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Market Development through Materials Substitution - Supplying Added Value to the Musical Instrument Industry

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Preface

The process of making this master thesis, which is the final task to accomplish in our degrees in Industrial Engineering and Management, has been both long and challenging. The thesis has been conducted at the steel research department at Sandvik Materials Technology, and at the Department of Production Management at Lund's Institute of Technology.

A desire to know more about the musical instrument industry was born at SMT and they initiated this project. The possibility to combine our interest for music with our knowledge in both market and technique has been very interesting and rewarding. We feel very lucky that we got the opportunity to write this thesis, since it has been a challenging process not only concerning the writing process, but making it in the mechanical industry that was an unexploited environment for the both of us. A lot of new impressions were gained as well as knowledge about the mechanical industry.

Throughout the thesis, we have received a lot of support and help from different people. First and foremost we would like to thank our two tutors, Sina Vosough at SMT and Ola Alexandersson at the Department of Production Management, for their valuable comments and guidance. Furthermore we would like to thank all the people working at SMT who have contributed with important information. Especially, we would like to thank Berndt Stenlund, Göran Berglund, Pasi Kangas and Anders Söderman who have taken time to help us answer our questions and our department for making our stay pleasant.

Since we have performed a market analysis we have been in contact both musicians and manufacturers, who have contributed to the thesis. We would like to thank them all for their time and engagement in the subject and give a special thanks to Lars Gerdt at Blåsspecialisten in Stockholm, who has shared valuable information about the wind instrument industry.

Finally, we would like to thank our families and friends for their support and encouragement during our University years.

Malmö, August 2007

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Abstract

The Sandvik Group is a world leading company and their unique competence in materials technology has resulted in three core areas; Cutting Tools, Mining and Construction and Materials Technology (SMT). This thesis has been initiated by their third business area, SMT, who is looking into the possibility to enter a new industry by offering superior material solutions. The industry is the musical instrument market comprising a number of different instruments made of various materials. The thesis' focus is put on the instruments consisting of parts made of metal alloys, since SMT is a world leading producer of high technology stainless steels and special alloy materials such as titanium.

The thesis is a market analysis of the musical instrument industry. Various analyses are made with the purpose to find out if SMT successfully can become a supplier of high quality materials to the musical instrument industry. SMT offers their customers, in this case the instrument manufacturers, a close cooperation to enable developing materials that fulfil the customers' demands and wishes. The potential parts should have evident problems with their current materials so that the possible solution developed by SMT gives an evident higher value for both the instrument manufacturer and the end customer.

Since the musical instrument industry is a very wide business, a couple of different steps are made to gradually reduce the quantity of the instruments to enable focus put on the most interesting parts. The tools used for this are, different field studies, literature studies, questionnaires sent out to musicians, stores and manufacturers, and interviews both with manufacturers and people within SMT.

It was found through the various analyses that SMT should invest in cooperation with a harmonica manufacturer. The harmonica consists of reed plates that are exposed to human saliva and oxygen leading to corrosion and wear. The market has currently a need for a more durable and more corrosion resistant material and that is perfectly in line with SMT's core competencies. The market is however not as big as hoped and it is necessary for SMT to gain a large part of the manufacturer's market. It is suggested that SMT should position themselves in the industry using the focused differentiation strategy.

This since the cooperation they offer to their customers are outstanding due to the fact that they take the research expenditures and try to develop a tailor-made material after the customer's wishes. The possible new product therefore comprises a superior quality which makes it possible for SMT to set a higher price.

It is furthermore recommended that SMT should be open for some other areas within the musical instrument industry. Regarding the trombone slide there is a belief that this could be a more profitable project even though the market is evidently smaller than for the reed plates. A trombone is a lot more expensive and the price should therefore be less sensitive to change. However, to enable a successful project on this product, process development must be undertaken in cooperation with a customer.

As to other products more investigations need to be made in order to clarify whether or not it might be profitable to enter their markets, for example with drum hardware and frets for the guitar. Problems have been discovered in these areas but contacts with interested manufacturers have not been initiated.

Sammanfattning

Sandvik är en verksamhet med unik kompetens inom materialteknik vilket har gett dem en världsledande position inom tre huvudområden; Verktyg i hårdmetall och snabbstål för metallbearbetning, Maskiner och verktyg för bergavverkning samt Rostfria och hög legerade stål och specialmetaller. Detta examensarbete initierades av det tredje huvudområdet som tillhör Sandvik Materials Technology (SMT). SMT vill undersöka möjligheterna som finns för dem att slå sig in på en ny marknad genom att erbjuda överlägsna materiallösningar. Marknaden som de eventuellt vill lägga till i sin projektportfölj är musikinstrumentmarknaden. Denna marknad består av otroligt många olika instrument, gjorda av en mängd olika material. Fokus i detta arbete kommer att ligga på de instrument och delar som är gjorda utan någon metallegering just eftersom SMT är världsledande inom rostfritt stål och andra specialmetaller så som titan.

Examensarbetet är en marknadsanalys av musikinstrumentindustrin. Flera olika analyser är gjorda med syftet att ta reda på om SMT med framgång kan bli en leverantör av material av hög kvalitet till musikinstrumentindustrin. SMT erbjuder deras kunder, instrumenttillverkare i detta fall, ett nära samarbete för att möjliggöra utveckling av material som möter och helst överträffar kundernas behov och önskningar. De potentiella delarna borde ha evidenta problem med deras nuvarande material så att den möjliga lösningen utvecklad av SMT ger ett uppenbart högre värde för både tillverkaren av musikinstrumentet och dess slutkunder.

Eftersom musikinstrumentindustrin är en väldigt bred industri tas ett antal steg för att gradvis reducera kvantiteten av instrument och dess delar för att möjliggöra fokus på de mest intressanta delarna. Verktygen som används är fältstudier, litteraturstudier, enkäter utsända till musiker, butiker och tillverkare av musikinstrument, och intervjuer, både med tillverkare och personer inom SMT.

Genom de olika utförda analyserna, fann man att SMT borde investera I ett samarbete med en munspelstillverkare. Munspelet består av stämplattor som är utsatta för saliv och syre vilket leder till korrosion och slitage. Marknaden har för närvarande ett behov av ett mer hållbart och mer korrosionsresistent material vilket perfekt stämmer överens med kärnkompetenserna på SMT.

Marknaden är dock inte så stor som man hade hoppats från början, vilket gör det nödvändigt för SMT att vinna en stor del av tillverkarens marknad. Det föreslås att SMT borde positionera sig själva på marknaden genom en fokuserad och differentierad strategi, eftersom samarbetet som de erbjuder sina kunder är enastående av den orsaken att de står för alla utgifter gällande forskning och utveckling och försöker skräddarsy materialet efter kundens önskningar. Den eventuella nya produkten innehar därför en överlägsen kvalitet vilket gör det möjligt för SMT att ta ut ett högre pris. Det är dessutom rekommenderat att SMT är öppna för ett antal andra områden inom musikinstrumentindustrin. Beträffande trombondragen så föreslås det att dessa eventuellt skulle vara ett mer lönsamt projekt trots att marknaden för dessa är betydligt mindre. En trombon är ett mycket dyrare instrument än munspel vilket innebär att de är mindre känsliga för prisändringar. För att lyckas krävs dock processutveckling i samråd med en kund.

Fler undersökningar måste göras för att kunna klargöra huruvida det skulle kunna vara fördelaktigt att gå in på andra marknader, såsom den för delar på trummor eller greppband för gitarrer. Problem har här blivit upptäckta men kontakter med tillverkare har ej initierats.

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1. Introduction

The background and purpose with this report are described to give the reader an introduction to the subject of the thesis. A description of today's musical instrument industry, necessary delimitations and target groups are also found in this chapter. The structure of the thesis will conclude this section.

1.1 Background

The musical instrument industry is yet an unexploited area for Sandvik, a high technology engineering group, with focus on tools for metal working and rock-excavation but also superior material solutions. They have great knowledge of high class materials such as stainless steel alloys and titanium. Continuous research is made to enable exploiting of new business areas and applications. The musical instrument industry is a pretty unknown area for Sandvik and the whole manufacturing industry.

Sandvik came in contact with the musical instrument industry two years ago, when Sina Vosough wrote his master thesis at Sandvik Materials Technology (SMT). He had an idea that it might be possible to use stainless steel instead of the regular carbon steel alloy in guitar strings. The results of the project was that two of the tested Sandvik stainless steels could be used as guitar strings, one for electrical guitars and the other for acoustic guitars. [1]

This initial contact with the musical instrument industry opened up an interest to exploit the rest of the industry. Since there are a lot of musical instruments on today's market, many of them comprising parts made from metal alloys, Sandvik want to map which opportunities that industry might bring to see if they could be a successful future player.

1.1.1 The Musical Instrument Industry

Much research has been carried out within the musical instrument industry. Different materials' properties and acoustic behaviours have been examined and

[1] Vosough, Sina., 2007-03-05

tested for years, to enable finding the best material for each application. However, investments in research and development to improve the quality and sound of an instrument never seem to cease. There are always improvements to be made and discoveries of new technologies make it possible for new materials and solutions to enter the industry.

There is room for both large and small manufacturers in the musical instrument industry. Some of the large manufacturers such as, Yamaha and Suzuki produce practically every existing instrument on the market while for example the violin business comprises a lot of small niche companies focusing on small scale production.

Some segments of the musical instrument industry have a conservative market that is reluctant to change. Musicians are used to have their instrument in a certain kind of material, used to its sound and disinclined to change. Still, many segments of the industry have problems with some parts of the instruments and are willing to try something new.

The musical instrument industry turns to a broad population. Everyone can play an instrument; it does not matter if you are old or young, man or woman, or professional or amateur. The market therefore includes a lot of different models. There are high demands on the materials' acoustic properties, durability, quality and so forth, on the instruments made for professionals, while the demands on a beginner's instrument are considerably lower.

1.2 Purpose

The aim with the report is that through various analyses find out if Sandvik Materials Technology successfully can enter the musical instrument industry by being a producer and supplier of high quality materials developed in close cooperation with the instrument manufacturers. The potential parts should have clear problems with their current materials so that the possible solution developed by SMT offer an evident higher value for the end customer. The potential areas received from the authors' analysis should be in line with the organisation's strategy and enhance its core competencies.

1.3 Problem Discussion

SMT initiated this project since they do not have a lot of knowledge about the musical instrument industry. There was a need to gather reliable information to enable making a well-founded decision on whether or not to enter the industry. Furthermore, if SMT decide that it is an appealing industry that might generate future profits they need to know which areas of the industry within which they are most likely to be successful.

In order to create a reliable analysis, the thesis will contain a number of interconnected approaches, presented in the methodology chapter, that are chosen to enlighten the potential areas in different ways to receive more valid information to base a more trustworthy decision on. Trough a thorough market analysis of the musical industry, the thesis will provide SMT with know-how about the musical instrument industry. The instruments' structure, existing problems and the areas where SMT's material can offer better solutions will be mapped.

1.4 Delimitations

The musical instrument industry is a very wide subject and delimitations will be made in order to focus on the biggest and most interesting parts. Musical instruments that are very rare and have a small, niche market will therefore not be investigated.

The most significant instruments in each of the large groups; fretted, keyboard, percussion, wood wind, brass wind, stringed and free reed, and their accessories will be described. A couple of selection processes will then be made to ensure that enough focus is put on the most significant parts. This to guarantee that adequate detailed information is obtained on some parts instead of general information on several areas.

Moreover, the thesis will not include all possible players and potential cooperation partners. The industry consists of many manufacturers and delimitations will be taken to only reflect a couple of the players of each final selected part.

1.5 Target Group

The primary target group is the research group at SMT who has initiated the project with the aim to use the investigation as a platform for more technical examinations and further on, if found attractive, developing products for new musical instrument segments. The secondary group is students at technical universities who have interest in technique and music, as well as market analysis and strategy.

1.6 The Structure of the Thesis

1) The first chapter provides a comprehensive overview of the background and purpose of the thesis with delimitations that forms the basis of the study.

2) An overview of the Sandvik group is presented. Sandvik Materials Technology and the three product areas, tube, strip and wire are described.

3) The methodology, research strategies and methods used in the thesis are here illustrated.

4) Different models and relevant theories, on which the forthcoming analysis is based on, are described in this chapter. It also includes facts about stainless steel and the materials that are used in musical instruments.

5) The structure of the different musical instruments and which materials they are made of are presented, and will function as a platform for the continued research. The market of the different instruments is also described.

6) An initial selection process opens this chapter. The empirical studies; Sandvik's strategies, strengths and materials are described as well as the response the authors gained from the market (musicians, retailers and manufacturers). A second selection process is presented, followed by more detailed information about the chosen parts and their manufacturers.

7) With the analysis tools presented in chapter four combined with the information collected about different materials and instruments and nevertheless the empirical studies, an analysis is performed. Recommendations for which parts SMT should take on are suggested and strategies for how to successfully enter a new market are presented.

8) This chapter summarizes the result of the thesis. The chapter will present which product that is most profitable for SMT to invest in, the concluded entry strategy and recommendations for further investigations.

2. Company Description

This chapter gives a short presentation of the Sandvik group and their business areas. Focus will be on Sandvik Materials Technology and its three product areas; tube, strip, and wire.

2.1 Sandvik Group

The Sandvik group has world-leading positions in selected areas with their advanced high-technology products. It is a global industrial group with representation in 130 countries, 42 000 employees and annual sales of approximately SEK 72 billion. The Sandvik group business concept is to contribute to improve the productivity and profitability for their customers by developing, manufacturing and market highly processed products. Sandvik should primarily be active in areas where they currently are or have the potential to be a world leader. Sandvik's unique competence in materials technology has resulted in three core areas; Cutting Tools, Mining and Construction and Materials Technology (SMT).[2]

2.1.1 Sandvik Materials Technology

This project will focus on the third business area, Sandvik Materials Technology, which is a world leading producer of high technology stainless steels, special alloy materials and advanced value-adding products, developed in close cooperation with customers. The division with sales of approximately SEK 19.300 million has five product areas, tube, strip, wire, Kanthal and process systems. [3] Three of those areas, tube, stripe and wire, might be interesting for developing products within the musical instrument industry and are therefore described in this chapter.

For more than a century has SMT been a producer of high-duty steels. It is a research-intensive company and has one of Europe's largest R&D facilities for stainless steel and special alloys in Sandviken, Sweden. For production SMT

[2] http://www.sandvik.com, 2007-03-07
[3] http://www.smt.sandvik.com, 2007-03-07

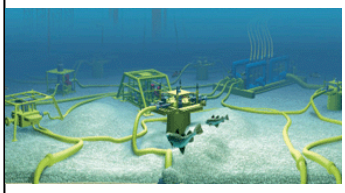
have about 900 steel codes and around 200 codes are added or withdrawn every year. They perform continuous process developments to optimise the materials' properties to ensure the best quality and service to their customers. The end user's need is always in focus and new alloys are tailor-made through close contact with the customer. SMT identify needs and create solutions that fulfil those needs. This can be done by devising new materials for known end-users, finding new applications or improving properties of existing materials.[4]

SMT's largest product group, tubular products, is mainly intended for industries with high demands on reliability in operation, corrosion resistance and mechanical properties. Such industries are for example chemical and petroleum-, oil and gas-, pulp and paper- and mechanical industries. The products are seamless or welded pipes and tubes of stainless steel. Other tubular products are alloys of nickel, titanium and zirconium that are used in for example advanced industries such as nuclear power and aerospace.[5]

The strip steel products have very good corrosion resistance, strength and are suitable for high temperatures. SMT has a wide range of strip products with different steel grades and sizes. The steel division has focused on developing and producing thinner and thinner materials and their strength is thin precision strip steels. The strip steels are used by SMT's customers for products like edge tools, razor blades, springs for high capacity and operational dependability etc. [6]

The wire products have a wide range of stainless steel grades and sizes with different mechanical properties. These products are made of stainless steels and special alloys based on for example nickel and are produced to suit many applications for example springs, medical and dental applications and fine mechanics. Special benefits are obtained from the stainless steel wire since it does not require expensive and environmentally undesirable surface treatment that is necessary for mild steel.[7]

[4] http://www.smt.sandvik.com/tube, 2007-03-07
[5] http://www.smt.sandvik.com/tube, 2007-03-07
[6] http://www.smt.sandvik.com/strip, 2007-03-08
[7] http://www.smt.sandvik.com/wire, 2007-03-08



Tubes for subsea applications used for oil and gas transportation.

SMT's strip steel used in razor blades

SMT's wire products in surgical needles with the best mechanical properties and corrosion resistance

Figure 1 A few examples of products where SMT's stainless steel can be used.[8]

[8] http://www.smt.sandvik.com, 2007-03-08

3. Methodology

This chapter aims at giving the reader an understanding of the methods used to fulfil the purpose of the report. Firstly, general methodological theories will be presented, and the chapter is concluded with a motivation of the choices made regarding methods, data gathering and source criticism.

In order to make a thorough and reliable investigation it is of great importance to initially consider how the report is to be designed. The aim of this section is to elucidate the procedure of the report and to guarantee its structure. When investigating which strategies and methods that are the most applicable, one has to decide what aspects are of value for the report.

3.1 Research Strategies

During the process of a study like this the researcher will be faced with different choices, and must take strategic decisions about which way to go. Every choice made, conveys advantages and disadvantages. The profits you do in one direction will bring losses in another. To achieve good research reasonable choices expressed in the report are decisive.[9]

There are several approaches to choose from when starting a research. Surveys, case studies, and experiments are most common. Since the report is a market analysis of the musical instrument industry and possible future research projects should be based on musicians and manufacturers existing problems with the current material we will not go further into describing experiments.

3.1.1 Surveys

The purpose of the survey is to get hold of information that can be analysed to obtain different patterns and to enable comparison. The intention is to provide a research as exhaustive and complete as possible of data at a given time. Asking the same questions to all respondents under the same conditions is a necessity. The task of making the question is not insignificant. It may not be as easy as you

[9] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. p.9

first would believe. Information must be gathered on whether the questions mean the same for all the respondents.[10] When choosing this form of research strategy it is imperative to make sure that the selection of interviewees is representative for the survey.[11]

Choosing this strategy, data could be collected either by sending out a questionnaire, which the examinees fill in and send back, or by an interviewer who with the help of a questionnaire meet the respondents in person and note their answers. Whichever method is chosen the purpose is to gather answers from several persons on the same question so that a comparison can be made.[12]

3.1.2 Case Studies

A case study is defined as a research of a smaller delimited group, which allows a detailed study with focus on depth rather than width as in the case of surveys. You start from an overall perspective and try to obtain information as exhaustive as possible.[13]

The main advantage is that when concentrating on few units, possibility will be provided to devote more time to complicated situations. Further advantages are that this strategy encourages usage of several methods and several sources. The focal disadvantage, on the other hand, is the lack of credibility concerning generalisation. Is the case representative enough? Moreover, the effects on the natural environment and situations due to the researcher's presence are not to be forgotten.[14]

Most researchers tend to favour one of these two data gathering methods; however, there is also a third one called case surveys. Case surveys bridge the gap between case studies and surveys to combine their respective benefits of in-depth, processual analysis and generalisable, cross-sectional analysis. In other

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[10] J. Bell. *Introduktion till forskningsmetodik, 2nd ed.* Studentlitteratur, Lund, 1995. p 18

[11] R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed.* Studentlitteratur, Lund, 1994. p 43

[12] J. Bell. *Introduktion till forskningsmetodik, 2nd ed.* Studentlitteratur, Lund, 1995. p 19

[13] R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed.* Studentlitteratur, Lund, 1994. p 44

[14] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. p 52-54

words, this method combines the case study approach of many aspects and the survey approach of many respondents, as seen in Figure 2.

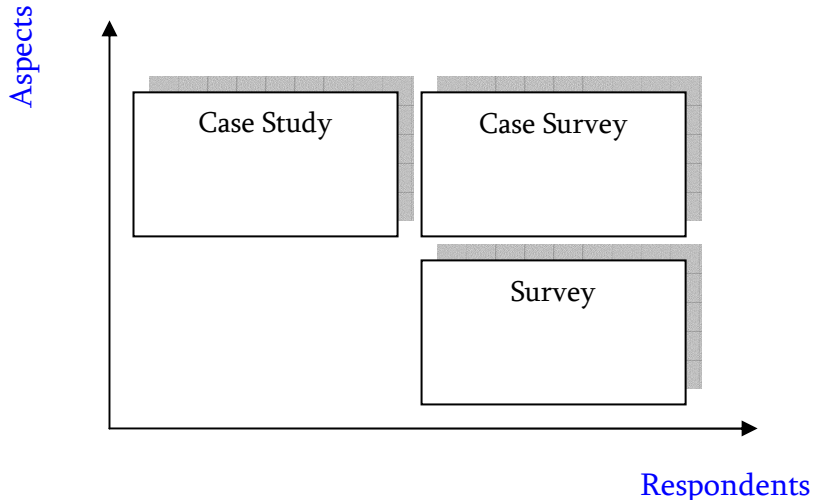

Figure 2 the Research Strategies and their Characteristics

3.2 Qualitative versus Quantitative Approach

When choosing a quantitative method, the purpose is to be able to describe the situation in a measurable way. This does however also implicate that those parameters that are of interest are measurable and in no need of interpretation.[15]

This is to be compared with a qualitative approach, which is concentrated on the perception from the involved parties rather than the actual facts.[16] Another description to distinguish it from the quantitative method is that it is based on for example how the customer describes the product and highlights the value of seeing it from the participant's point of view. It is important to emphasise that the methods described above can be combined.

[15] U. Lundahl, P-H. Skärvad. *Utredningsmetodik för samhällsvetare och ekonomer, 2nd ed.* Studentlitteratur, Lund, 1992. p 41

[16] M. Denscombe, *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna*, Studentlitteratur, Lund, 2000, p 244

The purpose with a qualitative approach is to obtain another and more deep knowledge than the fragmentised knowledge obtained with the quantitative approach. The ambition is to try to understand and analyse entireties.[17]

3.3 Gathering Data

There are several different methods to receive data from the source of interest. This can for example be literature studies, observations, interviews and questionnaires. When it comes to the choice between using a questionnaire, interview or observation as the source of information, it is of great significance to analyse which method best suits the objective. It is of interest to investigate how customers reason when choosing a supplier and which improvements they believe can enhance the characteristics of a certain instrument. It is best to do this by questions in some way and observation will therefore not be described.

3.3.1 Literature Studies

Literature involves all written material, such as books, brochures and periodicals. Since this type of information often is written for a certain purpose of a certain study, it is important to see this data as secondary, and to acknowledge the fact that it might not be comprehensive.[18]

3.3.2 Questionnaires

If the decision falls on applying a questionnaire to gather data, the construction of this must be such that it will provide the needed information, which the respondents can accept and that will not result in any problems when interpreting the answers. When using this method an early emphasis is put on how to analyse the answers.[19]

There are two aspects to consider when using questions to gather information. Firstly, the degree of standardisation which entails the amount of responsibility

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[17]R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed*. Studentlitteratur, Lund, 1994. p 99

[18] M. Björklund,Paulsson, *Seminarieboken-att skriva, presentera och opponera*, Studentlitteratur,Lund, 2003.p67

[19] J. Bell. *Introduktion till forskningsmetodik, 2nd ed*. Studentlitteratur, Lund, 1995. p 73

put on the interviewer when it comes to the design and order of the questions. Second, the degree of structure which entails to what extent the interviewee is free to interpret the questions. (Figure 3) The more standardised the questions are the easier it is to compare and generalise the answers. A totally standardised interview could also be written down which makes it the beginning of a questionnaire.[20]

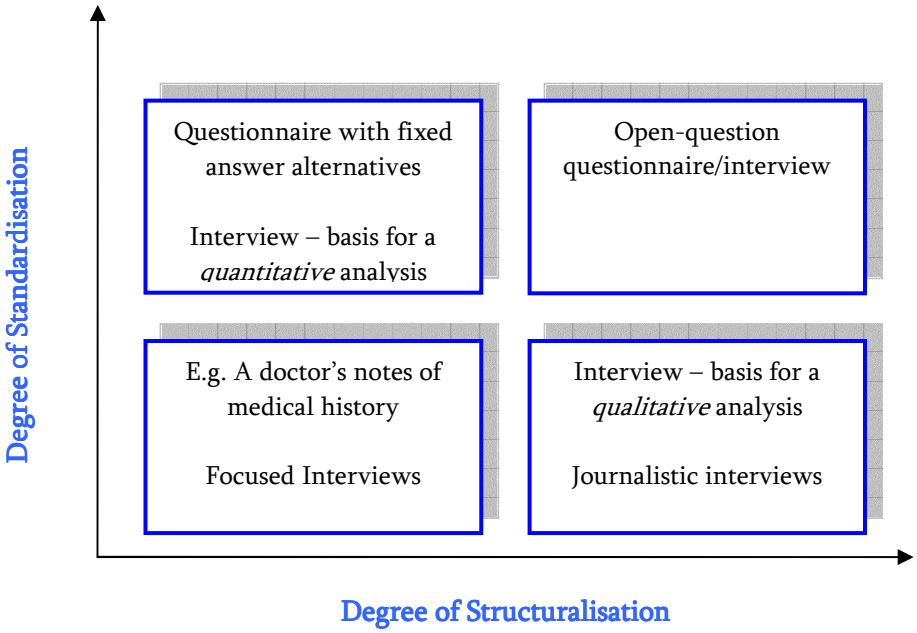

Figure 3 Examples of different types of interviews and questionnaires depending on high or low degree of standardisation and structuralisation.[21]

The types of questions used could be one of two types; open or fixed. Open questions provide full and rich answers but it requires more effort from the respondent plus the researcher will have a much heavier work analysing the answers. The characteristics are the opposite when it comes to fixed questions. The answers are easy to analyse but may not reflect the actual situation since there will be a limited amount of alternatives. Moreover, it might be irritating for the respondents not being able to express themselves in their own way.[22]

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[20] R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed.* Studentlitteratur, Lund, 1994. p 60-61

[21] R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed.* Studentlitteratur, Lund, 1994. p 62

[22] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. p 122-123

To be used in a research, a questionnaire must have a couple of features. The design should promote gathering information that can be applied for analysis. It should enable receiving the facts directly from the source.[23] After having designed the questionnaire there are a couple of central issues to look over. A careful review of each question should be made and some thought should be put on what the actual purpose for that question is to facilitate an easy identification of the irrelevant ones, which enhances focus on more important aspects of the topic at hand. The next step will be to reformulate the questions to avoid all ambiguity and to obtain questions sufficiently clear for the respondents to understand.[24]

To avoid too long answers and any misunderstandings, the questionnaire should be tested, before the real examinees has a look at it. This will ensure that the actual form sent out to the respondents will be easy to understand, will not take too much time and that the questions at issue will be correctly interpreted. The researcher should think about the style of the questions so that they are not irritating, they should also fit a style suitable for the target group.[25] Additionally, literature agrees on not using questions that are long, leading, negations, double-questions or presupposing.

