allowed. Bubbles, scratches, droppings or grains are not allowed as seen at a 2m distance.</li> </ul> </li> </ol> <p>(16.) For Molded and Sheet metal parts:</p> <ol style="list-style-type: none"> <li>Surface quality demands:             <ul style="list-style-type: none"> <li>No Zone markings. Consider all surfaces as Zone2</li> </ul> </li> </ol>																											
<table border="1"> <tr> <td>DESIGNER</td> <td>SCALE</td> <td>TITLE</td> <td colspan="2"></td> </tr> <tr> <td>DRAWN</td> <td></td> <td>SEMIHAL TOLERANCES</td> <td>DRAWING NUMBER</td> <td>DRW REVISION</td> </tr> <tr> <td>CHECKED</td> <td></td> <td>MATERIAL</td> <td></td> <td></td> </tr> <tr> <td>APPROVED</td> <td></td> <td>ZON</td> <td>NAME</td> <td></td> </tr> <tr> <td></td> <td></td> <td>PROJECT</td> <td></td> <td></td> </tr> </table>		DESIGNER	SCALE	TITLE			DRAWN		SEMIHAL TOLERANCES	DRAWING NUMBER	DRW REVISION	CHECKED		MATERIAL			APPROVED		ZON	NAME				PROJECT					
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FIGURE 4: Flip side of the drawing (4)

Figure 4 shows that the page was already full. The text was initially of normal size, but was reduced in size when there was more information needed and the readability suffered. It was written in English, and that was not common to all parties. The designers were used to it but the acceptance control and suppliers were not used to it, which caused problems in the manufacturing and acceptance.

Little by little, the idea arose that the company needs to have a quality standard which is easily accessible to all at the same time, it is easy to use, it is written in the language of the reader, and also in English. The standard should be such that new items can be added as the working methods evolve and other changes are needed. There should not be a length limit for the document. Also, the expansion of operations, first to Russia and then to China, brought new challenges to information sharing and keeping it up-to-date, as well as to having the information available to all parties regardless of time zones.

## **8 PKCE QUALITY STANDARD**

The PKCE quality standard started as a collection of flip sides of the design drawings. After this, a project team was assembled, which consisted of mechanics designers, project managers, quality department, managers of acceptance control and mechanics department, and one person from the acceptance control. These people were the ones who determined the PKCE's quality.

Customers quality standards and requirements were used to help determine the own quality for the company. Some customers had the latest quality standards available, while others had dated the standards in use and newer ones were unavailable. Some customers had a general set of instructions, which was only a rough guideline because each department had their own additional standards that were not in the company-wide standard. A decision was made based on these and also on the own in-house knowledge and skills as to what the company's standard is and how it can fulfill the quality needs of the customers.

### **8.1 Contents of the quality standard**

The aim was to gather all aspects related to assembly and delivery of the product. The standard gives the suppliers an answer to questions about a priority. For example, if the general instruction tells that the roughness of the surface is 3.2 but the drawing tells it is to be finer, then what is to be believed? It also tells the suppliers how to pack the products and into what sizes of boxes they should be packed and how the boxes should be marked when they contain multiple products. The standard also tells how the products should be cleaned before delivery. For control purposes, the standard tells at what distance the measurements should be made and how long the inspection should last and what is acceptable for each surface. The standard tells the controllers and suppliers what the default tolerances are and the tables for those, and also what should always be checked and what kind of logos are acceptable.

Controllers, suppliers and assembly line workers know from the standard as to what kind of scratches and defects the products are allowed and on which surfaces. Different coatings have their own set of rules as to how thick and covering they should be. Designers and suppliers have their own instructions for each material that is used by the company.

The standard was written from the very beginning both in English and in Finnish because there were so many people with different linguistic levels that would not benefit from the standard if it was only in English or in Finnish. So the standard became bilingual and it is possible that it will be translated into Chinese as well, depending on what is the easiest course of action in China. Every department who needed training was trained and the standard was saved to Wise where it would be accessible to all regardless of time zones. This means that every employee is able to access the standard in electronic format when needed. It was also decided that the mechanics department trains their own suppliers and sub-contractors, as well as share the manual electronically to the necessary personnel. The standard will be updated as new topics arise. The main responsibility for updating is with the mechanics of designers all over the world but, in principle, anybody can suggest an update and get the changes approved by certain people.

## **8.2 Deployment of the standard**

After the standard had been approved in Finland, it was first introduced to the designers and to the mechanics department in Finland. After that it was saved to Wise and internally distributed to all departments where it is used. The Chinese were responsible for training the local staff and leadership. In Finland the next ones to be trained were the production line, acceptance control and quality department. The standard replaced the flip side in the drawings and that practice vanished. The mechanics department was in charge of training the suppliers and distributing the standard to them.

The designers were happy with the standard as it immediately reduced inquiries from the production and acceptance control. It also aided in design and with the inspections

of the designs. The acceptance control was satisfied with the standard because it was written in Finnish and also because there were fewer variations between the designers because of the standard. The response from the suppliers has been positive because there are more details about the products and there is a standard that defines the defaults. The company's quality idea is now known to all parties.

The quality standard is certainly never going to be finished, but now it is easy to add new materials and their requirements, as well as to modify instructions as the requirements tighten and change. It is also a plus that it is easy to check the instructions one is uncertain. In addition, a plus is the fact that it is available regardless of the time zone.

## CONCLUSION

This thesis was made for PKC Electronics Oyj. The work documented the process for the products planned by the company and the problems caused by the lack of quality standard from the initial offering stages all the way to the delivery of the product to the customer. The work details the lack of the quality standard and the problems that caused to projects and shows with examples as to what the effects are on the company because there is no standard. The purpose is to assist designers, partners, contractors and inspectors as well as the quality department in their future work.

Modern customers and the customers' requirements in product design, planning of the manufacturing and product manufacturing require a good knowledge of the quality. It would be good to improve the quality of staff skills in the process because at the moment only a part of the personnel has a shared vision of quality and its requirements. The quality standard should be one of the most important tools when designing and assembling a new product. The standard helps reduce problems in the later stages of the project because rules and regulations promote the product flow throughout the production process. If problems arise at some point in the process, then all persons have access to the knowledge and further advice, which helps to avoid unnecessary loss of time.

This work was based on personal experience and plans and remarks done during projects, with the addition of tables and images to help clarify the ideas. This work tries to explain the effect of various functions on the whole process and on preventing possible problems. Hopefully the work will help PKCE's designers, partners, quality inspectors, buyers and project managers succeed in customer projects and account for possible problem areas in the scheduling of the project.

It is vital to check and update the standard from time to time, and hopefully that the company will invest more to that in the future. Training should be increased and standardized to ensure the quality. Sharing of information is also important in keeping the standard updated.



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