3.3.3 Interviews

The flexibility that comes with an interview is its greatest advantage. A talented interviewer may be able to get hold of information that a questionnaire in its simplicity may never obtain, due to the possibility to ask follow-up questions and enter deeply into topics that attract interest. However, there are also difficulties with this method. It is time-consuming and one needs to be aware of the fact that there may just be time for a few interviews.

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[23] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna*. Studentlitteratur, Lund, 2000. p 106

[24] J. Bell. *Introduktion till forskningsmetodik, 2nd ed*. Studentlitteratur, Lund, 1995. p 24, 74

[25] J. Bell. *Introduktion till forskningsmetodik, 2nd ed*. Studentlitteratur, Lund, 1995. p 83

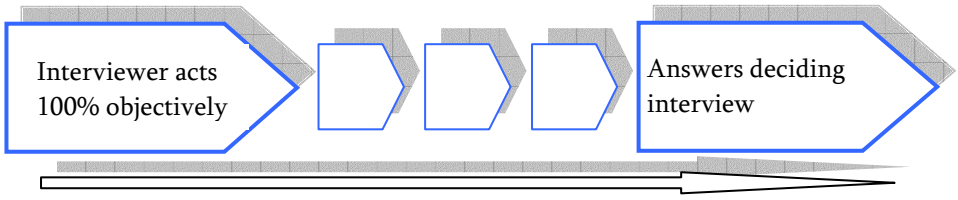

Figure 4 Different types of Interviews

The result of the quantification will be easier the more standardised the interview is. A structured interview may be a questionnaire filled out by the interviewer instead of the respondent. This may be the best form of interview for unaccustomed interviewers. Observing the chart above (Figure 4), the interview ought to be somewhere in the middle, with some liberty for the respondent to talk about subjects that are of importance to him/her but still with enough structure to guarantee comprehensive results.[26]

3.4 Method of Analysis

The longer it takes to start with the analysis the harder it is to maintain a pure relationship to the material. The purpose is to find themes, patterns and categories in the material.[27]

3.4.1 Qualitative versus Quantitative Analysis

Dealing with qualitative data involves more risks than dealing with quantitative data. Figure 5 illustrates the main differences in features between the two methods. As shown, qualitative analysis has to do with words, which are far more complicated to analyse than numbers. This is why the quantitative approach offers an analysis that is both more scientific and trustworthy.[28]

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[26] J. Bell. *Introduktion till forskningsmetodik, 2nd ed.* Studentlitteratur, Lund, 1995. p 90-91, 93

[27] R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed.* Studentlitteratur, Lund, 1994. p 91, 101

[28] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. 240

	Central Analysis Unit	Research associated with	Size of study	Perspective/ Focus	Roll of Researcher	Research Design
Quali tative	**Words**	**Description**	**Small scale**	**Holistic**	**Involved**	**Open**
Quanti tative	**Nbrs**	**Analysis**	**Large scale**	**Specific**	**Neutral**	**Predeter mined**

Figure 5 Qualitative versus Quantitative[29]

The qualitative data must be organised before commencing the analysis. This demands taking a few practical points into consideration. Effort should firstly be put on gathering all material in a uniform format. Then on using a format where there is space for the researcher to put notes in the margin. Subsequently, every bit of raw data should be identified with a unique code. This reference coding should enable an easy access of data already analysed and it can be used on all types of material. Finally a safety copy should be made of all original papers.

3.4.2 How to Interpret Data

Interpretation of data is a critical part in the process of writing a report.[30] Data that is not conducted for the cause of this specific report is called secondary data. Examples of this type of data are literature and brochures. When using secondary data it is important to keep in mind that the authors may have personal interests, which might affect the way they present the information. This implies that this secondary data has to be critically interpreted. [31]

Primary data are for example collected from interviews with potential customers. To secure that this data is interpreted correctly, the people being interviewed will take part of the documentation so they are able to approve the information before it is printed. Another way to assure that the data is interpreted in a trustworthy manner is to always be more than one person present at the interviews. This to avoid a tendency of one interviewer trying to

[29] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. p 204-207

[30] Holme.Solvang, Forskningsmetodik–om kvalitativa o kvantitativa metoder, Studentlitteratur, Lund,1997,p290

[31] M. Björklund, Paulsson, Seminarieboken-att skriva, presentera och opponera, Studentlitteratur, 2003, p 67

get answers that supports preconceived notions.[32] It is also essential to follow up the interviewees' answers and confirm the information given from other sources, for example from other interviews or literature concerning the subject. It should also be taken into consideration that the authors of this report also are biased of influences from the company and their university studies.[33]

3.5 Motivation and Criticism of Methods and Conclusions

When doing this kind of research it is crucial to control that it actually investigates what is the aim to investigate. That is, that it has high validity. Furthermore we need to know that the investigation is performed in a trustworthy manner. That is, that it has high reliability.[34]

3.5.1 Reliability

Reliability or trustworthiness is a measurement of to what extent an answer to a certain question is the same at different occasions and under the same circumstances. While formulating the questions it is good to ask oneself if there have been any recent events that may have influenced the interviewee's opinions. Other interesting thoughts are: if another researcher using the same questions will get identical results and come to the same conclusions, and if the same interviewer gets the same answers using the same questions at two different occasions.

There are several ways to measure reliability, however in the case of interviews and other qualitative research one controls the reliability whilst preparing the questions and performing the interview.[35]

A report with a high degree of reliability is distinguished by not being affected of different circumstances when doing the survey. There is in other words a low

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[32] J. Bell. *Introduktion till forskningsmetodik, 2nd ed.* Studentlitteratur, Lund, 1995. p 94

[33] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. p 158

[34] R. Patel, B. Davidson. *Forskningsmetodikens grunder – Att planera, genomföra och rapportera en undersökning. 2nd ed.* Studentlitteratur, Lund, 1994. p 85

[35] J. Bell. *Introduktion till forskningsmetodik, 2nd ed.* Studentlitteratur, Lund, 1995. p 62

degree of haphazard defects.[36] This is secured by conducting a large amount of surveys and by standardisation of the questions in the interviews. This step is vital to take in consideration since the aim with the report is to be able to make a generalisation of the result.

3.5.2 Validity

Validity however is a far more complicated concept. It is a measurement used to see if a certain question measures exactly what one wants it to measure.[37] There is a need to critically review these questions, for example by asking oneself if another researcher would obtain the same answers using the same questions.

3.5.3 Objectivity

When a report originates from a company, in this case Sandvik Materials Technology, it is vital to have in mind that the assignment might be biased. It is important to keep this affect under control in order not to jeopardise the result. The purpose with an investigation is to establish the situation as it is and not how interested party want for it to be.[38]

The researcher must be impartial and must not involve self identity, values and convictions when carrying out the research.[39] A researcher should try and be aware of in which ways values guide every aspect of the investigation and strive for an honest reproduction of them in the description of the research process.[40]

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[36] U. Lundahl, P-H. Skärvad, Utredningsmetodik för samhällsvetare och ekonomer, Studentlitteratur, Lund 1999, p 152

[37] J. Bell. *Introduktion till forskningsmetodik, 2nd ed.* Studentlitteratur, Lund, 1995. p 63

[38] U. Lundahl, P-H. Skärvad, Utredningsmetodik för samhällsvetare och ekonomer, Studentlitteratur, Lund 1999, p 76

[39] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Studentlitteratur, Lund, 2000. p 250

[40] U. Lundahl, P-H. Skärvad. *Utredningsmetodik för samhällsvetare och ekonomer, 2nd ed.* Studentlitteratur, Lund, 1992. p 76

3.6 Authors' Decisions

The chosen research strategies, data gathering systems, and all other methods that will be used for analysis, and source criticism in this study will be presented in this section.

3.6.1 Research Strategies

In the view of the fact that this project will need data that is detailed, precise and in depth a case study approach will be done, in form of a field study, in the beginning since it, initially, is a very wide project with a lot of existing musical instruments and parts on the market. With literature studies as a base, different musical instrument- and reparation stores will be visited to receive a general understanding of the different instruments and their parts and accessories. Information about how they look and function will be collected. This will suit the purpose, of gathering sufficient information to make a correct initial selection process, better.

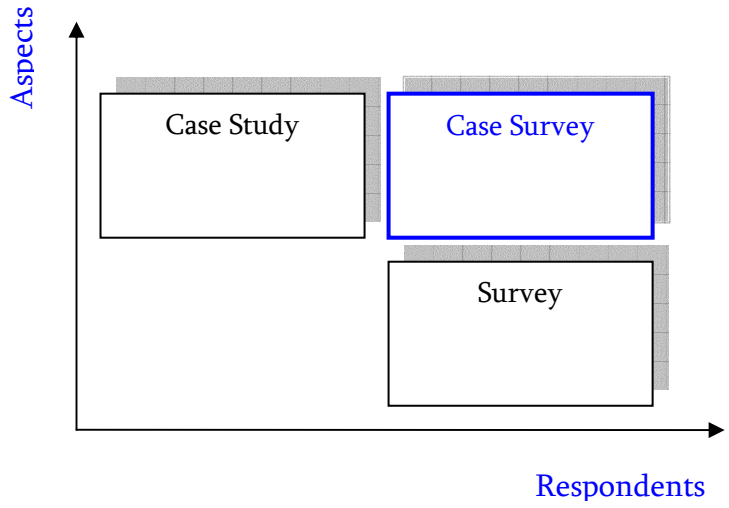

Figure 6 Chosen Research Strategy

After this initial study the number of instruments and parts will be reduced in the selection process and a survey will be made on the remaining areas. The selection of examinees for this survey will be subjective, since we already know whom to approach for valuable information. The selection may to a certain

degree also be of snow-boll effect since we expect to get referred from one manufacturer, orchestral leader or musician to another.[41]

This means that this will be a study using the above mentioned case survey approach (Figure 6).

3.6.2 Qualitative versus Quantitative approach

The aim with this report is to investigate what incitements there are for Sandvik to take on the musical instrument industry, and it will therefore not be sufficient to use the quantitative more wide approach. As mentioned before, the quantitative and qualitative methods can be combined. This will be the case in this report since it will be necessary for the authors to both get in-depth more individual information, as well as measurable and more general information about the products in question. The aim for this report is therefore to create a model that will be qualitative in its content but quantitative when interpreted in order to make it dynamic for further use. The gathered data will consequently be a good foundation for a future analysis.

3.6.3 Gathering Data

Initially literature studies and field studies of the different musical instruments will be made to receive information that will function as a base for a first elimination phase. Data about the structure of the instruments and which materials they are made of are gathered. The literature studies will then be a ground for the construction of the questionnaires.

In this report, the first part- the field studies- will be conducted through open interviews. That is, the authors will ask retailers and restorers of the different instruments about problem areas and material choice without preconceived notions and hope to receive information strong enough to base the initial selection process on. In the survey part it will be more appropriate to use questionnaires instead of interviews to get more information of the chosen parts. This decision was made since interviews are too time-consuming to accomplish with a high number of musicians, stores and manufacturers.

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[41] M. Denscombe. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna*. Studentlitteratur, Lund, 2000. p.23-24

The aim when making the questions for the questionnaires will be to standardise them as much as possible. Many thoughts about what information the authors' want to gain from the questionnaire will be made. There will be a mix of open and fixed-answer questions to secure that important information about current problems will not be missed, and still "force" the respondents to take position regarding important parameters. When it is a fixed question there will always be an alternative for the respondent to add a personal view.

Questionnaires for each of the chosen instrument will be made for musicians, manufacturers and retailers. The questionnaires for each group will be built in the same way, with the same posed questions, just changing the name of the part or instrument. After constructing the questionnaires, they will be sent out to a few respondents in each group to secure that the questions are easy to understand and that they provide the required information.

The purpose with the questionnaires for the musicians will be to gather information about current problem areas, important parameters when choosing an instrument and attitude against trying new materials (Appendix 1). The questionnaires that will be designed for manufacturers are the ones that will be most significant for the thesis. The information the authors want to receive from this category is the manufacturers' production size, pros and cons with the material they currently use, important parameters for their choice of material and the manufacturers' interest to change material (Appendix 2). The purpose with the questionnaires for the retailers is to add information to the other two categories if any uncertainties with their answers are shown. Appendix 3 shows a questionnaire made for a retailer.

To ensure a high return of the questionnaires, effort will be focused on making them as personal as possible. Furthermore, a short introduction to the project will be given to provide the respondents with some information about the investigation.

After analysing the answers from the questionnaires, interviews with the questionnaires as a base will be made in the segments where the answer-frequency was too low. The chosen interviewees will have explicit knowledge within the subject to counteract the risk of low trustworthiness when gathering information from a small group of people. A second selection process will then be made and more information will be gathered about the selected parts. An effort will be put on further interviews with manufacturers of the chosen parts, to get more detailed data to strengthen the final decision made in the analysis.

3.6.4 Method of Analysis

To counteract the risk of loosing a close relationship with the data, the interpretation of the gathered information will commence simultaneously as it arrives. Moreover, a review of the information will be made with the tutor at LTH, to assure a good understanding of the same data and that the interpretation will be done correctly.

To enable a trustworthy data interpretation an effort will also be put on always making interviews together and to establish continuous contacts with those answering the questionnaires to assure that the answers they give will be interpreted in a correct way.

Since the authors will be dealing with both quantitative and qualitative data, the interpretation will be divided into several parts, guaranteeing that no crucial facts will be overseen. All data will be organised before interpreting it, and there will be an effort on putting the qualitative data in a uniform design. This will be made to enable a well-presented, easier grasped presentation of the data in the empirical chapter.

3.6.5 Motivation and Criticism of Methods and Conclusions

In the case of this project the best way to secure a high reliability is to remain a high degree of standardisation of the questions both regarding the questionnaires and the interviews. Moreover, the two authors will take part in the interviews as much as possible, so that they can compare notes and the degree of accordance is a measure of the reliability.

To assure the validity in the report the questions that are to be used will be conducted in a thorough manner by testing them before using them at the actual market. A discussion about the questions with employees at the R&D department and with the tutor at LTH will be made to ensure that the questions will serve their purpose. Furthermore, the staff within the marketing department will be interviewed to get a hint of the current situation and what to measure.

4. Theoretical Framework

The intention of this chapter is for the authors to create a strategic adoption model which will provide sufficient information for the analysis part of this specific project. Initially the requirements of the theoretical framework will be formulated following the description of different parts of the chosen adoption model. Materials that are used in today's musical instruments are then described and conclude this chapter.

To answer the question how SMT should enter the industry of musical instruments, different analysis tools and models will be used. The thesis concerns products that already exist on the market, which is practically a new strategy for SMT. The model will be built on theory regarding sources of competition, market potential and categories of competitiveness. The analysis tools and models will lead to a conclusion about the above question. The final model will help SMT to choose the most profitable parts of the musical instruments and help them make a successful entry.

Theory concerning how to enter a new market and how to lucratively initiate a substitute product is the significant part of the model. The five forces framework is presented to give the reader information about which barriers of entry SMT must cross, what characteristics a substitute product should have to be successful and when intense rivalry appears and how to avoid it. The strategy clock analysis is chosen since it provides information about how to obtain a strong strategic position and the risks that may occur.

The potential of a new product and the ability to choose the right customers are the next elements of the theoretical framework. It is important to understand who the product creates value for, and how to target that group.

Another very important aspect is the value of the company's core competencies and what it is that makes them unique. Important assets, order qualifiers and winners, and critical success factors that enable a company to be a strong competitor are described to increase the understanding about what features it is that makes a customer choose a certain product.

4.1 Sources of Competition

Competition exists in every industry consisting of direct competitive rivals, but another form of competition, which may be more or less active, is the one concerning customers, suppliers, potential entrants and substitute products. The competition in a certain industry goes beyond the established combatants. Knowledge and awareness about the forces makes it harder for a competitor to threaten the company's position.[42]

The five forces framework will first be presented followed by deeper descriptions of each force. To conclude this section the strategic clock is illustrated to enlighten the competitive strategic options of a new business.

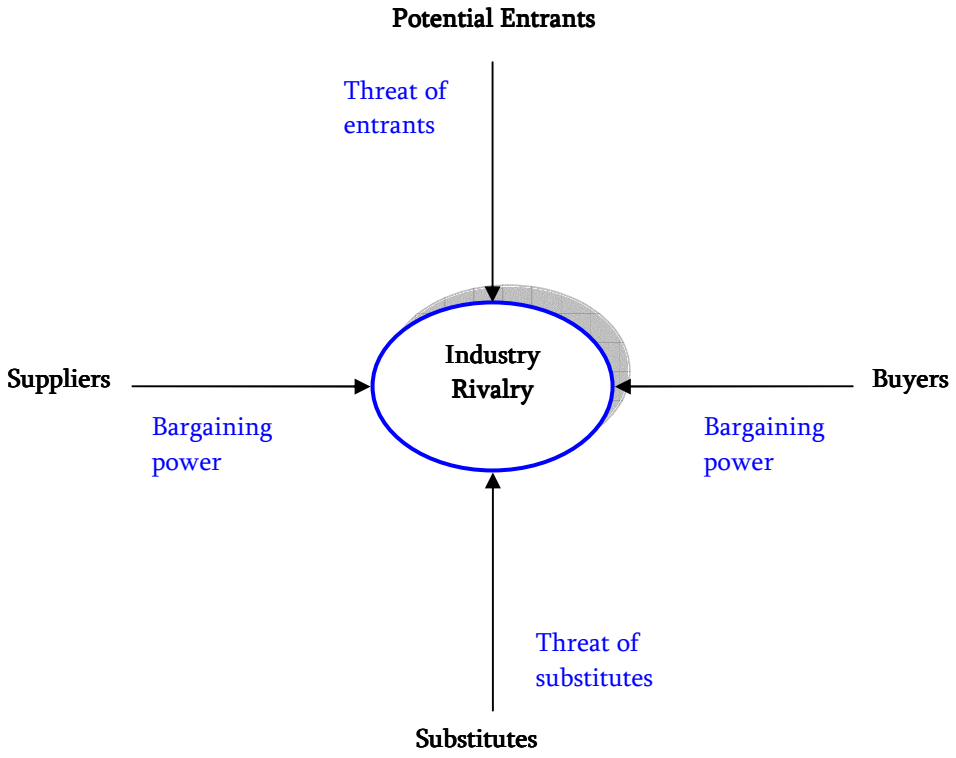

Figure 7 The Five Forces Framework

[42] M.E. Porter. *How Competitive Forces Shape Strategy,* Harvard Business Review, July-August 1997, p 2-3

The state of competition depends on five basic forces (Figure 7), according to Michael Porter's framework. The forces are not independent of each other since a pressure from one direction can lead to changes in another.[43] The five forces create a ground for recognising the ultimate profit potential of an industry. A company should seek a position where they can defend themselves against these forces but still receive the benefits of them. To obtain a strong position and diversification it is necessary to highlight the company's critical strengths and weaknesses, dig below the surface and analyse every single part of the different forces.[44]

4.1.1 Potential Entrants [45]

New capacity and a desire to gain market share increase when new companies enter an industry. If the new entrant will pose a serious threat or not, depend on the barriers of entry and the expected reaction from the well-established companies. Listed below are the six major sources of entry barriers that a new company has to overcome:

1. *Economies of scale*
   A new entrant must be prepared to take a cost disadvantage or produce a larger scale to be able to compete with the established companies, which have scale economies in production, research, marketing and service leading to benefits in e.g. distribution and financing.

2. *Product differentiation*
   It is expensive for new entrants to win over customers of a well known brand and they have to spend a lot of money to overcome customer loyalty. Brand identification comes from advertising, customer service, being first in the industry and product differences.

3. *Capital requirements*
   The capital needed for especially unrecoverable expenditures, advertising or R&D, is another barrier of entry. Large financial

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[43] G. Johnson, K. Scholes. *Exploring Corporate Strategy,6th ed.* Prentice Hall, 2002. p 112-113

[44] M.E. Porter. *How Competitive Forces Shape Strategy,* Harward Business Review, July-August 1997, p 2-3

[45] M.E. Porter. *How Competitive Forces Shape Strategy,* Harward Business Review, July-August 1997, p 3-5

resources are needed in order to be a new, strong competitor. Capital is needed for fixed facilities, customer credit, inventories and absorbing start-up losses.

4. *Cost disadvantages independent of size*
   Well-established companies may have cost advantages from the effects of the learning curve which is not accessible for a new entrant. The already established companies might have access to the best raw material sources, proprietary technology, government subsidies, favourable locations and/or patents, which is hard for a newcomer to compete with.

5. *Access to distribution channels*
   The industry will be harder to enter the more the existing companies have tied up the distribution channels. A newcomer must secure distribution of its product before entering a new industry.

6. *Government policy*
   Control of the government regarding for example license requirements, access to raw material and pollution standards, can make it very hard or even impossible for a newcomer to enter some industries.

It is vital for a potential newcomer, when deciding to enter or not, to consider what the established companies' reactions might be if a new company enters their industry. It could be hard to enter if the incumbents have a lot of resources to fight back with. Moreover, an additional disadvantage for newcomers is if the established companies have capacity to cut prices to keep their market share and/or if the industry growth is slow, which affects its ability to absorb a new entrant.

4.1.2 Suppliers and Buyers [46]

Suppliers bargain in an industry by raising prices or reducing quality. A supplier group is powerful when it is concentrated and consists of a few companies, the product is differentiated or unique, and there are switching costs for the buyers when changing suppliers. Switching costs arise when a product's specifications are tied to a particular supplier or if the equipment and product lines are tied to

[46] M.E. Porter. *How Competitive Forces Shape Strategy,* Harward Business Review, July-August 1997, p 5-7

the suppliers manufacturing facilities. Other factors that make the suppliers powerful are; when they are big and do not have to compete with other products and material for sale in a particular industry, and when the industry is not an important customer for the supplier group.

Buying power is probably high when the buyers are concentrated or purchase in large volumes, purchasing products that are standard or undifferentiated with supply alternatives, and when quality of the purchased part is unimportant for the end-product. Other important characteristics are; when the product is a component of the buyers' end-product and represents a big part of its total cost, leading to the buyer searching for favourable prices, and when the buyer earns low profits.

The choices of supplier and/or buyer groups are crucial strategic decisions. A stronger strategic position will be obtained by having suppliers or buyers that do not possess too much power. If a company is a low-cost producer in its industry or if its products have some special features, it can sell to powerful buyers and still earn considerable profits. When selecting buyers, focus should be put on segments with possibilities of product differentiation and where the threat of backward integration is insignificant. When the industry's product does not save the buyer any money the quality aspect has to be very momentous.

4.1.3 Substitutes [47]

The profitability of a market is high if the threat of substitute products is low. If a company with a strong position in an industry will face better or lower-cost substitute products, it will receive low returns. The substitutes both limit the profits in normal cases and reduce the high-prices and large earnings an industry can make when times are good. Substitute products are significant when they are subjected to trends improving their price-performance trade-off compared to that of the industry's product, or when they are produced by industries earning high profits. An industry where development increases competition often has to deal with substitutes that reach the market fast, which leads to price reduction or performance improvements. A company has to upgrade the quality of their products or differentiate them to stand up against the new substitute products.

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[47] M.E. Porter. *How Competitive Forces Shape Strategy,* Harward Business Review, July-August 1997, p 7

The substitutes often emerge through either price reduction or performance improvements. A substitute product needs to offer the market something more than the existing products in order to be successful and accepted. The substitute product must be cheaper to purchase, have better quality or other value added features.

4.1.4 Industry Rivalry [48]

An industry has a high profit potential if the rivalry or competition is low. To get an understanding about the industry's rivalry the concentration of the market share is measured and divided among the four largest firms. A low concentration ratio indicates that the industry has many rivals and that none of them have a considerable market share. This type of market is competitive and can be successful to enter. A high concentration ratio indicates that the industry has few rivals with a large piece of the market share, and the industry might therefore be hard to enter.

The existing competitors battle with price competition, product introduction and a lot of advertising. Intense rivalry appears when:

- There are many competitors or the competitors have the same size and power
- There is a competition over market shares because of slow industry growth
- The product is not differentiated nor has switching costs
- The fixed costs are high, leading to a desire to cut prices
- There are periods of overcapacity
- High exit barriers exist
- The competitors compete in different ways. Their strategies, origins and personalities are very unlike each other.

4.1.5 Formulation of Strategy [49]

After a review of the forces and their underlying causes, the company's strengths and weaknesses can be recognised by answering questions such as;

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[48] M.E. Porter. *How Competitive Forces Shape Strategy,* Harward Business Review, July-August 1997, p 7-8

[49] M.E. Porter. *How Competitive Forces Shape Strategy,* Harward Business Review, July-August 1997, p 8-9

where does it stand against substitutes, or against sources of entry barriers? When it is time to formulate a strategy, the company's capabilities should provide the best defence against the competitive forces, the balance of the forces should be at a good level and anticipation of shifts in the forces' underlying factors need to be made on a regular basis. This to be able to choose a strategy, suitable for the new competitive balance, and to implement this strategy before the competitors have recognised the change.

Positioning of the company can be made in numerous ways. One approach is to match the company's strengths and weaknesses with the given structure of the industry. A strategy can be to build protection against the company's competitive forces or to find positions where the forces in the industry are the weakest.

Prediction of eventual profitability can be made by utilising the structure used to analyse an industry's competition. A likely scenario of the industry, which may vary a lot from the existing structure, can be constructed after examination of each force and forecasting of the magnitude of each underlying cause. By doing this a company might find an industry with a good future sooner than other candidates, create a diversification strategy, and earn high profits before the industry receive more competitors, leading to lower prices.

4.1.6 The Strategy Clock Analysis [50]

The competitive strategic options of a new business are elucidated by the strategy clock analysis. In an industry with numerous players a company needs to place its product in a strategic position to be able to win customers. Different strategic positions are represented in the strategy clock (Figure 8):

1. No Frills

Low prices are the focus of this strategy and not the quality aspect or extra value added benefits. Products that fit well in a price sensitive market segment are suitable for this strategy. A risk with this kind of strategy is that the reached market segments can be very narrow.

[50] G. Johnson, K. Scholes. *Exploring Corporate Strategy, 6th ed,* Prentice Hall, 2002, p319-330

2. Low Price
This strategy focuses on the competitive power on price while still offering a product with the same quality and benefits as the competitors. The risk with the low price strategy is that it can lead to price-wars leading to low margins.

3. Hybrid
Using the hybrid strategy means that the company seek to compete with both price and quality/benefits at the same time. To be able to do this in a successful manner the company need to have a low cost base.

4. Differentiation
With the differentiation strategy focus is on offering high quality and superior product and service benefits to the customer either to a premium price or at the same price as the competitors. The risk with this strategy is that the added value must be high enough to bear a higher price or the company need to have a low cost base to enable competition with the same price as the competitors.

5. Focused differentiation
Here the focus is on a small market segment that has the will-power and capability to pay a higher price for high quality and high product and service benefits. A company using the focused differentiation strategy generally has a product that is supported by a strong brand. The risk that may occur is that the reached market segment is narrow and that the benefits of the product are not perceived by the customers.

6, 7, and 8. Strategies that are destined for ultimate failure
The offered product does neither offer a lower price nor higher quality/benefits to the customers.

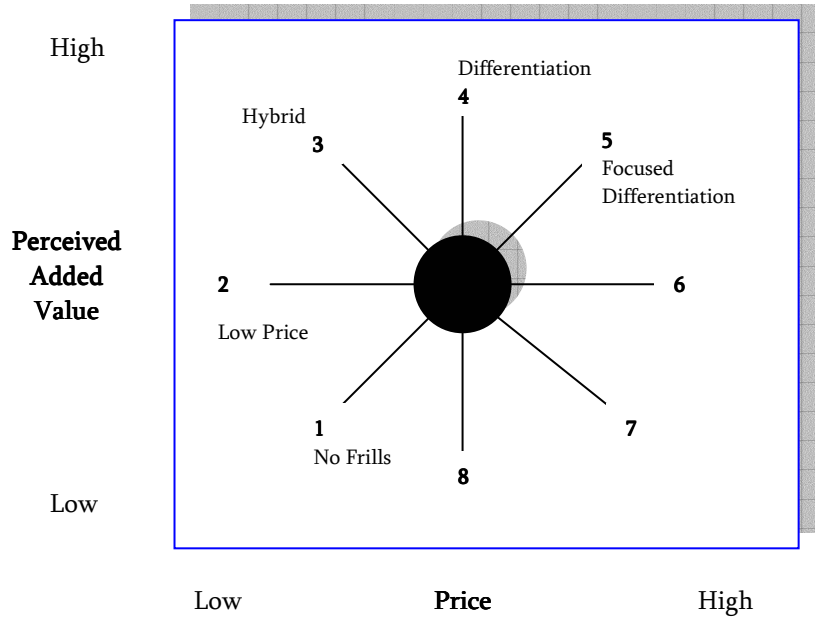

Figure 8 the Strategy Clock

4.2 Market Potential

This part of the thesis will enlighten the potential of a new product and show how to estimate its market and sales potential. The analysing process of the customers made to clarify that the right target group is reached will also be explained in this section.

4.2.1 New or Growing Product Potential [51]

When estimating the pattern of a market development and an eventual profit of a new or growing product, a comparison with the existing competitors can be made using three major aspects:

- *Relative Advantage*
  Comparison with the industry's other products to claim which benefits the new product has that makes it superior to its competitors. The

[51] D.R Lehmann, R.S.Winer. *Analysis for Marketing Planning,6th ed.* McGraw-Hill, USA, 2005, p 174-175

relative advantage of a new product often increases with time since different modifications are made and the production is run in.

- *Compatibility*
  Compatibility issues concern every actor involved, for example the company itself, the customers and, if it is a component in another product, the customers' customer. A new product will be adopted faster if the changes are smaller, not so complicated and easy to understand.

- *Risk*
  The probability that someone will buy the new product decreases with a large risk taking; financial, quality and so on. However the risk usually diminishes in time, leading to an increasing potential.

It is useful to compare the new product to similar products to get an understanding for how the industry might adopt it. These products' adoption pattern can be an aid in predicting the new product's entry to the market, ultimate potential level and sales forecasting. Two products are hardly ever perfectly comparable which complicates the prediction process. To be comparable the analogous product need to target a similar market, have similar perceived value (benefits provided and total value) and a similar price.

4.2.2 Methods of Estimating Market and Sales Potential [52]

It is important to use logic and common sense in addition to a model, when estimating the market and sales potential. A three step process, based on the potential buyers and users, can be made:

1. *Determine the potential buyers or users of the product*
   One way to interpret buyers is to see them as customers having the need that the product will fulfil, the required resources needed to refine or use the product and the ability to pay. Another way is to map which customers that do not qualify as potential customers, according to the previous statement. In addition to these approaches, other data sources such as surveys, commercial sources and government documents can be helpful.

[52] D.R Lehmann, R.S.Winer. *Analysis for Marketing Planning,6th ed.* McGraw-Hill, USA, 2005, p 175-178

2. *Determine how many there are in each potential group of buyers defined by step 1*
   An estimation of the size of each group is done in this step, and this is generally made simultaneously as step 1. Statistics exist about some parameters such as age and gender, but in the other cases an approximation has to be made.

3. *Estimate the purchasing or usage rate*
   There are two approaches to use when estimating the purchase or usage rate. The first way is to count the average purchasing rate determined by research and surveys, and the second is to count the usage rate based on the heaviest buyer. The heaviest buyer can be seen as having a buying rate that the other buyers can be convinced to purchase at. The market potential is then received by multiplying step 2 and 3.

The process behind the result is a lot more important than receiving a correct number. Making an analysis highlights the potential customers, often leading to thoughts about new segments, and reveals where purchasing power exists waiting for a new product, a new strategy or maybe even a new competitor.

4.2.3 Customer Analysis [53]

Information needs about customers can be broadly grouped into current and future information. The critical issues concerning current customers are: who the prime target markets are; what gives them value; how they can be brought closer; and how they can be better served. For the future we also need to know how customers will change; which new customers to pursue; and how to pursue them.

A useful way to approach customer definition is to recognise five main roles that exist in many purchasing situations. Often several, or even all, of these roles may be conducted by the same individuals, but recognising each role separately can be a useful step in a more accurately targeting marketing activity.

[53] D.R Lehmann, R.S.Winer. *Analysis for Marketing Planning,6th ed.* McGraw-Hill, USA, 2005, p 120-122

1) The initiator - the individual who initiates the search for a solution to the customer's problem.
2) The influencer – all those individuals who may have some influence on the purchase decision.
3) The decider – the individual who actually make the decision as to which product to purchase.
4) The purchaser - the individual that actually buys the product.
5) The user - the individual that actually consumes the item.

What is important in any buying situation is to have a clear idea of the various actors' possible impact on the purchase and consumption decision. Where the various roles are undertaken by different individuals, it may be necessary to adopt a different marketing approach to each customer. The different customers may be looking for diverse benefits in the purchase and consumption process.

Of importance for the future is how the customers will change. There are two main types of change essential to customer analysis. The first is changes in existing customers: their wants, needs and expectations. As competition intensifies the range of offerings, open to customers, increases. In addition, their experiences with various offers can lead to increased expectations and requirements. A major way of dealing with this type of change is to make continuous improvements. The second type of change comes from new customers emerging as potentially more attractive targets. Segments that may be less attractive at one point in time might become more attractive in the future. As social, cultural and economic change has affected living standards, it has similarly affected the demand for goods and services.

4.3 Categories of Competitiveness [54] [55] [56]

To effectively compete and continue being successful, a company must understand the market, themselves and the competition. A corporate strategy is

[54] G. J. Hooley, J. Saunders, *Competitive Positioning - the Key to Market Success*, Prentice Hall, UK, 1993
[55] L. Heracleous, *Strategy and Organization – Realizing Strategic Management*, Cambridge University Press, UK, 2003
[56] D.Hussey, P. Jenster, *Competitor Intelligence – Turning Analysis to Success*, Wiley, UK, 1999

for this reason very important, without which a company can end up in a strategic vacuum where universal solutions are used. This can little by little make the company fall behind in comparison with the competition. To be able to develop a successful strategy the company must first and foremost understand and agree on which market to choose to enter and act on, now and in the future. To create an interface between market demands and production a company has to understand its markets with order winners and qualifiers as a starting point.

The first step is to understand the market demands, and to be able to do this it is essential to comprehend that markets are heterogeneous and variable. Irrespective of how a company has chosen to compete on a market, the internal resources of the company must support this preferred competition strategy. A general frame of reference can be used to study the general goals of the company, to continue with the review of the marketing strategy of the company. Most importantly, a focus should be put on the reason why a customer considers buying what the company has to offer.

However, to commence, a brief description of core competencies will take place since these are the starting-off-point for all comprehension of a company's order winners, order qualifiers and critical success factors.

4.3.1 Core Competencies

Core competencies are defined as the underlying skills, technologies and competencies that can be combined in different ways to create the next generation of products and services. They provide potential access to a wide variety of markets. A core competency should furthermore make a significant contribution to the benefits the customer gains from using the ultimate product. In other words, the competency is important where it is a significant determinant of customer satisfaction or benefit. Moreover, a core competency should be difficult for competitors to copy. Clearly, a competency that can be defended against competitors has greater value than one which other companies can share.

Core competencies or core skills may stem from the skills of the workforce in assembling the product effectively or efficiently, from the skills of management in marketing or financial planning, or from the skills of the R&D department in initiating new product ideas or creating new products on the basis of customer research.

The crucial issue in identifying distinctive competencies is that it can be something exploitable in the market place. Having distinctive technological skills in producing a product is of little value if there is no demand for that product. Hence, an important role of marketing management is to assess the potential distinctive competencies of the organisation in the light of exploitability in the market.

The counterbalance to distinctive competencies, or exploitable strengths, is weaknesses relative to the competition. Where, for example, competitors have a more favourable or protected supply of raw materials, or a stronger customer loyalty, the company must be fully aware of its limitations and generate strategies to overcome, or circumvent them. Structural weaknesses, those inherent in the firm's operations, may be difficult or even impossible to eliminate. Strategies should be developed to shift competition away from these factors, to make them less important to competitive success. Other weaknesses may be more easily avoided once they have been identified, or even changed to strengths by exploiting them in a different way.

Finally, it is important to stress that strengths and weaknesses and the resulting core competencies are relative to the competition and require a clear understanding of both the company's and its competitors' capabilities. The distinctive competency of the organisation is a statement of what it does best or uniquely well. These factors form the basis for developing a competitive advantage in the market place.

4.3.2 Marketing Assets needed to be a Strong Competitor

Marketing assets are essentially properties that can be used to advantage in the market place. An asset-based approach to marketing attempts to match the assets of the organisation to the needs and wants of its chosen customers. In that sense it is different from a product orientation (which starts from what the company is, or believes it is, good at producing, irrespective of market requirements) and from a marketing orientation (where markets are chased because they are attractive irrespective of the company's long-term ability to serve the market more effectively than its competitors). This distinction is shown in Figure 9.

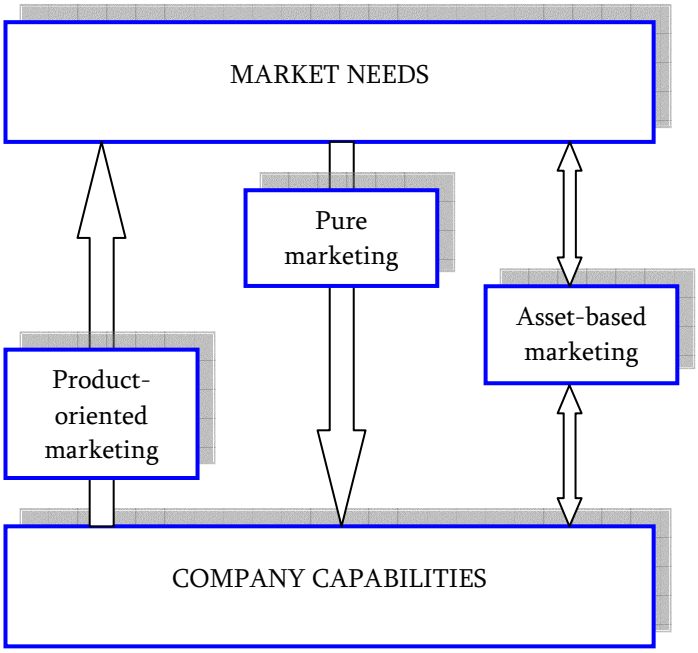

Figure 9 Marketing orientations

A wide variety of company properties can be converted into marketing assets. They can be usefully grouped under customer-based, distribution-based and internal assets.

Customer-based assets are those assets of the company, either real or imaginary, valued by the customer or the potential customer. Often they exist in the mind of the customer and are essentially intangible in nature. Examples are company name and reputation, brand name, country of origin, market domination and superior products.

Distribution-based assets are concerned with the manner in which the product is conveyed to the customer. They include the distribution network, its uniqueness and pockets of strength. Ensuring availability and increasing convenience of use for the customers, are two of the strengths of having a well-planned distribution network. Having a unique distribution, reaching the target market in an innovative way can also be an asset. Moreover, selective but close relationships between a company and its distribution outlets can lead to pockets of strengths. Where a company is unable, through size or resource constraints, to serve a wide market, concentrating effort, either geographically on specific

regions of the market or on specific outlets can enable a pocket of strength to be developed. Delivery lead time is a function of at least three main factors- physical location, order through production systems and company delivery policy. In an increasing number of situations the ability to respond quickly, at no compromise to quality, is becoming more important. Deliberately creating a rapid response capability can constitute a significant marketing asset. Similarly, particularly in volatile markets where the supplier's offering is on the critical path of the customer company, the ability to guarantee supply can be a major asset. However, the desire on the part of the supplier to meet agreed targets is central.

Internal assets are such as cost advantages (when the market in question is price sensitive), information systems and market intelligence (can be an asset in that they keep the company informed of both their customers and competitors), existing customer base (especially when dealing with repeat business), technological skills (can aid in cost reduction or in improving product quality), production expertise, copyrights and patents, and franchise and licenses. Resources become assets when they are actively used to improve the organisation's performance in the market place.

4.3.3 Order Qualifiers versus Order Winners

Order qualifiers are those criteria that a company needs to fulfil to be able to compete on a given market. Hence, they establish a product on a market and help maintaining the product on that market. To even be considered in a bid procedure, a supplier must meet these demands and continually strive towards keeping them to be able to maintain a competitive position on the market. They make the company's products qualified to participate in the final choice that the customer makes. However, qualifiers in their simplicity cannot win any new orders. Nevertheless they still have the potential to become order winners.

The customer's final choice, involves the customer buying the company's product by placing an order. The criteria that tip the scale in the right direction for a customer to choose that company's product are called order winners, and these can vary between different products and different customers. The order winner's central role is explained by the fact that better order winners provide increased market shares and volumes, which can augment the company's profits and its competitive advantages (Figure 10).

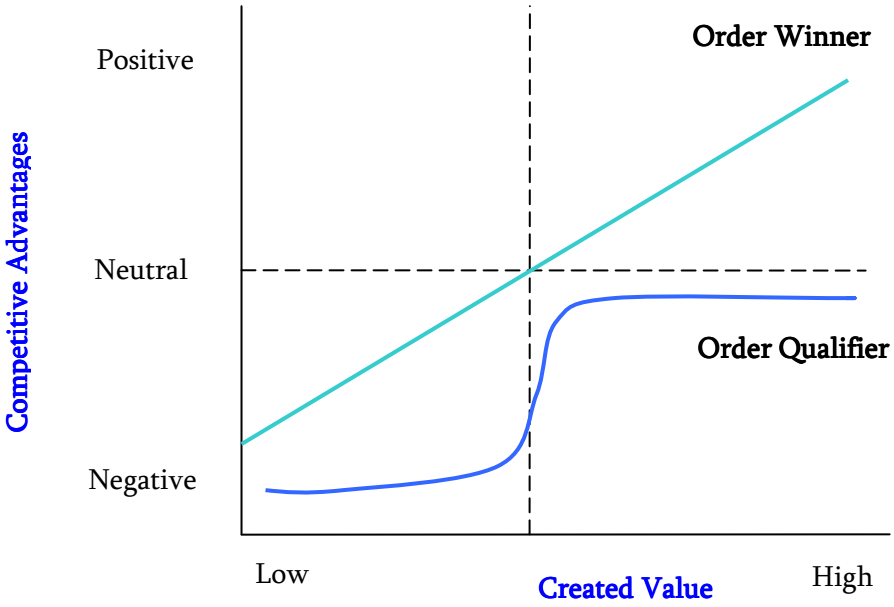

Figure 10 Order winners' and qualifiers' effects on competitive advantage and created value

Companies only need to be as good as their competition when it comes to providing order qualifiers such as no usage of child labour, warranty promises, price, quality, laws etc. However, they need to be better than their competitors when it comes to providing order winners to obtain positive competitive advantage (Figure 10). The intent of identifying these is to understand and get to know the market better. It is of importance to, in clarity, specify what they mean and to separate direct customer from end customer. Furthermore it is vital to comprehend that they are time- and market specific. This means that the order winners and qualifiers for a certain market will change over time and their characteristics are only relevant for the given market and can not be seen as relevant for any other market.[57] For example, price is more important on a mature market where overhead and material often constitute 85-90% of the cost. Similarly, a corporate strategy is market and time dependent and different factors have different significance for different companies.

The process of finding these criteria commences with an inventory of the relevant markets and then a division of these into segments. For each segment,

[57] T. Hill, *Manufacturing Strategy*, Palgrave, 2000, p 41

representative customers and products are chosen. Following, an assessment of the sales volume of each segment will take place. Then relevant order winners and order qualifiers are weighted against each other and subsequently chosen for every representative customer/product within each segment. When identifying different order qualifiers and order winners it must be decided how important these different factors are on the different markets.

4.3.4 Critical Success Factors versus Threshold Factors

The definition of Critical Success Factors is that they are "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation".[58] This, in clear drafting, means that they are the limited number of factors essential for the success of an organisation. In consequence, CSFs recount the basic conditions, internal or external, for the firm's strategy or those competencies or resources it must attain. A clear definition and understanding of success factors is necessary to obtain effective leadership. CSFs are features particularly valued by customers and used to differentiate between potential providers. A few examples are the reputation of a producer, after-sales service, price, delivery reliability and technical quality, some higher valued than others by specific customer groups. It is important to successfully target that group to receive a good position in the industry and outperform competition.[59]

CSFs can also be used as a guide and a motivator for key employees to perform in the desired manner, and in a way that will ensure successful performance throughout the strategy. Using these in discussions and planning will provide an understanding of the essential and critical elements of the strategy for employees throughout the organisation. Moreover, they help managers to focus on the basic critical areas of the strategy. Critical Success Factors should reflect the success of the defined strategy as well as represent the foundation of this strategy. They should be able to motivate and align the managers as well as other members of the organisation. Additionally, they should be both specific and measurable.

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[58] D. Hussey & P. Jenster, *Competitor Intelligence- Turning Analysis into Success*, Wiley, 1999, p 79

[59] G. Johnson, K. Scholes. *Exploring Corporate Strategy, 6th ed.* Prentice Hall, 2002. p 131, 148, 151-152

There are four basic types of CSFs: [60]

- Industry CSFs resulting from specific industry characteristics such as customer quantity
- Strategy CSFs resulting from the chosen competitive strategy of the business such as customer service
- Environmental CSFs resulting from economic or technological changes such as capital structure
- Temporal CSFs resulting from internal organisational needs and changes such as employee morale and productivity

Threshold factors are the requirements of a product that need to be achieved, for the company to be a part of the industry.

It can be hard to distinguish which feature it is that gives an organisation advantages over its competitors. That is, to discover which feature the customers value the most, the feature that is a CSF and not a threshold factor. With new products entering an industry new CSFs enter and competition to deliver these features arise. A former CSF can then be seen as a threshold factor.[61]

4.4 Stainless Steel

Stainless steel got its name from the fact that it does not stain, corrode or rust as easily as ordinary steel. When the alloy is not exactly detailed in type and grade the material can also be called corrosion resistant material. Stainless steel is alloyed with chromium as the principal alloy material with a content of minimum 12% in general. It has a high resistance to oxidation and corrosion in many natural and man made environments. Depending on the application area it is important to select the correct type and grade of stainless steel.

A minimum of 13% chromium is necessary to receive a high oxidation resistance in air and ambient temperature. In harsh environments up to 26% chromium is used. When chromium is exposed to oxygen it forms a passivation layer of chromium (III) oxide, Cr_2O_3. The metal remains glossy since the layer is too thin to be visible but it is still impervious to water and air and thereby

[60] J. F. Rockart, *A Primer on Critical Success Factors*, Dow-Jones-Irwin, 1986

[61] G. Johnson, K. Scholes. *Exploring Corporate Strategy,6th ed.* Prentice Hall, 2002. p 178, 369

protects the metal beneath from dissolving. Another good thing with this layer is that it quickly reforms when the surface has been scratched. Other materials such as aluminium and titanium have this passivation effect as well. The oxide layer can be scraped off when stainless steel parts such as nuts and bolts are forced together, which causes the parts to weld together. Nickel and molybdenum are other substances that contribute to passivation.[62]

4.4.1 Structures of Stainless Steels [63] [64] [65]

Stainless steels are divided into different groups depending on their crystalline structure. The largest group is the austenitic stainless steels. Their austenitic structure makes them non-magnetic and most of them can not be hardened. These steels consist of 12-30 percent chromium, 7-30 percent nickel and other metals, often 2-3 percent molybdenum. The carbon level is very low, generally under 0.05 percent. The benefits of austenitic steels are that they are easier to work with, to form and to weld since the carbon level is very low. Therefore, they have a big applying area in construction steels. The acid resistant steels belong to this category of stainless steels.

Ferritic stainless steels are magnetic and can not be hardened. They are corrosion resistant but less durable than the austenitic steels. They have a chromium level between 12-30 percent and a carbon level under 0.1 percent. This steel is hard to weld and is therefore not used for construction steel. It is used in environments where the steel is only modestly exposed and for machined details.

Martensitic stainless steels are magnetic and very strong. They can be highly machineable depending on alloying material. Moreover, they can be hardened through heat treatments. They have a content of 12-14 percent chromium, 0.2-1 percent molybdenum, 0-2 percent nickel and 0.1-1 percent carbon, which makes the steel harder but more brittle. Some types of chromatic steels belong to this group. The martensitic steels are generally used as blades in tools, such as knives and scissors. It is hard to weld and therefore not suitable for construction steel.

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[62] SIS, Swedish Standards Institute, *Rostfria Stål*, *7th edition*, SIS Förlag, 2003, p 25
[63] SIS, Swedish Standards Institute, *Rostfria Stål*, *7th edition*, SIS Förlag, 2003, p 30-37
[64] Berndt Stenlund, Sandvik Materials Technology, Marketing Support - Wire
[65] Anders Söderman, Sandvik Materials Technology, R&D Manager - Wire

Maraging steels (from Martensitic Aging) are iron alloys which are known for possessing superior strength without losing malleability. The iron base is alloyed principally with a large percentage of nickel to produce a very specific heat-treatment product. Other alloying elements include molybdenum, aluminium, copper and titanium. Maraging steel is essentially free of carbon, which distinguishes it from most other types of steel. The result is steel which possesses high strength and toughness, allows for easy machining with minimal distortion and resists corrosion and crack propagation. Moreover it has a uniform, predictable shrinkage during heat treatment and can be finely polished. Original development was carried out on 20 and 25% Ni steels to which small additions of Al, Ti and Nb were made. Stainless grades rely on chromium not only to prevent their rusting, but to augment the hardenability of the alloy as their nickel content is substantially reduced. Normal application areas are missiles, component applications that work at high temperatures and sporting uses such as fencing blades and bicycle frames.

Ferritic-austenitic stainless steel, also called duplex steels, have a very good corrosion resistance, a high mechanical durability. It consists of up to 29 percent chromium, 5-8 percent nickel, 1-4 percent molybdenum, less than 0.03 percent carbon and 0.4 percent nitrogen. These kinds of steels are stronger than the austenitic steels. Furthermore they are easy to both weld and form. The duplex steels are magnetic and can not be hardened. They are mostly used in highly corrosive environments.

Martensitic-austenitic stainless steels are magnetic and can be hardened. They consist of 13-16 percent chromium, 5-6 percent nickel, 1-2 percent molybdenum and 0.04-0.08 percent carbon. These steels are easy to weld and often used for turbines and propellers.

4.4.2 Different Levels of Corrosion Resistance in Steel Alloys [66] [67] [68]

From ordinary carbon steels to the finest and most exclusive stainless steels there are many different levels depending on what mechanical properties that are desired. Some of the different properties that affect the steel are corrosion resistance, relaxation resistance, formability vs. final strength and fatigue- and

[66] Berndt Stenlund, Sandvik Materials Technology, Marketing Support - Wire
[67] SIS, Swedish Standards Institute, *Rostfria Stål*, *7th edition*, SIS Förlag, 2003, p 25
[68] Anders Söderman, Sandvik Materials Technology, R&D Manager - Wire

tensile strength. The levels of corrosion resistance are roughly explained and visualised in the figure below (Figure 11).

1) Ordinary steel has a content of carbon, **C**, from 0.02% up to 1.6%. When it comes to carbon steels, this amount can be varied up to 2.1% carbon. The more carbon added to a steel alloy, the harder the material gets. A certain amount of carbon must be added to obtain hardenable steel, which means that the steel can be heat treated to acquire a hard and brittle material. Without the heat treatment the steel remains soft which is desired only in rare cases.

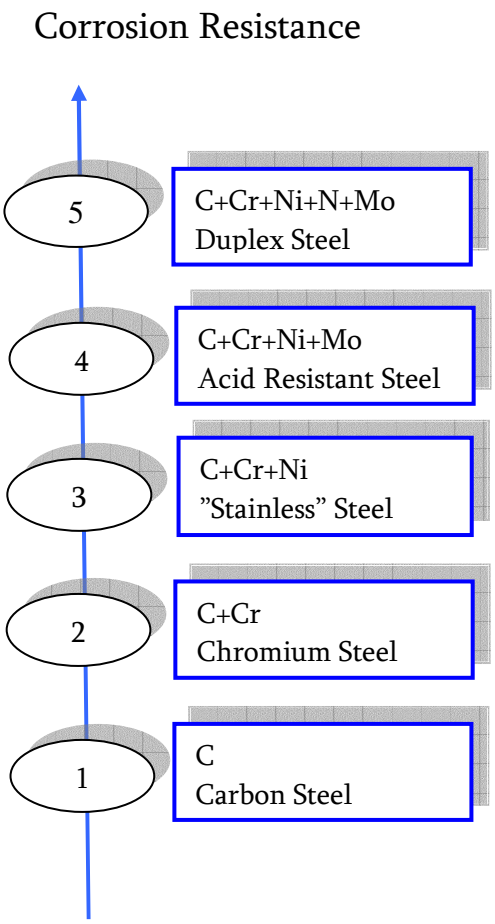

Figure 11 Corrosion resistances in steel alloys

2) When chromium, **Cr**, is added to a carbon steel the resistance to corrosion is considerably augmented. These steels are called chromium steels. To be categorised as a stainless steel, a minimum of 12 % chromium must be added to the carbon steel. Many manufacturers who deal with stainless steels argue that the corrosion resistance of the material must be higher than this for the material to be recognised as a true stainless steel. The alloy substance chromium has a ferrite creating effect. A pure iron-chromium alloy is therefore similar to the

unalloyed iron with regard to structure and mechanical properties. With augmented carbon percentage these steels can, much like the unalloyed carbon steels, be hardened as a result of martensite formation, and thereby obtain increased strength values.

3) On this level nickel, **Ni**, (≈8%) is added to the chromium (≈18%) alloy which principally affect the structure and the mechanical properties of the steel. By alloying the material this way an austenitic structure is obtained. This increases the material's formability, its viscous abilities and its corrosion resistance. This is the level that many would say is the first to be called stainless steel.[69]

4) When climbing higher in the refinement chart, materials with even greater resistance for oxygen and thereby rust will be found. These are called acid resistant steels. In these alloys you might find 2-3 % molybdenum, **Mo**. Steels on this level of the chart are rarely used because of their exclusiveness and sizeable prices.

5) Duplex steels have high resistance to corrosion. Since nickel is a very expensive material (≈40 000 $/ton), an effort was here made to find a material with less percentage of nickel. The lower content of nickel (≈5%) is compensated with a higher content of chromium (≈22%) and a supplement of nitrogen, **N**. Even here, molybdenum might be added to enhance the stainless properties of the material. The duplex steel is a perfectly good material with a lot of interesting and excellent qualities, with its austenitic-ferritic structure. However, the steel industry is a conservative business and people are reluctant to try new materials. In the U.S. for example, they have not accepted this alloy in the wire business, which means that it, in this shape, is not easy to sell, even though it is cheaper.[70]

4.5 Materials Used in Musical Instruments

In each instrument's tradition, a fundamental part is played by the materials used to manufacture it. The materials have also influenced both the tonal and the visual standards that instrument makers all over the world have tried to

[69] Berndt Stenlund, Sandvik Materials Technology, Marketing Support - Wire
[70] Berndt Stenlund, Sandvik Materials Technology, Marketing Support - Wire

attain. In cases where the material actually affects the sound, this has then helped defining the "real" sound of that instrument, and in all cases it has helped defining the traditional facade. Sometimes new materials can be used to advantage, but usually the traditions persevere for good reason.[71]

A metal that is used in a musical instrument must be easy to shape into different complex forms, it needs to be hard and durable against corrosion and on the same time have an appealing look. Ideal materials were gold and silver alloys since they fulfilled the requirements described.[72]

The mechanical properties, such as the density and modulus of elasticity, of a material are important when determining the nature of the sound in an instrument. These properties determine the frequencies and width of its mechanical resonance and impedance, assuming that the dimensions of the instrument are fixed.[73]

Clearly the manufacturing material of some instrument elements has a large influence on the acoustic behaviour of that instrument. This is the case with bells and cymbals, in which the whole solid material vibrates and radiates sound. Drums, guitar- and violin strings, and reeds of woodwind instruments can also be included in this sector.

The different materials that are used or can be used in a musical instrument will be described underneath. The different musical instruments and the material used for each part will be mapped in the following chapter (5. Musical Instruments).

4.5.1 Steel

Steel is an alloy mainly composed of iron, with a content of carbon between 0.02% and 1.7% by weight, depending on grade. Carbon is the most cost-effective alloying material, but many other elements are used. The qualities of the steel, such as the ductility, hardness, elasticity and tensile strength, change

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[71] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 711

[72] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 728

[73] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 717

when varying the amount of alloying materials. Chromium increases the hardness and melting temperature and vanadium increases the hardness while reducing the effects of metal fatigue whilst an alloy with nickel or manganese augments the tensile strength of the steel.

Modern steels are made with varying combinations of alloy metals to fulfil many purposes.[74] Carbon steel composed simply of iron and carbon, accounts for 90 % of steel production. Low alloy steel is alloyed with other elements, usually molybdenum, manganese, chromium, or nickel, in amounts of up to 10 % by weight to improve the hardenability of thick sections.[75] High strength low alloy steel has small additions (usually < 2 % by weight) of other elements, typically 1.5 % manganese, to provide additional strength for a modest price increase.[76]

Some more modern steels include tool steels, which are alloyed with large amounts of tungsten and cobalt or other elements to maximise solution hardening. Tool steel is generally used in axes, drills, and other devices that need a sharp, long-lasting cutting edge.[77] Many other high-strength alloys exist, such as dual-phase steel, which is heat treated to contain both a ferritic and martensitic microstructure for extra strength.[78]

Within the musical instrument industry the normal carbon steel is used in musical strings, keys, rods, posts and other small parts. Moreover, the material is used in many accessories such as endpins, stands and slides for guitar players.

4.5.2 Titanium

Titanium, **Ti**, is a transition metal with a white-silvery-metallic colour that is light, strong and corrosion-resistant. Once formed, titanium's reactivity works to its advantage. A thin, tenacious oxide coating forms on its surface, giving

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[74] http://www.materialsengineer.com/E-Alloying-Steels.htm, Metallurgical Consultants, 2007-04-04

[75] M.F. Ashby, R.H David. *Engineering Materials 2, 2nd ed.* Pergamon Press, Oxford, 1992

[76] http://www.schoolscience.co.uk/content/5/chemistry/steel/steelch3pg1.html 2007-04-04

[77] M.F. Ashby, R.H David. *Engineering Materials 2, 2nd ed.* Pergamon Press, Oxford, 1992

[78] http://www.intota.com/multisearch.asp?strSearchType=all&strQuery=dual-phase+steel 2007-04-04

excellent resistance to corrosion. To create strong lightweight alloys suitable for the aerospace, automotive and medical (prostheses) industries, titanium is alloyed with materials such as iron, molybdenum, vanadium and aluminium. The two biggest advantages of this metal is its corrosion resistance and that it is the strongest of all materials with regard to its weight. [79] In its unalloyed condition, titanium is as strong as steel, but 45% lighter. It has a density of 4507 kg/cm^3. It is therefore 60% heavier than aluminium but more than twice as strong.

As mentioned above, titanium is recognised for its high strength-to-weight ratio. When it is pure it is quite ductile and it has a very high melting point (1941 K=1668°C) which translates in a great resistance to heat, wear and corrosion. Nonetheless, it will lose some of its strength when heated over 430° Celsius. It can be difficult to machine since it will gall if sharp tools and proper cooling methods are not used, due to the fact that it is a quite hard material. Titanium's excellent resistance to corrosion includes a capability of withstanding attack by acids, moist chlorine gas, and by common salt solutions. This metal forms a passive and protective oxide coating when exposed to elevated temperatures in air, but at room temperatures it resists tarnishing. When it first forms, this protective layer is only 1 to 2 nanometres thick but continues to slowly grow; reaching a thickness of 25 nanometres in 4 years.[80]

Titanium can be used in musical instrument accessories such as endpins, but no part of an actual instrument has been found that is currently made of titanium.

4.5.3 Brass

Brass is an alloy of copper and zinc which has a higher malleability than both copper and zinc. As a consequence of having a low melting point (900-940 °C) and its flow characteristics, this material is relatively easy to cast. By varying the proportions of copper and zinc, the properties of the brass can be changed, allowing both hard and soft brasses. Aluminium makes brass stronger and more corrosion resistant. Moreover, aluminium forms a hard layer of aluminium oxide on the surface that is thin, transparent and self healing. To obtain a brass that is wear and tear resistant, combinations of iron, aluminium, silicon and

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[79] J.F. Shackelford, *Introduction to Materials Science for Engineers, 6th* ed, Pearson, New Jersey, 2005. p 420

[80] Emsley, J. Nature's Building Blocks: An A-Z Guide to the Elements. Oxford University Press,2001. p451-53

manganese can be used. There are also developed processes that provide dezincification resistant brasses, i.e. brasses that support high corrosion risks where the normal brasses do not meet the standards. However, there are high demands on the production of these alloys. Special attention needs to be focused on attaining the proper production temperatures and other parameters to avoid long-term failures.

Brass is principally used in musical instruments and is resistant to tarnishing. However, it needs to be protected with a coat of lacquer or plating to prevent the material from oxidisation and corrosion.[81] The normal brass used for musical instruments is yellow brass. This, just as the name implies, has a yellow colour. Yellow brass is an American term for 33% zinc brass.

Brass is the main material in most brass instruments due to its favourable properties when being "worked", since the material must be suitable for drawing into seamless tubes, bending to different shapes and so forth. Nevertheless, it must still be hard enough when finished to support minor bumps. Moreover, as most lip-blown instruments have an apparatus with complicated parts that must be attached to each other and to the body, the material must allow soldering and preferably tin soldering.

4.5.4 Silver and Gold

Silver, **Ag**, is a very ductile and malleable (slightly harder than gold) transition metal with a brilliant white metallic lustre that can take a high degree of polish. It is quite expensive and tarnishes easily. A major use of silver is as a precious metal. Sterling silver is 92.5 % silver, usually alloyed with copper. Jewellery and silverware are two major application areas. Many high end musical instruments are made of silver, since it is excellent to work and easily shaped. The one disadvantage of silver is that it tarnishes to black silver sulphide, although this is not generally a severe problem. Gold, **Au**, is the most malleable and ductile material. A single gram can be beaten into a sheet of one square meter. Pure gold is too soft for ordinary use and is typically hardened by alloying it with copper or other base metals. Gold also forms alloys to create exotic colours. Heat, moisture, oxygen, and most corrosive agents have very little effect on gold. Consequently, gold alloys possess all the advantages of silver, together

[81] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, 1998. p 730-731

with freedom from tarnish and a rich appearance.[82] Common applications are coinage, jewellery, tooth restoration and electronics because of its excellent conductivity.

4.5.5 Nickel Silver [83]

Nickel silver is a metal alloy of copper and nickel and sometimes zinc. Its name derives from the fact that it looks like silver, but it does not actually contain any silver elements. A representative industrial formulation is 65% copper, 18% nickel and 17% zinc. Hence, nickel brass would be a more technically correct name. Some nickel silver alloys, especially those with a high proportion of zinc, are stainless. It was first used for silver plated cutlery and other silverware. It is also used in zippers, better quality keys, costume jewellery, for making musical instruments and is highly valued for electrically powered model railway layouts since its oxide is conductive. It is appreciated for its corrosion resistance and high electrical resistance. It is also used to produce the tubes onto which oboe reeds are tied. Musical instruments such as the flute, saxophone, and French horn can be made of nickel silver. For example, some leading saxophone manufacturers such as Selmer, P. Mauriat, Yanagisawa and Yamaha offer saxophones, made of nickel silver, which possess a bright and powerful sound quality. An additional benefit is that nickel silver does not require a lacquer finish. A disadvantage with this material is its allergy provoking ability when in contact with a person's skin.

4.5.6 Carbon Fibre

Carbon fibre is a very strong, light and expensive composite material or fibre reinforced plastic. The plastic is most often epoxy, but polyester and nylon can also be used. It has many applications in fields such as, aerospace, automotive, bicycles, sailboats, and in consumer goods such as computers, hobby equipment and musical instruments. It is commonly used because of its high rigidity and low weight, but also because of its attractive appearance. It can also be used in a product to stiffen an otherwise flexible material. The carbon fibre can be enhanced through heat treatment processes. Carbon fibre heated in the range of 1500-2000 °C exhibits the highest tensile strength while carbon fibre heated

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[82] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 730

[83] Emsley, J. Nature's Building Blocks: An A-Z Guide to the Elements. Oxford University Press, 2001.

from 2500 to 3000 °C exhibits a higher modulus of elasticity. One way to produce it is by layering sheets of carbon fibre cloth into a mould in the shape of the final product. The alignment and weave of the cloth fibres is carefully selected to optimise the strength and stiffness properties of the resulting material. Since there is intricate work involved in these materials, the use in complex applications is limited. The market price of carbon fibre saw a 150% increase during 2005, primarily due to increased use in the civil aerospace industry. Global sales of carbon fibre reinforced plastics are estimated to be $9.9 billion in 2006 while the market demand was estimated to be 27,000 tonnes. [84] Hence, the price is approximately $370/kg. Similarly, the numbers are $13.6 and 34,000 tonnes in 2010, which illustrates a raise of price to $400/kg.

4.5.7 Conclusion

These facts show that there is and has always existed a close connection between the aesthetic ideal of a musical instrument and the materials from which it is made, together with the related connection between the necessary fabrication processes and the materials that make these possible. In some cases the choice of material has clear acoustic consequences that cannot be modified by changes in the hidden dimensions of the instrument, such as plate profile, while in other cases the choice of material has almost no acoustic consequences whatsoever, provided only that the dimensions and surface finishes can be maintained unchanged. Developments in materials and fabrication processes continually open up new possibilities, but these must be balanced against both tradition and aesthetic considerations.

[84] T. Roberts. *The Carbon Fibre Industry: Global Strategic Market Evaluation 2006-2010.*Material Technology Publications, 2006

5. Musical Instruments

The different musical instruments' structures, used materials and the market will be described in this chapter to provide the reader with a comprehensive understanding. This will also form one part of the basis on which the authors form their decisions in the upcoming selection process.

Since the purpose of the thesis is to establish if any areas within the musical instrument industry exist, that are of actual interest of SMT, a brief survey over the different instruments will be made. Instruments completely made of wood such as the recorder and instruments that are very unusual and therefore lack interesting market shares will be discarded before the examination, since they, in the eyes of SMT, do not possess any significant value. This will consequently constitute the first limitation made in this thesis Appendix IV – Organisation Charts Showing the Selection Process, Figure 1. A current market analysis of the different instruments will be presented in the end of this chapter to further highlight interesting market facts.

Each instrument will be taken down into parts which will be described and showed in an organisation chart. Every part will have its own box which will be marked yellow if there is a reasonable possibility that the part can be made of stainless steel or titanium.

The order of the detailed description of the instruments and their respective accessories is;

1. Fretted Instruments
2. Keyboard Instruments
3. Percussion Instruments
4. Woodwind Instruments
5. Brass Wind Instruments
6. Stringed Instruments
7. Free Reed Instruments

5.1 Fretted Instruments – The Guitar

As mentioned above, unusual and small-market instruments will be discarded before the examination. In the section of fretted instruments that means that the banjo, mandolin, ukulele etc, will leave place for big-sellers such as the guitar, both acoustic and electric.

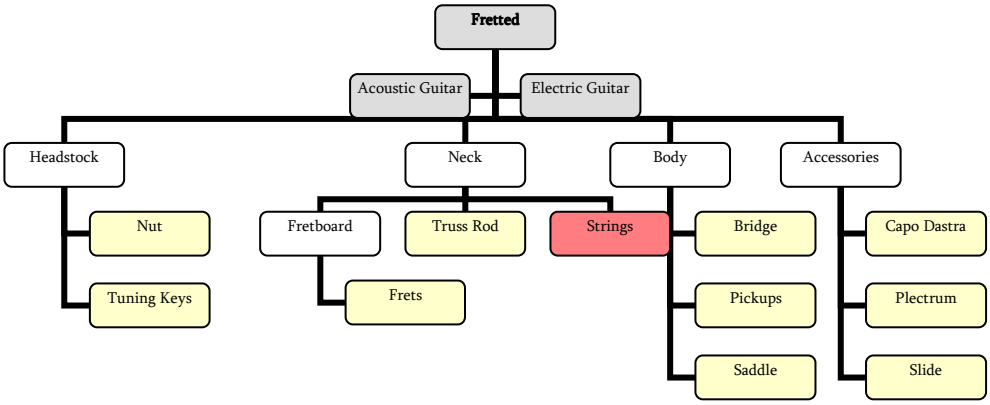

Figure 12 Initial map of potential guitar parts

Usually the guitar is divided into three bigger jointed parts on which the smaller ones are attached; the body, the neck and finally the head. The guitar comprises many smaller parts (Figure 13). The main parts and the parts that are significant for this thesis will be presented in Figure 12 and then described below. SMT has already developed a suitable stainless material for guitar strings which makes them uninteresting in this thesis. They will therefore not take place in the examination of the guitar. Relevant accessories will, however, be pointed out and explained.

5.1.1 Headstock

The headstock is fitted with *tuning keys* that adjust the tension of the strings, which in turn affects the pitch. Tuning keys are currently made in many different materials, such as wood, brass, steel, plastic and nylon. The ones that are used depend on the preferences of the musician.

1. Headstock
2. Nut
3. Tuning Keys
4. Frets
5. Truss Rod
6. Inlays
7. Neck
8. Heel – Neck Joint
9. Body
10. Pickups
11. Electronics
12. Bridge
13. Pick Guard
14. Back
15. Soundboard (top)
16. Body sides (ribs)
17. Sound Hole
18. Strings
19. Saddle

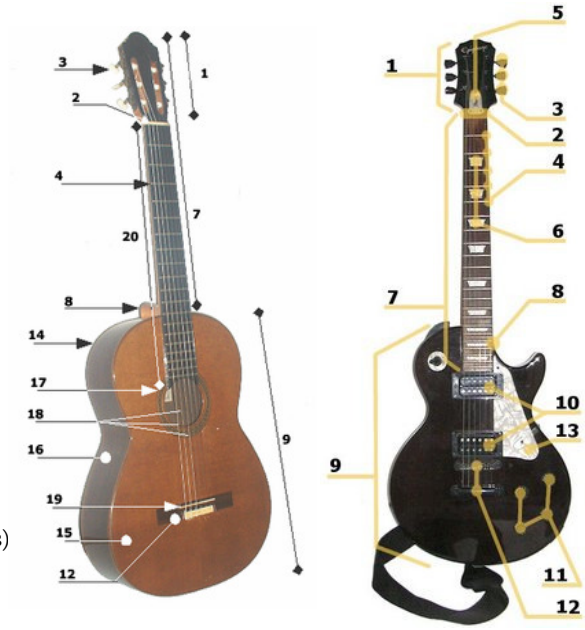

Figure 13 the Acoustic and Electrical Guitar Parts

The small strip between the headstock and the neck, more exactly the fretboard, is called the *nut*. This holds the strings in place and can be made of bone, plastic, brass, graphite, stainless steel or other medium-hard material. It can contribute to tuning problems if it is not properly cut, causing string slippage, and/or string buzz.

5.1.2 Neck

The neck is a long wooden extension where the frets, fretboard, tuners, headstock and truss rod are attached. For the guitar to hold a constant pitch during tuning and when the strings are fretted, the neck has to endure the bending stress that arises.

The fretboard is curved a little crosswise on acoustic and electric guitars and flat on classical guitars. It is embedded with metal strips. These are called *frets* and are usually made of a nickel alloy or stainless steel. The frets cut down the vibrating length of the strings when pressed down, which produces different

pitches. The frets are normally the first permanent parts on a heavily played guitar that will wear out. They can be re-shaped to a certain extent and replaced if needed. The frets are accessible in different measures, depending on the type of guitar and the player's style.

The metal rod that runs along the inside of the neck on an electric guitar is called a *truss rod*. Tightening the rod will curve the neck back and loosen it will return it forward. The strings put a lot of tension on the neck and the truss rod helps bringing the neck back to a straighter position. Guitars with strings made in nylon do not have truss rods since the strings do not place that high tension on the neck. The truss rod is generally made out of steel but other materials such as graphite can sometimes be used.

Figure 14 a Guitar Truss Rod

5.1.3 Body

The thin top of the body, the soundboard is mostly made of spruce, cedar or mahogany. This is the most prominent part in deciding the sound quality of the guitar. Energy from the vibrating strings is transferred to the guitar top that starts to vibrate and sound arises. Even the back and the sides of the guitar body are made of wood, principally mahogany or rosewood. Each wood is chosen for its aesthetic effect and structural strength, and plays a significant role in determining the instrument's quality of the note, also called timbre, which is characterised by the way the top vibrates.

The body of an electric guitar is usually carved from a wood such as maple, basswood, ash, poplar, alder or mahogany. The *bridge* holds the strings in place on the body. The main purpose of the bridge on an acoustic guitar is to transfer the vibration from the strings to the soundboard so that air starts to vibrate inside the guitar which amplifies the sound. On most of the electric guitars made today, the bridge can adjust each string so that intonation stays correct up and down the neck. The bridge, often made out of wood, is located between the string and the resonant surface. A common bridge model incorporates a separate bearing surface called a *saddle*, on which the strings rest. The material used for the saddle; bone, ivory, high-density plastic or metal, is harder than the material used for the bridge.

The *pickup*, an electronic device usually placed right underneath the strings on an electric guitar, identifies the vibrations of the strings and can amplify the sound of the string. Pickups usually consist of a magnet, tightly wrapped in copper wire.

5.1.4 Accessories

A guitar player that wants to change the pitch of an open string can use a *capodastra*, also called capo, which is clipped onto the fretboard to shorten the strings. Many variants of capos exist but they commonly consist of a rubber-covered metal bar, to hold down the strings, fastened with a strip of elastic or nylon.

The term *slide* got its name from the sliding motion of the slide against the strings. This is a particular method or technique of playing the guitar used in blues and rock to create a glissando effect. Normally a guitar player regulates the pitch of the strings by pressing down the string against the frets. When using a slide, it is placed upon the string to vary its vibrating length and pitch. The slide can then be moved along the string without lifting which creates a continuous transition in the pitch. A slide is today constructed of glass, plastic, chrome, brass or steel depending on the weight and tone desired.

A *plectrum* is used to pick the strings and is held between the thumb and first finger of the picking hand. They are generally made of plastic but types of bone, wood and steel exist.

5.2 Keyboard Instruments – The Piano

As a result of the decided first limitation keyboard instruments manufactured in uninteresting material, such as the synthesizer and organs, and unusual ones such as the cembalo and the clavichord, are put aside to make room for closer examination of instruments with higher potential such as the piano.

The grand piano and the upright piano are constructed in more or less the same way. A description of an average sized Grand Piano will be presented. A piano is a large instrument that consists of thousands of parts. A simplified diagram

of the piano is shown in Figure 15. The strings extend from the pin block across the bridge to the hitch-pin rail at the far end. When a key is depressed, a damper is raised, and a hammer is thrown against the string, setting it into vibration. Vibrations of the string are transmitted to the soundboard by the bridge.[85]

1. Frame
2. Soundboard
3. Strings
4. Action
5. Pedals
6. Case
7. Pin block
8. Bridge

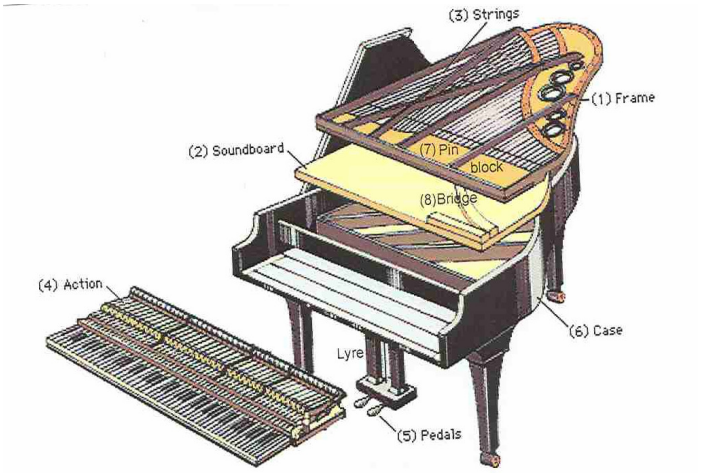

Figure 15 Construction of a Grand Piano

The main parts of a piano are the keyboard, the action, the strings, the soundboard and the frame (Figure 16). These parts contain all kinds of materials most of which will not play an important part in this report. The frame is made of cast iron and the soundboard of spruce. The strings make use of high-steel wires with copper windings (bass), whereas the keyboard and action contains thousands of parts of different materials such as felt, paper, cloth, wood, brass, plastic and steel.

[85] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 353

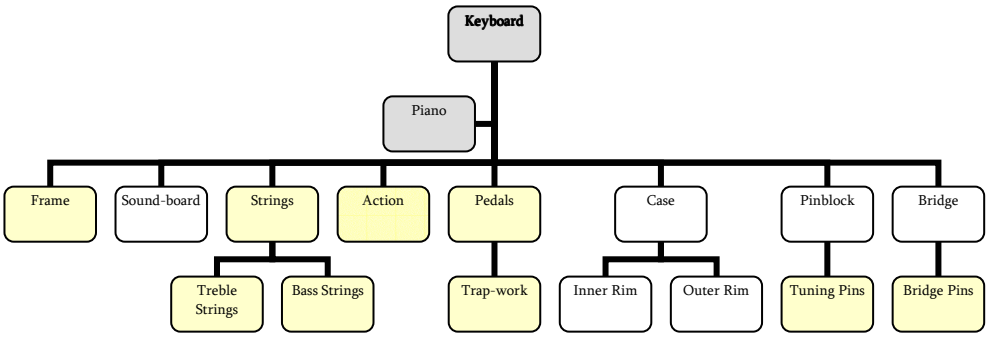

Figure 16 Initial map of potential piano parts

5.2.1 Frame and Soundboard [86]

The frame supports a gigantic amount of stress exerted by the strings which makes it crucial for the material to be extraordinary strong. Therefore, the frame is normally made of cast iron. The average upright or medium-sized piano's strings have a combined pull of about 18 tons. The tension, however, in a 9 foot concert grand is close to 30 tons.

On its own, the sound of a string vibrating is pretty weak. The soundboard amplifies this sound in a piano. The soundboard is a large, thin wooden diaphragm. Usually it is made from Sitka spruce, up to 1cm thick.[87] The advantage of this wood is that it has just the right balance of stiffness and flexibility to effectively transmit sound. The soundboard is bowed slightly upward towards the strings. This helps it to maintain compression, which in turn makes it more vibrant, and keeps it from caving in under the pressure from the strings.

5.2.2 Strings

A typical concert grand piano has 243 strings, varying in length from 2m at the bass end to 5cm at the treble end.[88] Both treble and bass strings are made of steel, although bass notes have a steel core, with a copper winding, which

[86] http://www.concertpitchpiano.com/GrandPianoConstruction.html 2007-04-05
[87] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 353
[88] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 353

allows the string to vibrate freely on the same time as it has a sufficient thickness to produce the low note. Modern pianos have the bass strings crossing diagonally over the treble strings, to conserve space and fit the longest possible bass strings into a cabinet.[89]

5.2.3 Action and Pedals

The sensitive inner mechanism of the piano is called the action. This part translates all the nuances of ones playing to the hammers who in turn hit the strings. The action is made of thousands of parts consisting of materials like wood, paper, cloth, felt, brass, plastic and steel. All these parts must work together in a clear-cut chain reaction, with precision as high as a thousandth of an inch. Therefore, it is vital to regulate these moving parts to assure evenness, speed, power and control. Moreover, adjustments must be made periodically to compensate for wear, compacting of cloth and felt, and changes in wooden parts due to atmospheric conditions that come most noticeably with the change in seasons.

Usually special operations like sustaining or softening the sound are carried out by two or three pedals that the piano normally have. They are connected to the action by a series of levers, dowels and springs called the trapwork.[90]

5.2.4 Case

The wooden framework to which the plate is bolted and the soundboard is glued is called the case or the rim. This contains of two parts: the inner and the outer rim. The plate and soundboard are attached to the inner rim. Different manufacturers use different woods such as laminated maple, spruce and beech.

5.2.5 Pin Block and Bridge [91]

The pin block is a laminated plank made of hardwood such as maple or beech that is attached to the plate and the inner rim. Steel *tuning pins* are embedded in holes in the pin block, around each of which one end of a piano string is coiled. To ensure that the strings maintain their proper tension without

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[89] http://www.concertpitchpiano.com/GrandPianoConstruction.html 2007-04-05
[90] http://www.concertpitchpiano.com/GrandPianoConstruction.html 2007-04-05
[91] http://www.concertpitchpiano.com/GrandPianoConstruction.html 2007-04-05

slipping, the pin block has the task to hold the tuning pins tightly enough by friction alone.

The strings pass over wooden bridges that transmit vibrations of the strings to the soundboard. Like the pin block this is mostly made of maple or beech. To keep the strings in place, to aid in sound transmission and to cleanly terminate the vibrating portion of the string (much like guitar player's finger would press down on the fretboard), steel *bridge pins* are driven into the bridges. Bridges must be well constructed, both to transmit sound properly and to avoid splitting under the hundreds of pounds of downward pressure exerted by the strings.

5.3 Percussion Instruments – The Drum Kit

With the chosen limitations instruments such as the tambourine, the gong, the xylophone and other hand percussion were discarded and full focus was put on the traditional drum kit. This was identified as the percussion instrument with the most potential parts for this investigation.

1) Bass Drum
2) Floor Tom
3) Snare
4) Tom-toms
5) Hi-Hat
6) Crash and Ride Cymbal

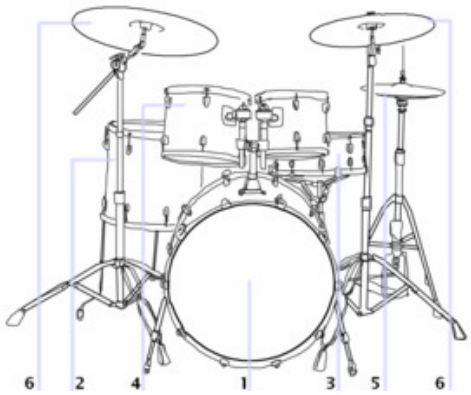

Figure 17 the Construction of a Traditional Drum Set

A drum kit is generally constructed by a bass drum, toms, a snare, a hi-hat and cymbals (Figure 17). Toms have a vibrating system with a single membrane open to air on both sides, whereas the vibrating system for bass drums and snare drums entails two membranes united by an enclosed air cavity.[92]

[92] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p

The organisation chart presented below (Figure 18) illustrates each part of the drum kit and a more detailed description of each comprehensive part will follow.

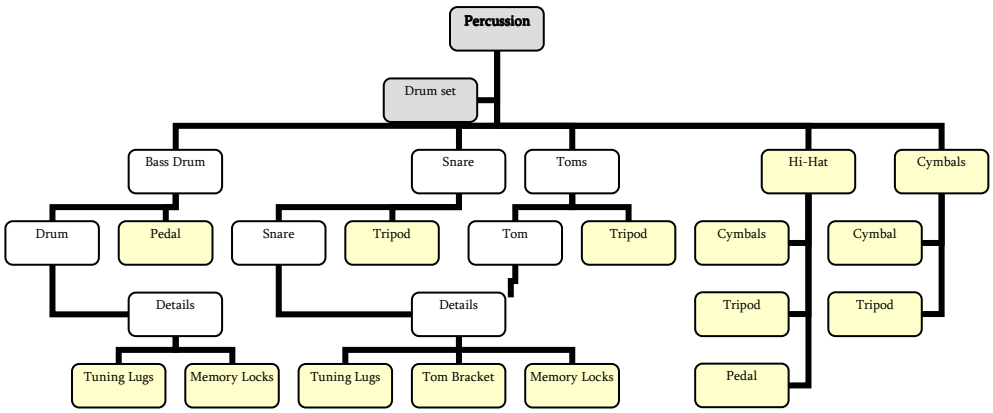

Figure 18 Initial map of potential drum parts

5.3.1 Bass Drum

The instrument that radiates the most power in an orchestra is the bass drum with a diameter of 80-100cm. A bass drum normally has two heads set at different tensions. The sound of the bass drum depends on where the drum is hit. It is operated with one or more mechanical pedals. [93] These pedals are often made of aluminium, the light and durable material suitable for the purpose of the pedal. However, pedals in plain and stainless steel can also be found.

The creation of perfectly round shells is a crucial factor, especially with wood, when achieving a superior tone quality for both bass drums and the ones described below. The cylindrical shells are pretty rigid support structures for the light membranes in drums. The curvature of the shell makes it stiff against deformation, such as uniform radial displacement of the walls. Thus, it supports

[93] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001, v 7, p 608-610

the inward tension produced by the two drumheads. The compressive stress in the shell of a small drum with deep and thick walls is not very high.[94]

The tuning lugs are placed symmetrically around the round shells. The amount of lugs is different depending on drum type and size. The purpose of the lugs is partly to hold the hoops into place, which in their turn hold the head into place, and partly to set the tune or the acoustics to a desired level, hence the name: tuning lugs. The lugs consist of a precision-machined lug nut inserted in a small springless casing. Attached to the drum shell at its nodal point by a single bolt, allows the shell to vibrate freely. A special nylon insert prevents tension rods from becoming loose during play. The lugs can be made gold, chromium, carbon steel or zinc.

The memory locks are placed on all stands to remember at which points of the stands the different parts should be set, when taking them apart and putting them back together again. It is a kind of a lock screw placed right above the stand locks for an easier assembly, thus the name: memory locks. They ensure consistent and reliable rack systems setups. These locks are currently mostly made of zinc but can also be made of heat-treated hard steel.

The round shells of the bass drum, snare and toms can be made of wood or man-made materials such as fibre-glass, pressed steel, acrylic glass, resin-composite etc. Wood or composite shells can be polished by laminating in plastic in a large variety of effects and colour. Steel is usually chromed, fibre glass self-coloured and acrylic glass tinted or clear.[95]

5.3.2 Snare Drum

An orchestral snare drum has a diameter of 35 cm and is 13-20 cm deep. It is a two headed instrument, also called a side drum with a "head" stretched over the top and bottom openings. A cluster of snares made of curled metal wire, metal cable, plastic cable or gut is stretched across the bottom head. When the top head is struck, causing a sudden increase in pressure within the instrument, the

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[94] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998.

[95] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 7, p 608

snare head vibrates against the snares. If the snares are moved away from the head the sound is completely different.[96]

An orchestral snare drum is made of wood or metal with a "head" stretched over the top and bottom openings. Snares made of curled metal wire, metal cable, plastic cable or gut cords is stretched across the lower head.

5.3.3 Tom-toms

A tom-tom is a cylindrical drum, single or double-headed, without a snare and range from 20-45 cm in diameter and from 20 to 50 cm in depth. A general tom consists of a shell and chromed or plated metal hardware. It can be attached to a floor stand with an adjustable mounting or to a bass drum.[97]

The tom brackets or tom holders hold the tom-toms in place. They consist of screws and a hold, both made of steel and zinc. They should maintain any position with excellent stability and positioning accuracy, moreover, it should be easily adjusted and endure great tension.

5.3.4 Hi-Hat and Cymbals [98]

A basic drum set normally consists of at least one suspended cymbal and a pair of hi-hat cymbals. There exist many different types of cymbals for example hi-hat, crash, ride, splash and china.

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[96] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998.

[97] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 24, p 579

[98] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 6, p 799

A hi-hat consists of two cymbals that are generally 33-38cm. The weight of a modern hi-hat is often medium to heavy and the lower cymbal is heavier than the upper. These cymbals are much heavier than modern crash cymbals, reflecting a continual trend to lighter and thinner crash cymbals as well as heavier hi-hats.

The crash cymbal is used mainly as an occasional effect since it produces a loud, sharp and comparatively short-duration crash. They are mounted on a stand in a drum set. Their thickness range from paper-thin to very heavy, depending on the music type, but all have a thin edge. They are most typically 41 to 49 cm in diameter and the alloy for each manufacturer's models varies.

A standard part of the drum kit is the ride cymbal which function is to maintain a rhythm. Standard diameters are from 46 to 56 cm. Larger and thinner cymbals tend towards a drier, shorter sound, while larger and thicker cymbals tend to respond better in louder volume situations, and controversially.

A small cymbal used for an accent in a drum kit is the splash cymbal. For their size, generally a range in size from 15 to 30 cm in diameter, they are hit relatively hard to produce a quick attack and decay.

The round cymbal plates are constructed from four main alloys, all consisting copper; bell bronze, malleable bronze, brass or nickel silver. There exist several polishes or finishes in modern cymbals. The traditional finish is bare metal that is allowed to tarnish in time. Other finishes, a result of abrasive polishing, that are bright and brilliant are not as usual as the traditional kind.

5.3.5 Accessories

The cymbals and some drums, for example the snare, in a drum set are fixed on a tripod. The tripods are made of metal and the height is regulated by screws and shafts. To make the tripod stabile it has three “legs” made of the same metal as the rest of the stand.

One or two metal rims that are cast or pressed are fixed by threaded tension rods or lugs to nut boxes that are bolted to the shell hold. The tension rod construction needs to be precision machined, cast and fitted to enable predictable and secure tuning without inhibiting resonance or introducing extra vibration. The different parts will be under a great tension when playing the drum. The mounting systems can vary a lot from simple cast block on the shell to advanced frame clamp on the tuning lugs without any attachment to the shell.[99]

5.4 Woodwind Instruments

All-wooden instruments like the recorder and the pan flute, as well as atypical instruments such as the bagpipes will not be examined as a result of the preset conditions.

Woodwind instruments are more or less constructed of the same parts. Each part will be described commonly for the woodwind family (Figure 19) and differences will be highlighted. The saxophone and the flute, for example, differ since the saxophone is made of brass and the flute of silver or nickel silver. Moreover the flute does not have a reed which is a common denominator for the rest of the woodwind family.

5.4.1 Mouthpiece

The saxophone as well as the clarinet relies on a mouthpiece and a single reed to produce the vibration that generates a tone. [100] The reed is a large single reed that is clamped onto the beak shaped mouthpiece by a metal ligature.[101] These ligatures are wide bands that secure the reed at one or more locations depending on the mouthpiece. It is important that it provide enough freedom for the movements of the reed to vibrate while playing the instrument. To

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[99] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 24, p579

[100] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 486

[101] http://library.thinkquest.org/22673/clarinet.html, 2007-03-13

receive a full rich sound this must be done with as little dampening as possible.[102]

The oboe and the bassoon are double-reed instruments, the oboe reeds bound to a cork-jacketed narrow brass tube that is inserted tightly into the upper end of the instrument, and the bassoon reeds are attached to a metal crook.

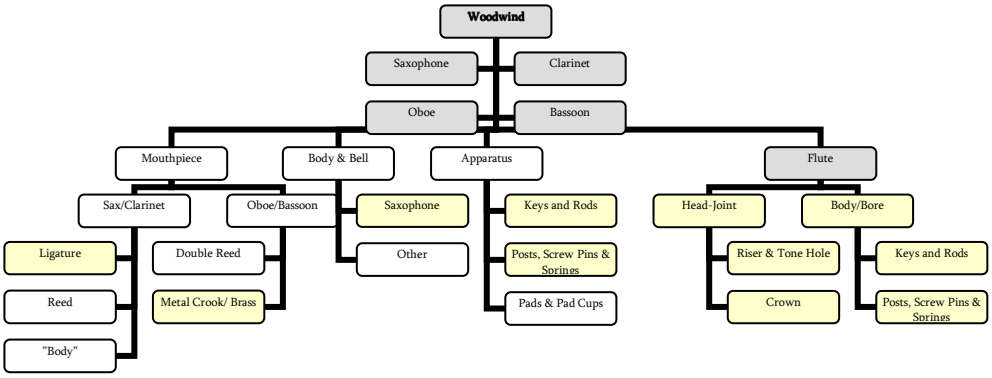

Figure 19 Initial map of potential woodwind instrument parts

5.4.2 Body & Bell

The saxophone is a complex, woodwind instrument made of brass. The two main parts that the saxophone consists of is the neck and the body. The neck is a removable metal tube that attaches the top of the body. The body is a conically shaped tube with soldered posts or attached plates, called ribs, which support the apparatus. The body consists of three parts, the body tube where the fingers operate the keys, the bow and the bell.[103]

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[102] Patent nbr: 5398582, Filing date Apr 1, 1993, Issue date Mar 21, 1995, Inventor, Gary T. Smith

[103] http://www.saxophone.org/buyersguide/2.html, 2007-03-12

Figure 20 Woodwind instruments from left to right: the Saxophone, the clarinet, the oboe and the bassoon, and finally the flute on the bottom.

The oboe and the clarinet are similar in many ways. Both are made from wood, are of the same length and have metal keys. However the bore of an oboe is conical whereas the clarinet has a cylindrical one but with a conical lower part. Both consist of a mouthpiece, reed, ligature, barrel or socket, upper-body section, lower-body section and a bell. The bassoon is distinct from the oboe family because of the bassoon's even narrower cone semi angle and the long folded tube.

The choice of material for a wind instrument is not primarily decided with respect to acoustics, since these instruments have relatively rigid walls and different materials does not have very diverse acoustical properties. The reason as to why different wooden materials are chosen is mainly because they are relatively cheap and easily fabricated into the desired shapes.

Since the vibrating element is the enclosed air, a change of material, wood, or for the saxophone; metal or alloy, does not affect the sound that much. A change in the thickness of the material, however, will have a much greater impact on the sound of the instrument. Moreover, it is properties such as ease of

fabrication, stability, feel and appearance that have the largest impact when deciding what material to use in a wind instrument.[104]

5.4.3 Apparatus

The apparatus consist of the pad cups which hold leather pads, the rods that connect the pads to the brass keys, and the posts that hold the rods and keys in place. The screw pins that connect the rods to the posts, and the springs that cause keys to return to their place after being released, are generally made of steel, or aluminium on less expensive instruments. All these parts are attached to the body tube.

The rods support and facilitate the movements that appear when playing. It is very important that they are strong so the instrument will stand up to extended playing. The rods should not be overly pliable. Another important element on the saxophone is the leather pads that must cover the holes on the saxophone, or it will not sound properly. There is a disc over the pads made of plastic, metal or brass, called resonator, which helps to reflect the sound back into the horn to aid sound projection and increase overall volume.[105]

The other instruments have a similar apparatus, however, they have most of their holes open surrounded by rings and only a few of their holes are covered with padded keys. [106] The bassoon has six holes that are bored through a thickened wall and contribute to its typical tone quality.[107]

5.4.4 The Flute

The flute is a member of the woodwind instruments but instead of using a reed it produces sound from a flow of air against an edge. A flute consists of a head-joint and a bore. A riser, a metal section, raises the lip plate from the head-joint tube. This is where the player blows air and thereby generates sound. A cap, called the crown is located at the end of the head-joint. This helps keep the

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[104] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p717

[105] http://www.saxophone.org/buyersguide/2.html, 2007-03-12

[106] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998.p491

[107] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998.p494

head-joint positioned at the body. The middle section is the main body of the flute which comprises the majority of the keys.[108] The modern metal flute has a tapered head-joint, a cylindrical bore and large tone holes (normally 16) closed by padded keys.[109]

In flutes, silver has long been the preferred material. Pure silver is far too soft so the normal alloy is either traditional "900 Fine" US coin silver (900/1000 parts of silver with the remainder mainly copper) or Sterling Silver, which is 925 fine. This silver is excellent to work; seamless tubing can be readily produced, and the tapered head-joint can easily be shaped. Keys can also be cast or forged at a reasonable temperature and are appropriately strong. Only the posts of the key work need to be made of steel, and 11 carat gold is used for the springs of the best models. Student flutes are mostly made out of nickel silver plated with silver or sometimes with chromium.[110]

5.5 Brass Wind Instruments

After reviewing the initial limitation a decision was made not to examine more extraordinary brass instruments such as the cornet, the euphonium and the flugelhorn. This decision makes it easier to focus on the usual brass instruments seen in Figure 21. Moreover among the studied instruments a discarded instrument can find one it can be compared with.

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[108] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 9, p 31-32

[109] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p729

[110] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 729

Figure 21 The Studied Brass Instruments: Trumpet, Horn, Trombone and Tuba

Brass instruments are constructed of more or less the same parts (Figure 22), although the shapes and sizes of the parts differ immensely. Many different materials have been tested and used for brass instruments, however, so far, the manufacturers and musicians always have returned to the original material – brass. The bell pipe is the tube segment that terminates in the bell. This may include the bow next to the bell. The lead pipe is the first section of tubing of a brass instrument extending from the mouthpiece receiver to the next joint. It usually tapers, unless it is equipped with a tuning slide. Each big part, and its relative construction, is described more in detail below.

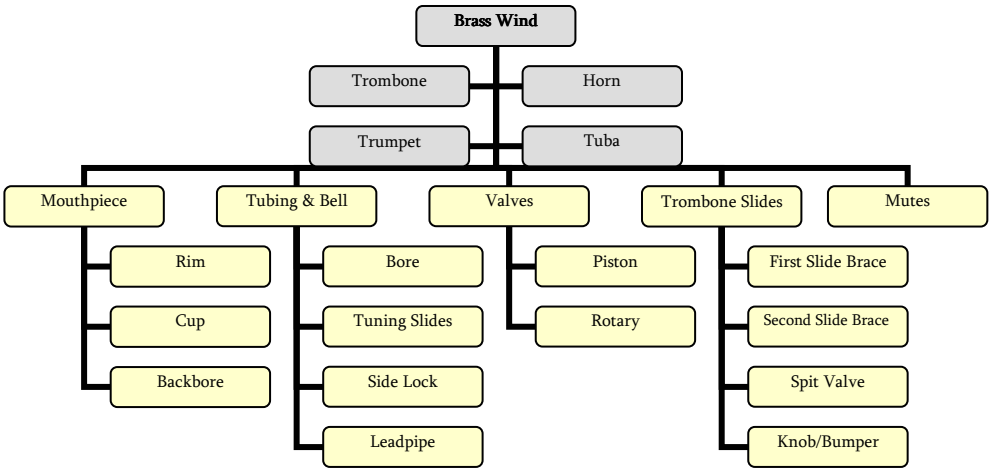

Figure 22 Initial map of potential brass instrument parts

5.5.1 Mouthpiece

The trumpet mouthpiece has a circular rim with a cup behind, which leads the air into a much smaller opening which tapers out slightly to match the diameter of the trumpet's lead pipe. The sound, how easy the trumpet is to play and the comfort, are affected by the size of the different parts of the mouthpiece.

The trombone mouthpiece, which is closely related to the trumpet's, is inserted in the slide section. It is a separate part of the trombone and comes in many different dimensions and each variation affects the tone quality. The horn has a much smaller mouthpiece which facilitates the fact that it is set one octave higher than the other instruments. The tuba on the other hand has a larger trumpet mouthpiece.

The mouthpiece can be made from any material that is machineable to dimensions of very close tolerances. A musician feels changes in the acoustics of his instrument as a result of mouthpiece variances of 0.025 mm which makes precision highly important. Most manufacturers choose brass or plastics, whereof brass mouthpieces generally are plated with silver or gold.[111]

[111] Lawson Brass Instruments, Inc., http://lawsonhorns.com/mouthpieces.htm 2007-06-14

5.5.2 Tubing and Bell

The horn and the tubas is a conical bore instrument that consists of a tube that is wrapped into a coiled form and finger-operated valves that help control the pitch. A conical bore instrument has a tapered bore with a gradually increasing diameter along its length. Tubas with the same pitch can vary a lot in size. They can have the same pipe length, but the thickness of the pipes and the bell can differ considerably.

The trombone and the trumpet, which are cylindrical bore instruments, consists of a cylindrical tube bent into a complex shape with the smallest piece being the mouthpiece receiver and the largest the throat of the bell. The design of these tapers has to be carefully made so they give a correct intonation of the instrument. Tenor trombones typically have a bore of 1.14 cm to 1.39 cm in diameter after the leadpipe and through the slide. The bore expands through the backbore to the bell which typically have a diameter between 17.8 cm and 20.3 cm. The bells come in many different brass mixtures, which affect the tone quality, and sizes. There exist interchangeable bells so the player can select bells after different artistic requirements.

As with woodwind instruments the choice of material is not principally decided with respect to acoustics. The mechanical properties of the material used for most lip-blown instruments must be suitable for drawing into seamless tubes, bending to different shapes and so forth. The finished instrument also has to handle minor bumps without getting buckles. Since silver and gold, used in flutes, are too expensive for larger instruments, these materials are ruled out. Otherwise excellent materials such as stainless steel have been too difficult to fabricate into the complex shapes required for brass instruments.[112] Brass and bronze are two materials that are suitable for this purpose, and since brass is more easily worked it is generally used. When used, the brass is polished and lacquered to prevent corrosion.

[112] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p 731

5.5.3 Valves [113]

Cylindrical piston valves are used to change the pitch in many brass instruments. When a piston valve is opened, each valve changes the pitch by diverting the air stream through additional tubing, thus lengthening the instrument and lowering the harmonic series on which the instrument is vibrating (Figure 23).

In the rotary valve a rotation of a passage in a transverse plug regulates the flow of the air, lengthening the instrument and thereby changing the pitch. Rotary valves where long preferred by most brass players on account of having faster action, but since the arrival of improved design for the piston valve they are less common. Another reason might be that rotary valves generates a music sound that is a little more uneven and staccato, whereas piston valves generates a more smooth and natural sound.

Figure 23 Piston Valve and Rotary Valve

A trumpet makes use of three piston valves; most modern horns however, use rotary valves. Each length of tubing is a separate part, called tuning slides, and is moved to regulate the horn's tuning. A tuba normally has three to six valves, both piston and rotary valve models exist. Which to choose depends on the quality of the musician playing the tuba.

5.5.4 Trombone Slides

The slide section consists of a leadpipe, inner and outer slide tubes (Figure 24) and bracing, and inner and outer slide stays that are tin soldered. The venture, found in the leadpipe, is a small condition of the air column that adds some resistance and dictates the tone of the instrument. The feature of the trombone is the telescopic slide that allows the player to regulate the length of the air column. An extended length is lowering the pitch.

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[113] Alexandre Grand-Clément, *Brasspecialisten AB*, 2007-06-14

Except for many different slide types a wide variety of valve attachments and combinations are available. Additional tubing connects the slide to the bell of the instrument through a neckpipe. A ferrule is attached on the joint connecting the slide and bell sections, to secure the connection of these two parts. A small tuning slide is usually included in the valve attachments tubing so this can be separately tuned.

The inner slide is in most cases made from chromium-plated nickel silver while the outer slide can be made either from nickel silver or brass.[114]

Figure 24 Trombone Slides

5.5.5 Mutes

A mute is a device that alters the timbre of a musical instrument. It can also be used to reduce the volume. These are either squeezed into the bell, or hung or clipped to the outside of the bell. These mutes are typically made out of aluminium, brass or copper metal. However, they can be found in more economical materials, such as plaster, cardboard and plastic. Each of which presents a different sound.[115] There are an endless row of different mutes, but the most common one is the straight mute since it is available for all brass instruments (Figure 25). This is a hollow, cone-shaped mute that fits into the bell of the instrument and has small pieces of cork that squeeze against the inside of the bell and hold the mute in place. The straight mute gives a metallic and nasal sound when played.

Figure 25 Straight Mute

[114] Lars Gerdt, *Lars Gerdt AB*, Trombone Manufacturer 2007-06-14
[115] Alexandre Grand-Clément, *Brasspecialisterna AB*, 2007-06-14

5.6 Stringed Instruments

When faced with the established limitations, rare stringed instruments such as the lyre and the lute were decided not appropriate for an examination. Furthermore, the viola was set aside since it is very similar to the violin when it comes to material and construction, only bigger in size and more variable in its proportions (Figure 26).

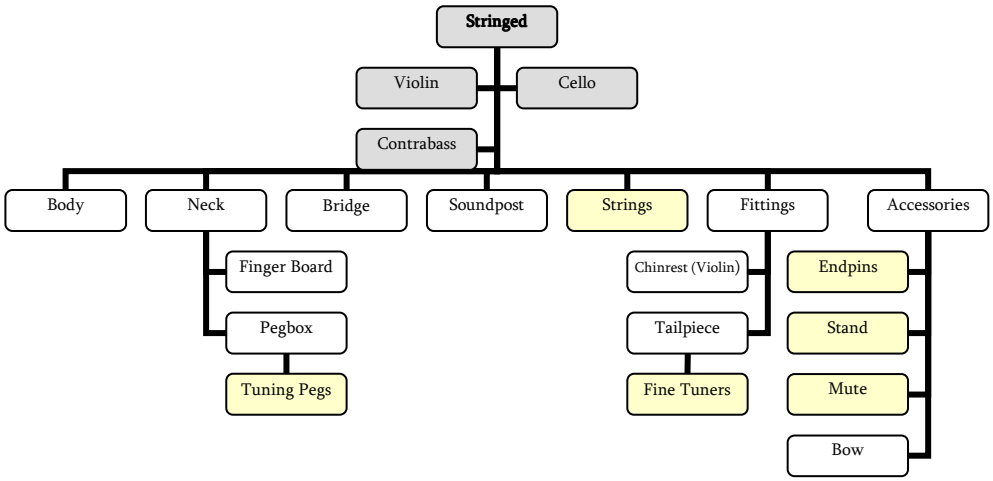

Figure 26 Initial map of potential violin parts

Following, the three examined stringed instruments; the violin, the cello and the contrabass, will be described element for element in more detail. Even though there are many differences between these instruments, there is a possibility that study them as a unit from a materialistic point of view. Since the biggest difference from this view is their sizes.

Figure 27 the Violin, Viola, Cello and Contrabass

5.6.1 Body, Neck, Bridge and Soundpost

A violin consists of a body, a neck, a bridge, a soundpost, strings and various

fittings (Figure 28). The task of the soundpost is to reinforce the tone that is generated when the bow is drawn against one or several strings.[116]

The violin is tuned with the help of four pegs placed at the pegbox at the end of the neck. Small adjustments are preferably tuned by adjusting the fine tuner screws at the tailpiece. The fingerboard is exposed to a lot of wear when playing and has to be manufactured in a durable wooden material. [117] The bridge separates the strings from the body. It is a precisely cut piece of maple.[118] It is important that its height is correct so the violin is not hard to play. At the violin's lower part is the attach point for the strings, called tailpiece. [119]

The stringed instruments are constructed of more or less the same parts, with different shapes and sizes. The bodies are made of several different wood types. Maple is most generally used for the back, the neck, the pegbox and scroll and the rib. The top is usually made of spruce since it is

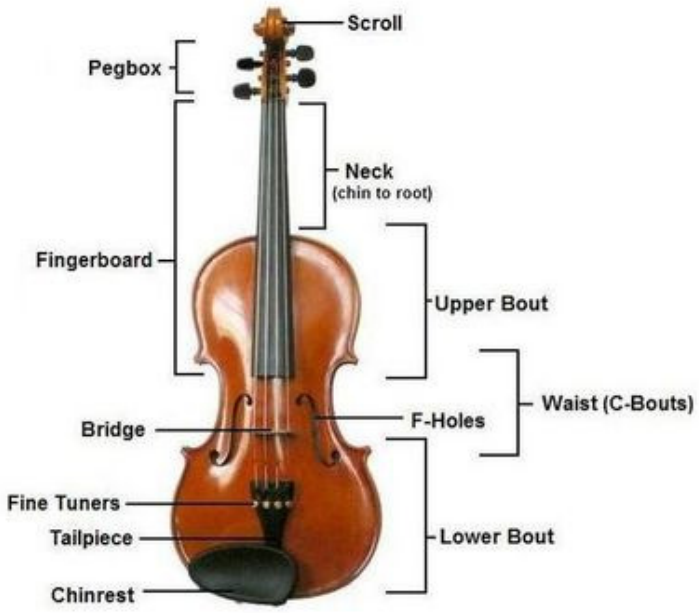

Figure 28 The construction of a violin

[116] http://hem.passagen.se/rydmark/slojd/fiol/fiol.html, 2007-03-22
[117] http://www.violinateljen.com/fakta/skotselrad.html, 2007-03-23
[118] Dilworth, J. *The Violin and Bow—Origins and Development*, Cambridge University Press, 1992.
[119] http://hem.passagen.se/rydmark/slojd/fiol/fiol.html, 2007-03-22

softer in the bottom than the maple which gives a better sound. Ebony is commonly used for the tailpiece and the fingerboard since these parts wear a lot when playing. The bridge is a precisely cut piece of maple.[120]

Another member of the family is the cello. The cello is much larger than both the violin and the viola. The cellist is seated when playing, holding the cello between the knees and supporting it with a sharp stick, the endpin, against the floor. The contrabass is an instrument that is very large and difficult to move. It has a more pear-shaped body and the player hold it in a standing position.[121]

5.6.2 Strings

The violin has four strings, Strings have a limited lifetime depending on how much and how intensely the musician plays. Every kind of strings has its own unique character that can change the sound of the instrument. [122]

For a long time, sheep and bull gut was used as strings for violin family instruments. These do not have a desirable sustainability for change in weather and humidity. They go out of tune often and have a tendency to break. Nonetheless, even after alternative string materials, such as metal and synthetic, were introduced, gut strings remain in production since their warmer tone still is desired by some players. Modern gut strings are usually wrapped in metal. Most violin E strings are unwound but some are gold plated in order to improve tone quality.[123]

However, metal strings offer a unique problem as they are susceptible to oxidation and corrosion. Wound strings that use metals such as brass or bronze in their winding will eventually corrode as moisture and salts from the player's fingers build up oxides on the string. As a result, the string will lose its brilliance over time. To help solve this problem, string manufacturers apply metal plating or polymer coating to protect the string from corrosion.

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[120] Dilworth, J. *The Violin and Bow—Origins and Development*, Cambridge University Press, 1992.
[121] http://hem.passagen.se/rydmark/slojd/fiol/fiol.html, 2007-03-22
[122] Dilworth, J. *The Violin and Bow—Origins and Development*, Cambridge University Press, 1992.
[123] http://www.violinateljen.com/fakta/guide.html, 2007-03-23

Nowadays the most popular material for the core of violin, viola, cello and bass strings is stranded nylon, also called "Perlon". First introduced in the 1970s and 80s, synthetic strings are now widely manufactured. These synthetic-core strings are preferred by classical string players because of their richer overtones and warmer tone. Conversely, most jazz and folk string players favour the steel-core strings for their faster response, low cost and tuning stability. Aluminium is the most commonly used winding material for bowed instruments. [124]

5.6.3 Fittings

A general fine tuner consists of a metal screw that moves a lever to which the string is attached. They are usually used if the strings are made of solid metal or composite strings that might be hard to tune with the pegs solely and not for gut strings that are more elastic.[125] A screw that has been untouched for a longer time can come loose by itself, which is normally caused by changed air-moisture.

5.6.4 Accessories

There are several accessories belonging to stringed instruments. Most of the usual stringed instruments are played with a *bow* but can also be plucked. The bow is constructed of a wooden stick with stretched horsehair, which generates sound when drawn against the strings. Additionally, a good *chinrest* is important since the violin is placed between the neck and the collar bone. It is a shaped piece of wood, or plastic, attached to the body with a metal bracket. Moreover, the *mute* is nowadays widely used to dampening the vibrations of the strings and thus reducing the sound. These can be made in wood, rubber, metal etc.

Another accessory important for the cello and the contrabass is the *endpin* (Figure 29). This is the device that helps the musician hold the instrument steady on the ground. It is most often made in metal, or in some cases wood or carbon fibre, but pieces in titanium can

Figure 29 The Endpin

[124] Dilworth, J. *The Violin and Bow—Origins and Development*, Cambridge University Press, 1992.
[125] Dilworth, J. *The Violin and Bow—Origins and Development*, Cambridge University Press, 1992.

also be found. It is extensible from the bottom of the instrument, and secured with a thumbscrew.

5.7 Free Reed Instruments – The Harmonica

In this section focus will be put on the harmonica. The reed organ was considered too "small", from a market point of view, to pass the set limitations and the interesting part in the accordion, the reed plate, will be described under the harmonica. A harmonica consists of reeds that are designed collectively as "free reeds". These reeds are also found in the accordion, the reed organ and any other free reed instrument.

Each part shown in Figure 31 is put in the free reed organisation chart below (Figure 30) and following, a presentation including a more detailed description of the parts, will be found.

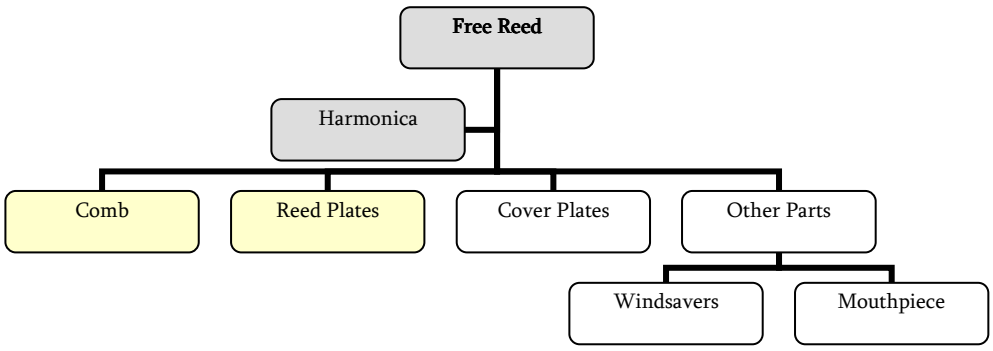

Figure 30 Initial map of potential parts for free reed instruments

5.7.1 Comb

The comb is the main body of the harmonica and this part contains the air chambers that cover the reeds. The comb is nowadays made from plastic (ABS) or metal and not from traditional wood materials. This development took place since there was a need for a more durable material.[126]

[126] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 10, p 851-854

5.7.2 Reed Plates and Cover Plates

Reed plate is the term for a group of several free reeds in a single house. Individual reeds are usually riveted to the reed plate but can also be welded or screwed in place. Most harmonicas are constructed with the reed plates screwed or bolted to the comb or each other. A few brands still use the traditional method of nailing the reed-plates to the comb. The cover plates cover the reed-plates. The choice of cover plates is extremely personal. Because they project sound, they determine the tonal quality of the harmonica. The reed plates can be individually replaced when the plates are bolted to the comb. This is useful because the reeds eventually go out of tune through normal use, and certain notes of the scale can fail more quickly than others.[127]

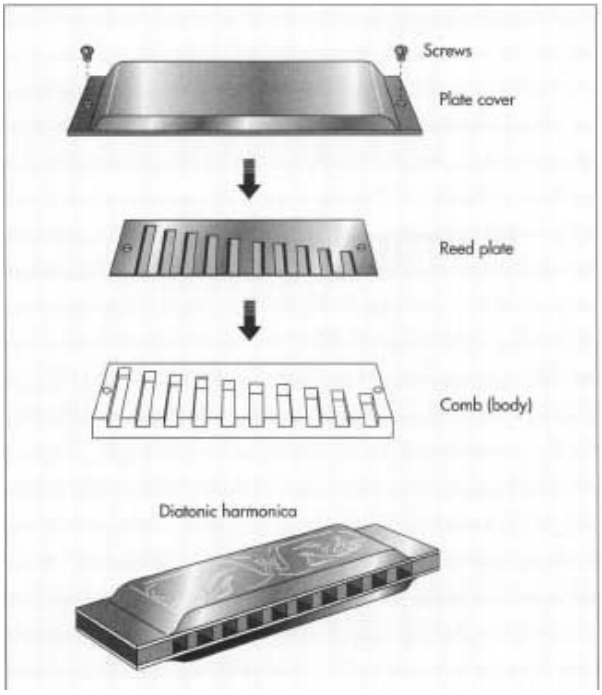

Figure 31 Harmonica parts starting at the top: screws, plate cover, reed plate, comb, and harmonica.

The reeds in the harmonica are grouped in pairs, where one reed is nominally operated by blowing pressure and the other one by suction. These two reeds are closely attached by the small air volume in the reed channel and therefore have a more complex operation than a single reed.[128] The most popular harmonica has 10 holes and 20 reeds, 10 for blow notes and 10 for draw notes.

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[127] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 10, p 851-854

[128] N. H. Fletcher, T.D. Rossing. *The Physics of Musical Instruments, 2nd ed.* Springer, NY, USA, 1998. p

Figure 32 shows that the reeds have different sizes, placed on the reed plate in ascending order. It is the length and thickness of the reed that determines the note. The reed is riveted in one end and the other loose end is stretched some tenth millimetres above the hole (Figure 32). The reed's loose end vibrates up and down. A small rust formation in the hole or on the plate stops the tone formation, which makes the material choice an important factor.[129]

The reeds are usually made of brass, but can sometimes be made of steel, aluminium or plastic. The reeds are cut from precision-tapered strips of brass alloy material. Both the cover- and the reed plates are generally machined from brass.[130]

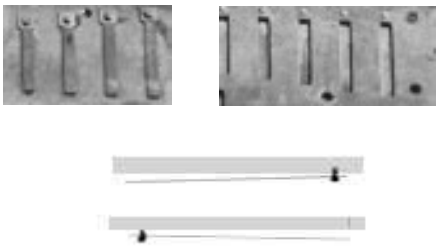

Figure 32 Reeds and Reed Plates

5.7.3 Other Parts [131]

Windsavers are typically found in chromatic harmonicas, chord harmonicas and many octave-tuned harmonicas. Windsavers are used when two reeds share a cell and leakage through the non-playing reed would be significant. For example, when a draw note is played, the valve on the blow reed-slot is sucked shut, preventing air from leaking through the inactive blow reed. The windsavers are one-way valves made from very thin strips of plastic, knit paper, leather or Teflon glued onto the reed plate.

The *mouthpiece* is placed between the air chambers of the instrument and the player's mouth. This can be integral with the comb, part of the cover, or may be an entirely separate unit, secured by screws. In many harmonicas, the mouthpiece is purely an ergonomic aid designed to make playing more comfortable. However, in the traditional slider-based chromatic harmonica it is essential to the functioning of the instrument because it provides a groove for the slide.

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[129] http://hem.fyristorg.com/bluesmunspel/uppbyggn.htm, 2007-05-28
[130] http://www.madehow.com/Volume-3/Harmonica.html, 2007-05-28
[131] S. Sadie. *Dictionary of Music and Musicians, 2nd ed.* Macmillan Publishers, London, UK, 2001,v 10, p 851-854

5.8 The Market of Musical Instruments

The information concerning the market of musical instruments is obtained from the NAMM Global Report 2005. NAMM is an international Music Product Association. The name NAMM comes from the acronym "National Association of Music Merchants" but that term is no longer used. Instead the association says that NAMM stands for "the interest of the global music products industry".[132]

In 2004 the sales of music products hit a record of $7.354 billion in the US market, which was a growth of 5.4 percent compared to the previous year. The product categories that stood for most of the sales were fretted instruments (for example the guitar family), drum kits, portable keyboards and digital pianos (Figure 33).

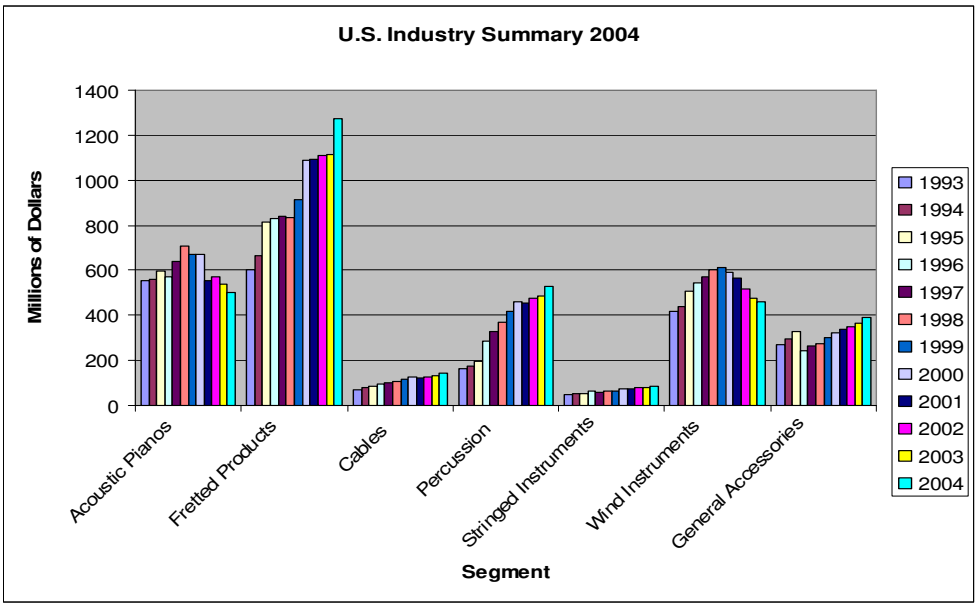


Figure 33 a Summary of the U.S. Musical Instrument Industry in 2004

The Chinese manufacturing of instruments has led to a lot of import which presses the prices and profits. To maintain the same revenues as before the manufacturers, distributors and retailers has to make a 15 percent higher unit volume.

[132] http://www.namm.org/frequently-asked-questions#1, 2007-06-04

Since the musical industry is a very wide business containing both instruments with new technology and instruments such as the violins, based on an ancient design, it is hard to make generalisations. Some trends such as the improvement of economy, higher employment level and rising consumer confidence have led to a better sales climate. Another important trend is the shift in customer demographics. There are currently five major groups;

1. Kids between 12 an 20 years
2. Parents of kids between 12 and 20 years
3. Professional musicians
4. Institutions such as churches, schools and nightclubs
5. Adult amateur players

Other interesting facts found in the NAMM global report was that the Unites States market accounts for 42.6 percent of the market sales share, followed by Japan at 15.9 percent and Germany at 6.0 percent (Figure 34).

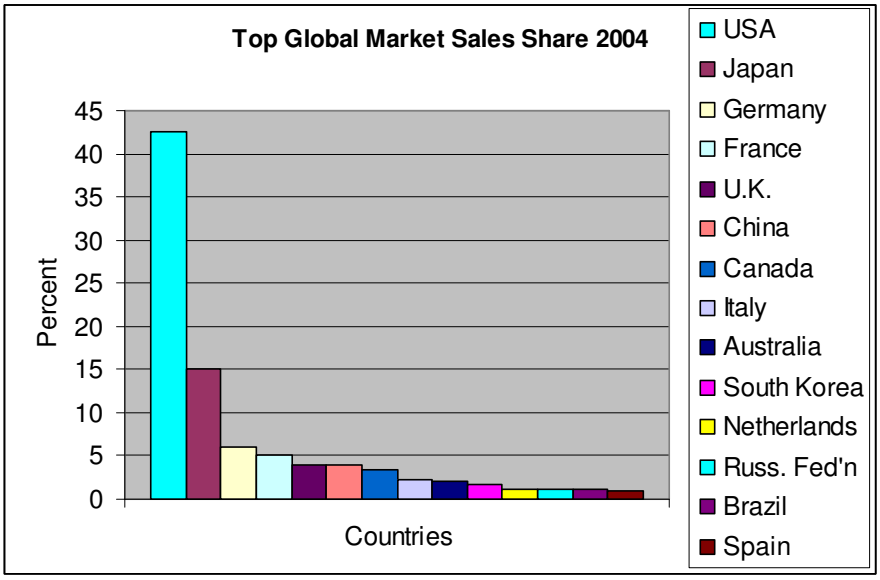


Figure 34 Overview of different countries markets sales shares

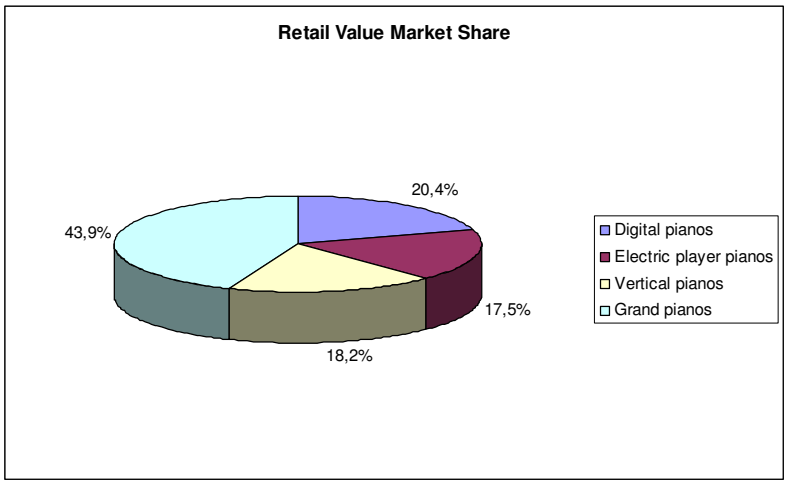
5.8.1 Attitudes towards music

More than one half of the households in the United States have at least one person, age 5 or older, who currently plays a musical instrument, which is the highest figure since the study of attitudes began in 1978. In 2003, 48 percent of the households had two or more persons that played a musical instrument,

compared to 40 percent in 2000. These trends indicate that the musical instrument industry in the United States is growing. Other information received from the study was that people in general think that music plays a very important part of their lives and 67 percent of the ones not playing an instrument wanted to learn to do it. Most of the surveyed people preferred buying a new instrument as opposed to a used.

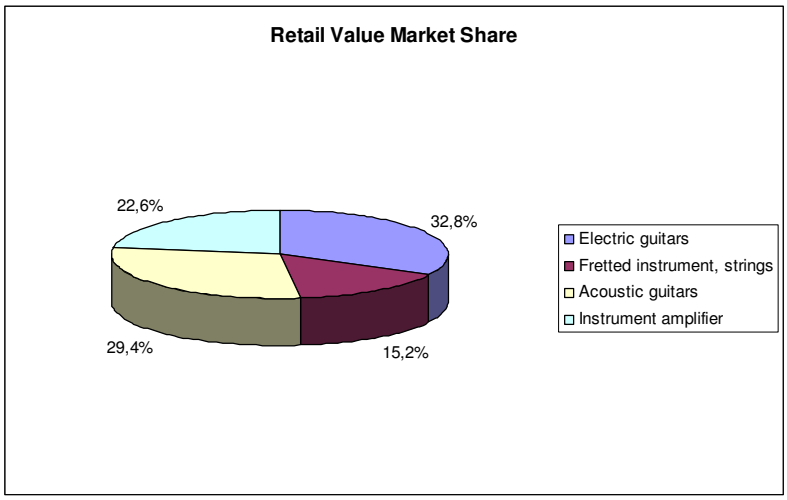
5.8.2 Fretted Instruments

The sales of acoustic and electric guitars have increased tremendously as a result of the lower average selling prices combined with a better economy. In 2004 1.618.700 units of acoustic guitars and 1.683.970 electric guitars were sold. This was an increase of 38.6 percent respectively 43.5 percent from the sales volume the preceding year. The lower prices have made the guitar an impulse item. An average price for acoustic guitars lands at $299 and $320 for electric ones. The guitars have also gained traction in the schools, which holds a promise of an even bigger market expansion. Since there is a big increase of entry-level products there will probably be players that will change to higher-priced and better quality guitars in time. It is enough if only a small percentage, around 5 percent, will trade up, to assure that the guitar makers will have a stable future.



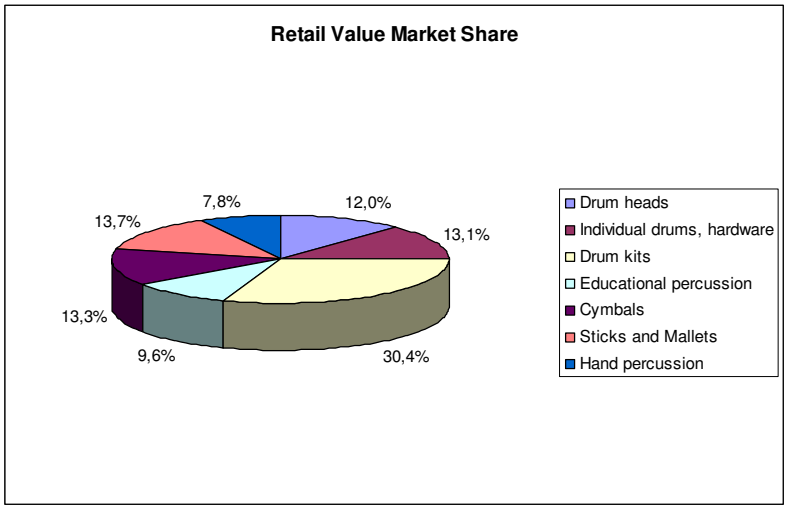
5.8.3 Pianos

The decade-long trend that the sale of grand pianos and digital pianos increases and the sale of vertical pianos declines continued during 2004. The price of a grand piano has dropped by 5 percent which might be one of the reasons for the stable growth. The sales of vertical piano are affected by the digital pianos, a cost-effective alternative. Each year, the number of grand pianos equipped with digital player systems increases.



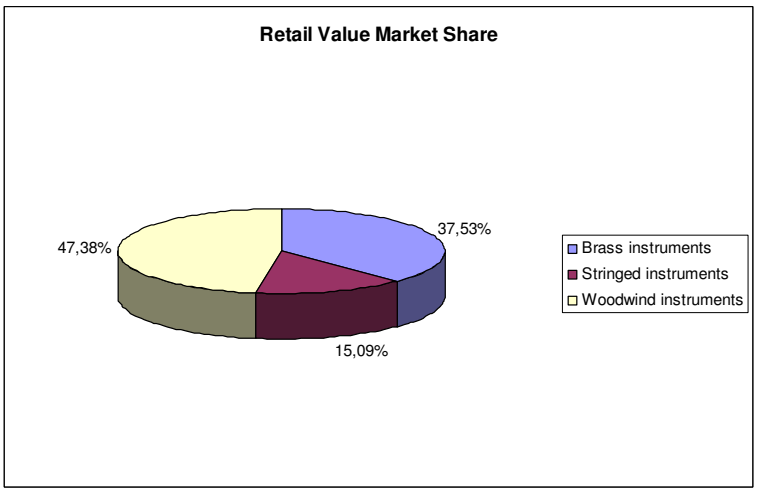
5.8.4 Percussion Products

This segment is the "brightest" in the musical industry, both considering units sold and dollar volumes. The factor spurring these gains is higher product value. 268.200 units of drum kits were sold during 2004 which was an increase of 24 percent. The dollar value increased with 11.4 percent and gave a total value of $160.6 million. Drum kits are nowadays accessible to a bigger part of the population and beginners since an average selling price is below $600. More kits sold also led to more hardware, cymbal, drumhead and stick sales.



5.8.5 Wind and Stringed Instruments

During 2004 the sales of wood-winds, brass-winds and stringed instruments increased with 7.5 percent to over 1 million units sold.



5.8.6 The U.S. Imports and Exports of Music and Sound Products

Since the available information about sales numbers and quantities of the different musical instruments and their parts are limited, it is complemented with statistics about the U.S. imports and exports. This might clarify some important trends and add information about smaller musical instrument areas. In 2004 the United States imported musical products from a total of 106 countries. The countries that stood for the largest part of the U.S. import were China with 47 percent and Japan with 10 percent of the total import value. The United States import of musical instruments and parts interesting for this investigation are shown below (Figure 35).

Description	Quantity	Value ($)
Fretted Instruments	2.639.960	198.059.769
Guitars under $100	2.292.043	82.391.206
Grand Pianos	41. 444	189.246.161
Tuning Pins for Stringed Instruments	2. 652	1.216.592
Drums	1.950.590	93.110.748
Cymbals	620. 440	16.163.786
Mutes, Pedals, Dampers, Spurs for Drum Pedals	-	36.497.383
Saxophones	95. 614	39.496.672
Clarinets	100. 794	18.798.378
Flutes and Piccolos	382. 429	13.062.297
Parts and Accessories for Woodwind Instruments	-	29.068.685
Brass Instruments (Valued under $10 each)	35. 044	77. 231
Brass Instruments (Valued over $10 each)	148. 287	43.627.452
Parts and Accessories for other Wind Instruments	-	7.001.489
String Instruments (played with a bow)	341. 016	30.070.162
Mutes, Stands & Holders for Stringed Instruments	-	2.226.149
Parts for Instruments played with a bow	-	11.612.418
Mouth Organs (Harmonicas)	376. 957	8.478.933

Figure 35 U.S. Imports of Musical Instruments

In 2004 the United States exported musical instruments to 175 countries and their biggest destinations were Canada with 19 percent, Japan with 16 percent, and Mexico with 11 percent of the export value. The United States exports of the musical instruments and parts interesting for this investigation are shown below (Figure 36).

Description	Quantity	Value ($)
Fretted Instruments	117.752	53.474.676
Guitars	152.346	72.937.449
Parts and Accessories for Fretted Instruments	-	29.660.996
Upright Pianos	1.595	2.830.215
Grand Pianos	980	5.132.465
Parts and Accessories for Pianos	-	3.862.002
Percussion Musical Instruments	1.406.449	37.366.262
Woodwind Instruments	61.905	10.474.182
Wind Instruments	174.582	5.532.183
Brass Instruments	48.936	16.589.634
Mouth Organs (Harmonicas)	47.016	294.042

Figure 36 U.S. Exports of Musical Instruments

6. Empirical studies

In this chapter the selection process will be presented and described in two parts. The first one will be followed by data gathered about the SMT strategy and their product development process, core competencies and various materials. Subsequently, a presentation of the gathered results from the questionnaires will take place followed by the second part of the selection process. Concluding this chapter, a detailed description of the chosen parts as well as their respective manufacturers will be found.

6.1 The Initial Selection Process

Throughout the project the authors have to consider a selection process. From the mapping of the musical instruments a large amount of parts have been identified. However, this amount needs to be reduced prior to gathering information from manufacturers, musicians and other specialists within the musical instrument industry. To reduce this amount, a decision had to be made of which ones to bring to the next step. When facing this task of assessing which parts that are of higher interest, a series of field studies were made. The first parts to be removed are all kinds of strings: for piano, guitar and stringed instruments, since studies about these parts already have been initiated.

6.1.1 Field Studies

Visits to musical instrument retailers and repairers/restorers of the various instruments offered diverse insights. Discussions about current problem areas of the different instruments and discussions about change of material and its impact on the acoustics gave essential information for the authors to rely on when taking this decision.

Firstly a rough thinning was performed to eliminate parts in materials, such as wood, leather, plastic and nylon. An assumption was made that it is more likely that a Sandvik material can offer better and higher quality solutions for a part that is currently made in a metal alloy. Another factor that served as an incitement for this choice is that in a traditional industry such as the musical instrument industry, it might be a smaller step to change a metal into another metal than change material completely. This was a choice taken by the authors in mutual understanding with their contact person at SMT, Sina Vosough.

Parts such as fretted and stringed instrument bodies and necks; the guitar fretboard; the piano frame, soundboard, action and case; drum heads and woodwind bodies, were thereby eliminated.

6.1.2 Interviews with Sandvik

Facing the next elimination, information was gathered about the current materials used for musical instruments, such as brass, silver, gold and nickel silver, and Sandvik materials such as stainless steel and titanium. This data was gathered through meetings with the different production departments of SMT, literature and Internet sites. A comparison was made to identify the advantages and disadvantages that the Sandvik materials have over the current materials. This information in combination with the input from our field studies gave us a good foundation for taking the next step of the selection process.

Restorers of the different instruments have wide and deep knowledge of both the manufacture process of different instruments and of the different problem areas, since they are the ones who receive the purchased instruments when a problem occurs. Through various dialogues with them this additional selection could be carried out in a trustworthy manner. Parts such us stands, pedals, the guitar nut, guitar tuning keys, drum bodies, capodastras, plectrums and snares could on account of the latest described discoveries be abolished from the list of possibly interesting parts.

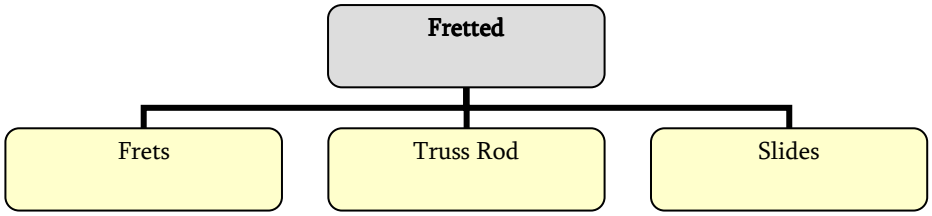
Remaining parts of wind instruments, such as all brass and saxophone bodies: bells, tubing and pistons were removed because of their complex shapes and the high demands on the manufacture material for example ability of tin soldering. This is necessary since it should be easy to exchange parts when damaged and when parts are obsolete. Moreover, since these parts are considerable in size, turning to the high quality stainless steels that Sandvik could offer would significantly increase the price of the instrument. The mouthpieces of brass instruments have been tested and made in many different materials already, and even though they may be fashion crazes for a while, both musicians and manufacturers always return to brass, which helped with the decision to eliminate these as well.

Even though a first assumption was that drum cymbals would remain in the list of possible candidates until the next step, there was a change of heart. In our field studies we got the information that there already exist manufacturers

who have made cymbals in a material with a shiny metallic colour and even though the cymbals are better and have higher quality they are really hard to sell as drummers buy with their eyes and are all looking for the traditional ones in yellow brass.

6.1.3 Possible Candidates

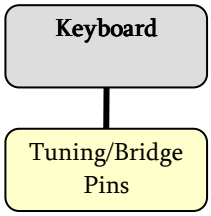
The remaining parts are the ones that will be taken to the next level where we will ask leading manufacturers and musicians all over the world for their opinions about these parts, areas of improvement and material choice. Following, a short description of each selected part and why they are merited to continue to the next step is made.



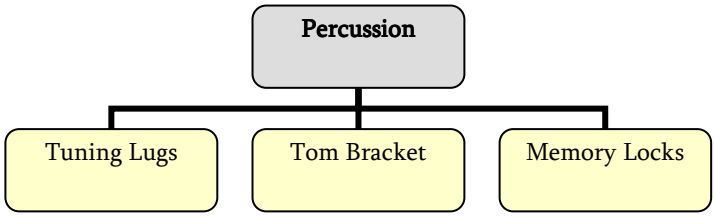
Frets have already been manufactured in stainless steel due to the constant wear a guitar player lays on them. However, according to several guitar retailers and musicians there are still improvements to be done. Moreover, discussion with production teams at Sandvik Materials Technology also resulted in an understanding that the exclusive Sandvik materials could enhance the qualities of current frets in stainless steel.

The **truss rod** is a metal strip located inside the neck of the guitar. The main requirement on the material of this component is that it must be durable and very strong, since this is the part that you stretch when the wooden neck due to change in humidity expands in one direction. The tension can thereby be significant. Even though there has not been any concrete facts saying that the truss rod is subjected to corrosion, Sina Vosough and his colleagues at SMT R&D found this part interesting which finally merited it to continue to the next step.

Slides are currently made in many different materials. There are no restrictions as to how the material must be to support the acoustic requirements. It is here the inner and outer diameter that plays a role in determining the tonal qualities. The reason to bring these to the next level is partly because it is believed that there is definite wear on such parts, since they are run up and down the strings. The other factor is that through the field studies the impression was gotten that this is an accessory that most guitar players find fun to use at some time, in addition to this it is something that is not very sensitive to change, contradictory it is rather more interesting if it is a novelty.

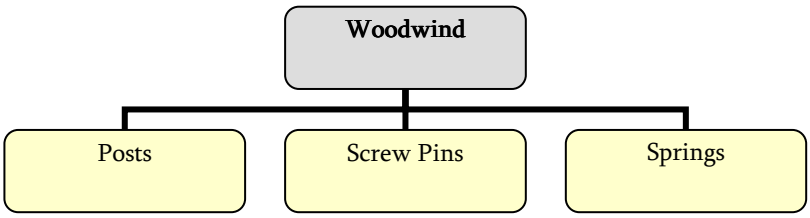


The pins inside the action of the piano: **bridge and tuning pins**, were merited for the next step on account of their need to be durable and strong, since the strings put a tremendous amount of tension on them. Additionally, evidence from the field studies suggests that these parts possibly are suitable for this study and as well for Sandvik in the long run.

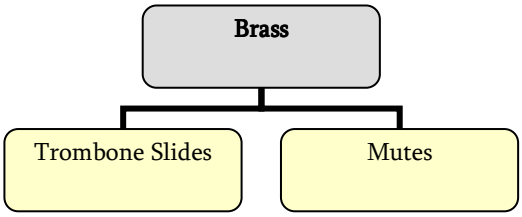


When it comes to drums a discussion was held with "Doctor Drum"[133], who has played the drums professionally for many years, and has, besides a genuine interest a great knowledge about drums, the different materials used and how their features change with change of material. With the exclusive help of Dr Drum, three problem areas were identified. The **memory locks** that normally are made of zinc, often cracks which would make it a perfect candidate to bring to the next level. The same problem can be found with **tom brackets** and **tuning lugs**.

[133] Jörgen Olsson, Drum Specialist, Malmö Musikaffär

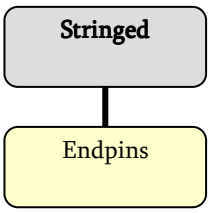


Woodwind instruments are more or less eliminated from the list because of their usage of wood and their complex shapes. Nonetheless, the general opinion generated in the field study was that parts that with probability would gain improvements in a change of material are **posts, screw pins and springs** used to keep the keywork in place. These parts are currently subjected to corrosion and will gradually rust and consequently will need to be replaced, which merited them to continue to the next level.

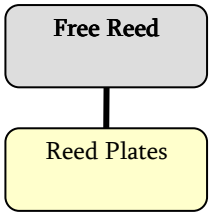


When initially visiting restorers and manufacturers of brass instruments, the **trombone slides** were the first parts that seemed to be problematic. The inner slide is often made in nickel silver and the outer one in brass. When a trombone player plays his instrument corrosion usually occurs on the surface of the inner slide. Moreover there are problems in the manufacture process, when drawing the slides, with the chromium plating. This part of the process is currently posing risks and weaknesses on the instrument. There was also a strong interest in this research and hopes that a chosen stainless steel could remedy these risks and problems. A contact was also established with a small manufacturer in Stockholm, Lars Gerdt, who is willing to test drawing the material when it is on the cards.

Another accessory that was appointed interesting by restorers and salesmen was **mutes** for wind instruments. Not so much because of materialistic properties but for market interests. This is an accessory that all wind instrument players have at least one of, which results in a big market and hence a possibility to obtain high sales volumes if the market shows interest in this project.



Even though endpins for cellos and contrabasses already can be found in titanium on the market, Sandvik decided to continue with these since there is the possibility to produce these in a Sandvik material that have the same properties as a stainless steel but is much lighter. This material is also much cheaper than titanium, which could be of interest for the market.



Already one year ago, when Sina Vosough met with different manufacturers on an exhibition for musical instruments, a keen interest was shown for the production of reed plates in stainless steel. Since these are continually exposed to humid air and saliva when playing, they are subjected to a big risk of corrosion. The most usual material used for reed plates is presently brass, as for many other parts of musical instruments, since it is relatively cheap and easy to work. However, if a superior material such as stainless steel could be used and thereby decrease the frequency for exchanging reed plates, there is a strong belief that this may result in a future project for SMT.

6.2 Strategy at SMT

Sandvik's main strategy is to be first on the market and to be one step ahead of the competition. Sandvik help their customers to increase their productivity by offering high-end solutions and helping them to adjust to these. Furthermore, they offer products designed after the customers' needs and wishes. Mostly when initiating new projects they turn to areas where they already have established customer relations and a well-known brand. However, they are also doing research within new niche areas and markets to see if they can offer superior solutions to already existing ones.

6.2.1 SMT Business System

Being a part of the Sandvik group involves a responsibility, for example there is a demand on how to reach the common goal both regarding quality and profitability which everyone should follow. Since SMT has more than 8000 employees, spread around the world, they need a common model for a line of

action. They have studied companies in other trade industries that have reached great success and high profitability, and mapped what have made these companies successful. From these experiences, SMT has created a special suited business model, called SMT Business System.

SMT Business System is the common platform for SMT's way of working and doing businesses. The Business System comprises new work procedures within manufacturing, marketing and sales, purchase, product innovation and competence development.

This new work procedure has successively started during 2005 and is still spreading throughout the organisation. The work procedure means that unnecessary steps will be reduced by working smarter. Everyone should work in the same direction. It might not be easy all the time, but it is necessary for SMT to be able to reach a higher profitability and to satisfy the customers. For production, the new work method will gradually free production capacity and shorten lead times. To receive the benefits from the change, SMT have to ensure that they fill up the free capacity with the right products, at the right selling price and with the right profitability. A clear strategy about which products to prioritise, how the price should be set and how to acquire the best profitability by selling value, is therefore needed.

The Business System is built so that everyone should be self-critical and open-minded for changes. If something is not working, the system is open for improvements. It is the small steps that lead SMT to bigger steps and great progress.

6.2.2 The Sales Organisation

The sales organisation is the link between the customer and the production. They are making the most out of the capacity of each production unit and should possess specialist knowledge in order to create larger orders or more complex products.

Traditionally, the sales organisation has worked primarily with sales value. When deciding what price to set, the production costs have been examined, as well as the competitors' pricing and market demands. This kind of pricing is still common when it concerns products that sell in large volumes. Since SMT offer a lot of niche products, with a very high value for the customers, SMT had to develop a new pricing method. One example for increased customer value is

when a material replaces a previous one which increases the value of the final product for the customer. This material may be lighter, stronger or tougher. A value that SMT's customers can use to offer the market a more unique product than its competitors. Other examples of higher customer values are when the new material makes it possible for the customer to carry out more advanced operations, run a process more efficiently or enhance the properties of the product's material. Therefore SMT wanted to add information to their pricing strategy so that they could offer a fair price, for both themselves and their customers, and thereby increase their profitability. Often, the increased profitability for they customer is estimated and divided so that SMT receive 50 percent and the customer 50 percent.

6.2.3 The Production

SMT have a wide range of products that are manufactured in production units located around the world, in Sweden, UK, USA, Brazil and China. Thus, an easier distribution to their customers is obtained, since the customers much like the production units are scattered all over. Intelligent planning is therefore needed to create a good balance in the production with low storage and high delivery reliability.

As in almost every industry there are some machines or production units that can be bottlenecks in the production. Cooperation between the production and the marketing- and sales departments is therefore greatly important. This to be able to construct a reliable plan of the best order mix and highest planning results. Before deciding which orders to book they are classified in A,B and C, depending on their profitability which is determined by customer price, material cost and the use of bottleneck capacity. Order A is of course the order with the highest profitability. The orders are only divided in groups when they are booked and not when they are confirmed and have entered the system. Then all orders and customers are treated in exactly the same way.

6.2.4 New Product Development

Research and product innovation are extremely expensive but absolutely necessary for SMT to maintain their leading position on the market. To continue being one step ahead of their competitors SMT need to continually develop and launch new products.

To cut down on the costs it is important for SMT to launch the new materials and products onto the markets as fast as possible. To enable this SMT has to work side by side with the customers, listen to their needs and manufacture products that fulfil those needs, so the new product can be sold directly to the customer when it is fully developed.

6.2.5 Strategy for the Future

SMT do not strive for a complete forward integration since they believe that this will increase their responsibility to an unwanted extent. For example when it comes to surgical products, they do not desire to make the final product used in the hospital since this makes Sandvik liable if a problem with the product occurs while operating. However, an effort will be put on integrating one step forward. Today, most deals that are made involve Sandvik selling a certain amount of steel strip, wire or tube. The next person in the refinement chart might only change this part modestly, by for example cutting it to pieces, but may augment the price as much as a hundred times. This is a step in the value chain that Sandvik want to encompass in the future to be able to set higher prices and therefore earning higher profits and also obtain a fuller understanding of the value chain and its customers.

6.3 SMT's Lean Product Development System [134] [135]

Every R&D project goes through a project model that is called the SMT lean product development system (Figure 37). The process consists of three major parts each divided into three subgroups and several milestones to ensure that the project will be finished in time and with the right quality. This thesis concerns the first part of the model which will be described in detail, while the other two parts only will be briefly illustrated.

[134] Sandvik Intranet, 2007-07-02

[135] Pasi Kangas, Sandvik Materials Technology, Manager project and product development

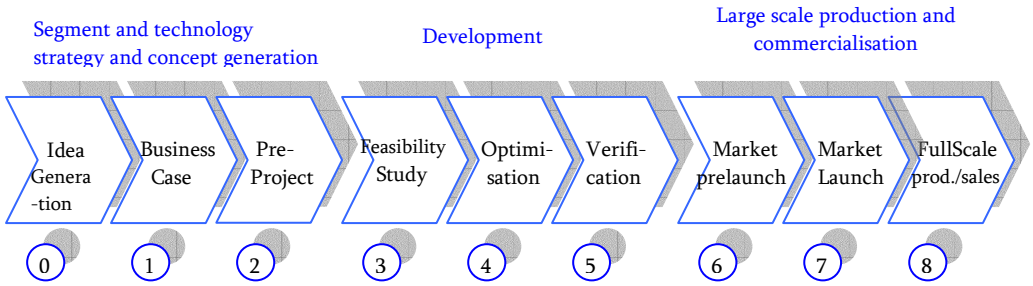


Figure 37 The nine steps of the lean product development system

6.3.1 Segment and Technology Strategy and Concept Generation

The purpose with the first part of the model is to, in a systematic and creative way, identify un-met customer needs. The new concepts can be generated from for example the employees, global trend analysts, external partners or through target efforts. The generation process of new concepts creates an important base for the decision to commence with a development project or not. This first section starts with the idea generation process.

0. Idea Generation

To be able to choose which ideas that seem to be most successful for SMT a paper, called a concept sheet, is completed. The concept sheet consists of four control questions. The first two questions that need to be answered are made to clarify if and how the new innovation fits Sandvik, if it is suitable for SMT's current strategy and if the existing production equipment is enough or if investments in new equipments are necessary. The other two questions that need to be answered is what value

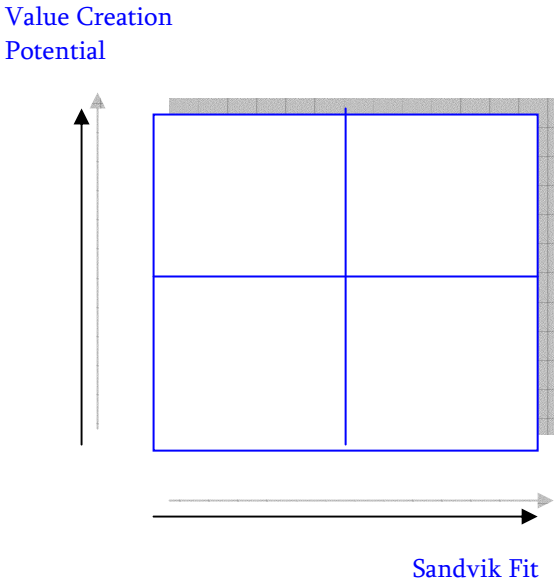


Figure 38 the Project Potential Matrix

the new innovation has for the customer and what the current and future market potential might be.

The different ideas are placed in a matrix (Figure 38), to illustrate the projects that seem to become most successful. The projects that fit Sandvik very well and have a good potential for creating value for the customer are the ones that are put in the top right square of the matrix, and should without a doubt continue to step 1. The projects that end up in the bottom left corner will be discarded without further notion. The other squares are not that easy to decide on. With projects located in the top left one, a discussion must be held to see if there is any potential for Sandvik to increase the project's fit at Sandvik, through for example investing in new facilities or machines if the existing ones are not compatible. Similarly, for the square on the bottom right hand, the question that needs to be asked is: "Can we increase the project's value creation potential?"

1. Business Case

The R&D manager decides which ideas are of most interest for SMT. A comprehensive rough business case is made on the chosen ideas. The purpose of the business case is to make sure which projects that could result in a possible business deal in the future, how high the profitability might be and how long time it will take before the research and development part is finished and the product can be put on the market.

A standardised business case includes an innovation description, the value of the innovation, the Sandvik fit and the financial attractiveness for Sandvik. At least three customers and three end-users should be interviewed to ensure enough market input to the business case.

This thesis will terminate with the business case which will be the base for further research and for a possible pre-project.

2. Pre-project

After a review of SMT's portfolio it is decided which projects that should be initiated on its risk-adjusted return on investment and strategic fit. The project will be overviewed and a team will be composed and assigned the new project.

6.3.2 Development

A cross-functional team with a devoted project leader drives the development phase. It is significant that the team works in close contact with reference customers and ties them to the development process. To minimise the time spent on development, the activities are parallelised as much as possible. All resources are efficiently allocated based on potential and urgency.

6.3.3 Large Scale Production

The third and last part of the lean product development system is the large scale production and commercialisation phase. Here the purpose is to run the production parallel to the commercialisation. The launch should not be initiated before the production is prepared and committed to delivering. It is important to have a continual information flow across the functions to secure synchronisation and alignment. Moreover, the sales force should have enough information and be well prepared before the production starts.

6.3.4 The Project Portfolio

The different steps for a possible new project have now been described. A final project portfolio at SMT encompasses many different types of projects. SMT currently have many ongoing projects and add new projects continuously. It is important not to have too many projects in the portfolio simultaneously since it only leads to unnecessary jam in the organisation and pulls focus away from important projects.

The projects are divided into A, B and C projects to make them easier to handle. Projects of type A are the top projects which should get all the resources they need. B projects are necessary to reach a set target, but not as important as A projects. C projects do not generate as high profitability as the other two groups but can be important for the future. It is important to see if the C projects are competitors to A and B projects and decide whether or not to continue with those projects.

A general portfolio consists of a mix of the squares shown in Figure 39. Some projects are high risk projects that might generate a high profitability, and some projects have a high risk level and a low possible profitability but are part of larger projects. The ideal scenario is to have a lot of projects in the top right box of the matrix which of course is close to impossible to obtain.

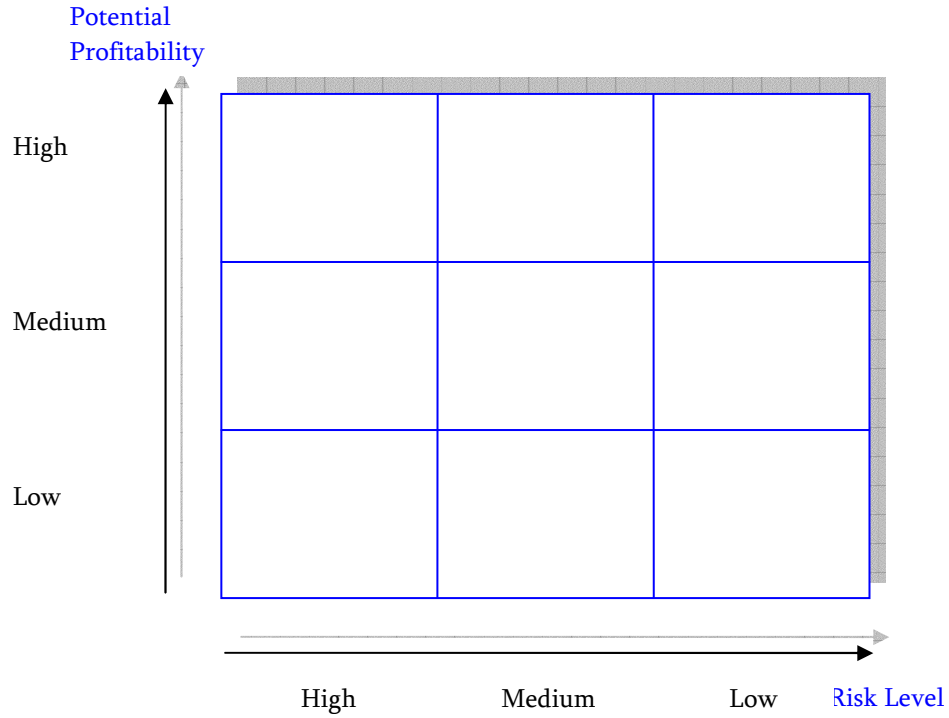


Figure 39 Choice of Portfolio Mix Matrix

6.4 Core Competencies– The Powers of Sandvik [136] [137] [138]

After interviewing key employees at Sandvik Materials Technology, reviewing annual reports and selectively searching the intranet sites, a wide amount of information was found as to how Sandvik deal with competition and how they act to continually win orders. In the broader sense, Sandvik's real core competency is their ability to provide their customers with new, developed state-of-the-art materials for their specific applications. However, the core competencies underlying this ability are of a greater number and are vaguer in their specifications.

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[136] Sandvik Intranet, 2007-07-03

[137] Pasi Kangas, Sandvik Materials Technology, Manager project and product development

[138] Johan Hernblom, Sandvik Materials Technology, Omvärldanalytiker- New Technologies

They can be summarised by these four statements about Sandvik:

1) Focus on advanced materials;
2) Continuously breaking new ground;
3) Uncontested leaders in new application areas; and
4) World-class competence in strategic knowledge areas

However, the Sandvik vision sums up the important underlying fact that permeates the whole organisation and therefore the core competencies: the extremely clear customer focus. Industries constantly need to improve their productivity, which is something that Sandvik makes possible. They are dedicated to help their customers fulfil, and even exceed, their targets. By developing competitive and innovative solutions based on a creative relationship with their customers a joint success is assured. Sandvik sees themselves as their customers' productivity planner.

6.4.1 Global Leadership

The Sandvik Group is a global enterprise in the true sense of the word. However, all business is local. Being global provides economies of scale. It is important to effectively utilise the common strength existing between the Group's operating areas and markets – in R&D, production, marketing, administration and logistics. Benchmarking is an important tool, in order to achieve "world class" in all their operations. Comprehensive information technology support is a driving force towards their leadership. Sandvik's strategy is that "key operations" shall take place mainly within Sandvik. Non-strategic operations can be outsourced. This is why they have conserved their smelt metallurgy in their operations.[139] This is a true core competency, since this makes the materials impossible for competitors to copy. It is always feasible to identify the different parts of substances in a metal, however, by having full control over the metallurgical processes, Sandvik keep the order of the blending procedure secret, which has equally big influence on the final properties of the material. Additionally, to keep their position on the market as a world-leader of stainless steels, they continually seek solutions that provide optimum quality, availability and cost-efficiency.

[139] Pasi Kangas, Sandvik Materials Technology, Manager project and product development

6.4.2 Targeted R&D

Another core competency that Sandvik possess is their exclusive R&D activities, which is also an operation that they have kept within the organisation. They spend more on R&D than its competitors. Some of the competitors, for example Tubacex in Spain, do not even have their own R&D department. Instead they copy everything they do, and will therefore never have the opportunity of being the first player on a new market.

The foundation for the R&D investments at Sandvik is the input they receive from their widespread direct contacts with the market. The ultimate purpose of all the R&D efforts is to help support the vision – to improve the customers' productivity. In addition to new products and services, the Sandvik R&D programs comprise many different fields such as materials and process development, machine and tool design and systems development. For example, there is currently a lot of research and trials done with soldering stainless steel at SMT. There has been some improvements in the area, even though, this research is far from finished, there must be more investments in research, both monetary and time, to meet potential demands from customers.[140] To ensure maximum customer value, R&D at Sandvik involves leading state-of-the-art technology, dynamic patent activities and extensive added value. R&D also provides Sandvik with more efficient production processes and more rational product lines. However, it shall be said that they are cautious when it comes to patents. They are reluctant to apply for patents concerning core competencies since they want to keep the information about these operations hidden from the competition.[141]

Within Sandvik, they do not regard research as an end in itself, but rather a highly target-oriented operation. Their research efforts are often undertaken in cooperation with customers located in many areas of the world. Their objectives are to develop new materials adapted to meet the special needs of customers and to assure themselves, in detail that the material will perform as intended when applied by the end user.

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[140] Anders Söderman, Sandvik Materials Technology, R&D Manager - Wire

[141] Pasi Kangas, Sandvik Materials Technology, Manager project and product development

6.4.3 Niche Focus

Sandvik's ambition is to be specialists focused only on market segments where they are, or can see an opportunity to become, a world leader. Furthermore, these areas should preferably have a greater growth, or potential for growth, than the industry average. A diversified customer base has many advantages. Different segments have different business cycles which makes Sandvik less sensitive to fluctuations in the business climate. Acquisitions of complementary companies will help to create a stronger Group with greater coverage in strategic market and business areas.

Some examples of present areas with a niche focus are medical and dental applications, applications for the oil- and gas industry, and precision components.

6.4.4 Customer Partnership

Sandvik's products and services are marketed in close cooperation with customers throughout the world. This is done mainly through Group employees but also with a large number of selected distributors and agents, as well as through other supplementary channels, such as electronic trading. Building strong customer relations is crucial for their success. The ambition of Sandvik is to always offer their customers an added value. The objective is that this added value should have a "hard" and a "soft" dimension. Customers shall look upon Sandvik as offering a benefit, rather than just a product.

6.4.5 Advanced State-of-the-Art Technologies

Rapid advances have been made in materials development in recent decades. Today, this field is based on a high tech interplay of such factors as thermodynamic computer simulation, advanced metallurgy, demanding structural analysis, mechanical testing, corrosion testing, as well as application tests on the materials in their working environment.

The heavyweight among the powerful instruments used in the Sandvik laboratories is an analytical-transmission electron microscope. Using these instruments, they can obtain a magnification of up to 800,000 times. This means that even the tightly packed atoms of a flat surface can be distinguished. All this is possible because they use electrons rather than visible light to obtain the image. This method provides considerably enhanced resolution and enables

Sandvik to undertake significantly more ambitious analysis than would be possible using a conventional microscope.

Increasingly advanced techniques and instruments will provide a greater in-depth knowledge about various materials and combinations of different materials: Knowledge that will be invaluable in the efforts to develop new and even better materials for their customers.

6.4.6 Quality

The key directive at Sandvik is complete customer satisfaction. They provide their customers with products and services that conform to all requirements. Moreover, they are fully committed to continuous improvement as a strategic approach to achieve these quality objectives.

In 2006 Sandvik initiated the quality initiative which among time delivery, value based selling and new product introduction are the key initiatives in the strategy plan 2006 to 2008. Parts of the programme have already proved successful while other areas need further improvement. The main key performance indicator for quality at Sandvik is cost of non conformance in which Sandvik measure the quality cost in relation to cost of goods sold. As seen in Figure 40 Sandvik has since 2002 reduced the cost of non conformance from 16 % to the range of 10 %. In April 2007 they recorded the best quality situation ever, with 8.5 %. [142]

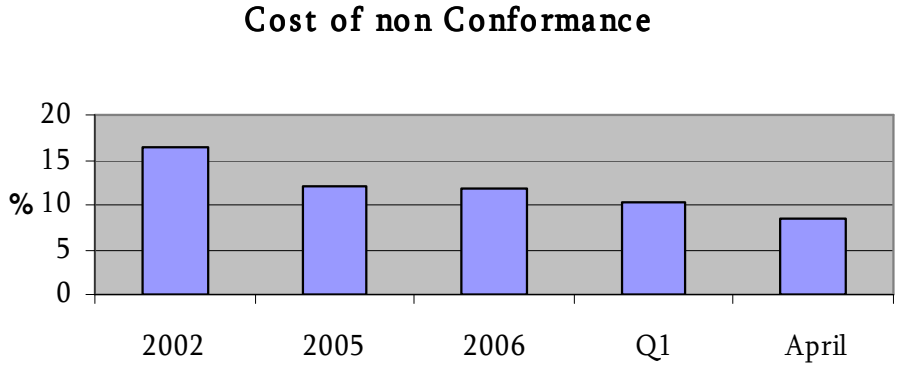

Figure 40 Cost of non conformance chart

[142] Sandvik Intranet, 2007-07-05

In Sandviken there is currently a quality committee which steer and co-ordinate 11 on-going quality projects. The policy and associated quality objectives are reviewed and communicated to all employees on a regular basis.

Sandvik control material properties throughout the manufacturing processes by using the optimum starting material for each steel grade, the latest production technologies and efficient quality control. This has been made possible through fully integrated production methods and the company's long experience in the manufacture of demanding materials.

Sandvik Materials Technology have a comprehensive quality management system approved by internationally recognised bodies and hold an ASME quality system certificate as material organisation. Approval to ISO 9000 is also held, as well as product approvals from Lloyd´s Register (U.K.) and JIS (Japanese Industrial Standards Committee).

6.4.7 Distribution

SMT has customers and production units all over the world. Their largest customers are foremost located in Europe, but Asia is a market that is growing. An important measure of the capability of Sandvik in worldwide sales and distribution is therefore global availability. Sandvik cope with production units in, among other countries, Sweden, UK, USA, Brazil and China, and worldwide distribution through subsidiaries and dedicated distributors. The distribution is geared to a variety of customer needs. Top delivery performance is the goal regardless of where the customers are located. Product availability is being improved continuously by shortening manufacturing lead times and immediate delivery of some orders, from a number of different stock locations, is offered. To be able to meet these demands, Sandvik have four efficient distribution centres in strategic locations, which coordinate the physical distribution process. These centres are located in Sandviken (Sweden), Venlo (Netherlands), Milan (Italy) and Halesowen (UK).

The distribution organisation is recognised for its efficient and high quality administration and physical handling, and its timely responses and prompt deliveries. Moreover, they work towards customer driven services with a continuous focus on improving quality, processes and services. The goal is to optimise goods flow, capital efficiency and thereby the value for the SMT customers, by providing warehousing, cross docking, and forwarding services for the different product areas at SMT.

6.4.8 Competitor Analysis

Sandvik Materials Technology does not have that many competitors, playing in their league, on the market today. However, the product area of tube does meet some competition. Their largest contenders are, Sumitomo Metals which is located in Japan, and Tubacex which is situated in Spain, whereof Sumitomo is the largest, since Tubacex, as mentioned before (6.4.2 Targeted R&D), do not even have an R&D department. SMT continuously make competitor analysis to be aware of how the market and the competition develop. This also aids in comprehending their own position on the market and upcoming trends in their relevant industries. SMT's competitors in stainless steel products are currently not producing materials for the musical instrument industry.

6.4.9 Sales Organisation

The final core competency that Sandvik have, as an advantage over their competitors, is that they also kept the sales organisation within the Group. This makes it possible for Sandvik to have a comprehensive view and a comforting control over the whole value chain. Moreover, since they do not use other channels for the sales organisation an extra profit can be made.

6.5 Sandvik Materials [143] [144]

Sandvik Special Steel is produced in three forms: wire, strip and tube, whereof tube is the largest and most profitable area at the moment.[145] Sandvik steel is produced in a wide range of steel grades with excellent properties in terms of corrosion resistance, strength, workability, suitability for use at high temperatures etc. One success factor is that Sandvik has the ability to tailor their products to meet specific customer demands. Sandvik carries several different types of hardenable stainless chromium steel in their standard range of products. Each of which has its own particular combination of hardness and corrosion resistance properties. It is an advantage if a material is easy to manufacture. Therefore, formability is an important factor. It should also function reliably during a long service life, even if it is used in a corrosive or in another way demanding environment.

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[143] Anders Söderman, Sandvik Materials Technology, R&D Manager - Wire
[144] Anette Sjöberg, Sandvik Materials Technology, R&D Manager - Strip
[145] Pasi Kangas, Sandvik Materials Technology, Manager project and product development

The product program for the different Sandvik steels contains many different grades, performance capabilities and dimensions for all types of demanding applications with different requirements on strength, relaxation resistance, fatigue strength, corrosion resistance and ductility. The hardening and tempering process gives the steel its required microstructure. This results in optimum mechanical properties and provides the necessary wear resistance.

6.5.1 Alloyed Non-Stainless Steels and Carbon Steels

These steels when cold formed have very good properties in terms of forming, blanking and machining. Subsequent hardening and tempering makes the steel hard, tough, resistant to wear and suitable for use as springs and other high strength applications.

6.5.2 Martensitic Stainless Chromium Steels

These steels have excellent properties for forming and grinding sharp edges and, after hardening and tempering also an increased hardness.

6.5.3 Austenitic Stainless Steels

These steels have superior qualities in respect of resistance to corrosion and depending on structure they can also possess very good spring properties, low relaxation and high fatigue strength. The strength in these grades is achieved by cold forming, which makes them available in a wide range of dimensions and mechanical properties. A further increase in strength can be obtained by a simple heat treatment in the temperature range 350-480 °C.

6.5.4 Duplex Stainless Steels (Austenitic-Ferritic)

The modern duplex stainless steels have excellent corrosion properties. They are not as sensitive to stress corrosion cracking as austenitic steels. Moreover, these steels hold low relaxation and high strength, which makes them durable. Thermal expansion is lower than for austenitic steels, which can offer design advantages in certain cases.

6.5.5 Sandvik Nanoflex

Sandvik Nanoflex is an ultra high-strength material combined with good corrosion resistance. It is an alloy with carbon, chromium and nickel as shown in the figure below (Figure 41). By a simple heat treatment after cold deformation, extremely high tensile strengths levels in combination with a good toughness are obtained. Because the heat treatment is made at a low temperature, dimensions are perfectly maintained. In the as-delivered condition, Sandvik Nanoflex displays excellent forming properties. The exceptional strength and toughness of Sandvik Nanoflex enables thin material to be used leading to a reduced weight. For certain applications Sandvik Nanoflex can, with remained strength and stiffness, reduce the weight compared to titanium or aluminium. The good corrosion and wear resistance of Sandvik Nanoflex keeps life-cycle costs low. Attractive or wear resistant surfaces can be achieved by various treatments. These facts all support the fact that this is a material both highly used and highly appreciated by Sandvik's customers.

The tensile strength is around 1700-2000 MPa, however, higher strength is available, for example up to 3000 MPa for wire. With a generalisation it can be said that a bolt only needs half the diameter in Nanoflex to endure the same tension as a bolt in ordinary stainless steels. This indicates that in the case of space being an important parameter, this durable material is an excellent choice. It is available as wire, strip, bar and tube, with very fine dimensions of close tolerances.

6.5.6 Differences in Properties

The differences in properties between Sandvik's ordinary stainless steels, duplex steels (Springflex) and Nanoflex are shown in Figure 41.[146] It can for example be seen that the primary advantages of Nanoflex are relaxation resistance and formability versus final strength, which means the level of ductility put in relation to the strength when the forming is done (since this forming process normally decreases the final strength considerably).

[146] Anders Söderman, Sandvik Materials Technology, R&D Manager - Wire

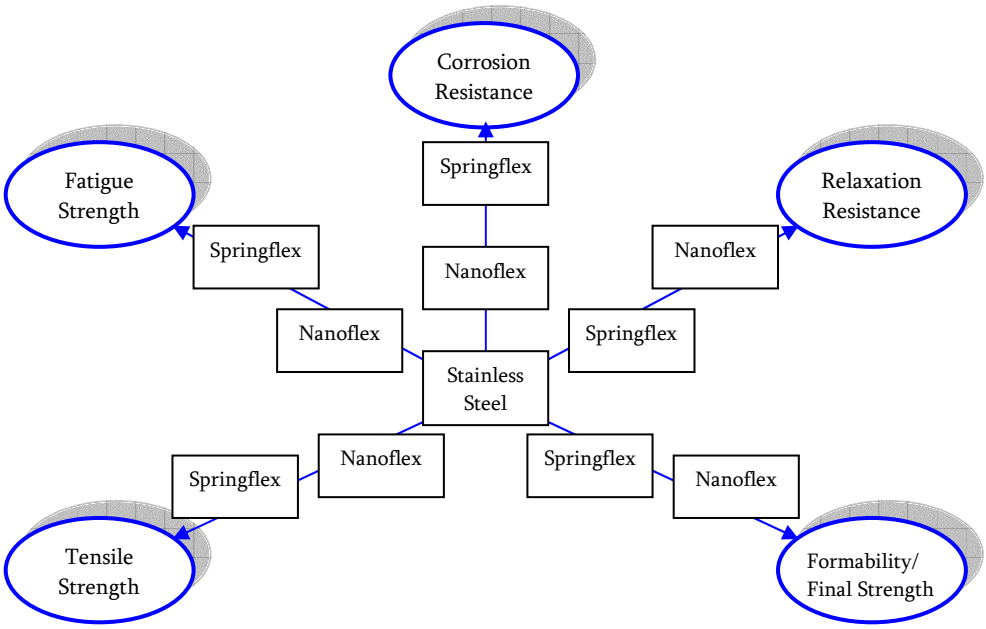


Figure 41 Properties of the Different Sandvik Materials

6.6 Results Gathered from the Questionnaires

When facing the task of finding interesting interviewees within the areas of musicians, musical instrument stores and manufacturers, an extensive search was conducted on the internet, in the yellow pages and among friends. A decision was taken to make the circular as wide as possible to ensure, if not a higher return measured in percentage, then a higher amount of answers to base the analysis on. This decision was taken to try to improve the trustworthiness of the thesis.

Questionnaires were subsequently sent out, in round numbers, to 60 stores located all over Sweden and to 80 musicians or musical associations for example symphony orchestras to which several questionnaires were sent. With the musicians it can be assumed that the amount of questionnaires sent to musicians of the different instruments were equal. That is, about 10 questionnaires were sent out per instrument. The manufacturers were more carefully selected mostly on the basis of their position on the market which could be translated into purchase volumes for Sandvik's part. A geographical limitation was not taken on account of the fact that Sandvik has production units at strategically

chosen places all over the world to enable a fast distribution to whatever location the customer may be present at. Figure 42 show the amount of questionnaires sent out to manufacturers of the different interesting instruments chosen in the initial selection process.

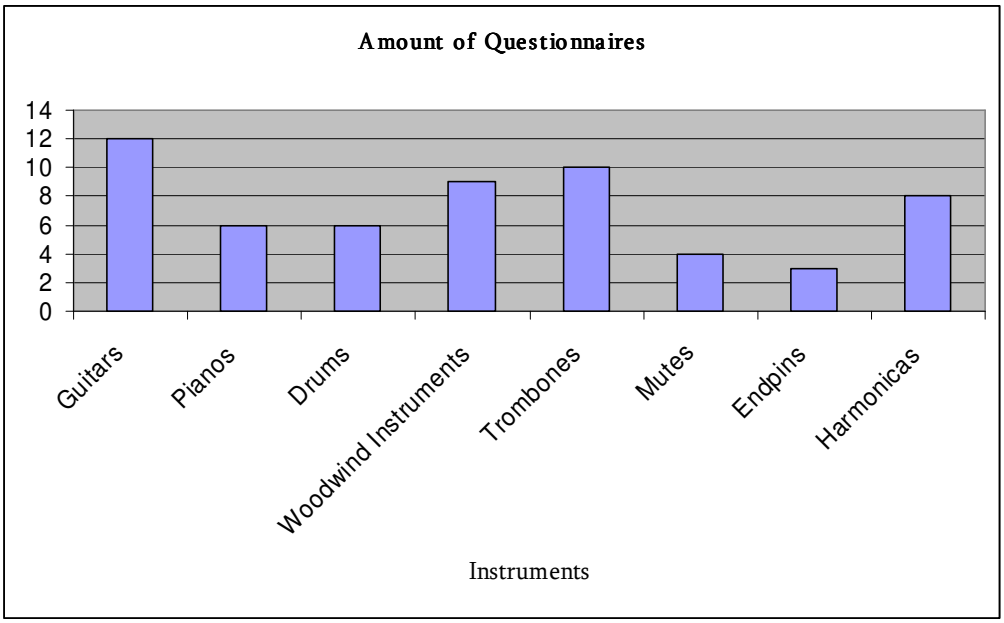


Figure 42 Amount of Questionnaires Sent out to Manufacturers of the Different Instruments

When the questionnaires were sent out a date, three weeks ahead, was set when a reminder should be sent out to those who had not yet answered. After additionally two weeks an effort should be made to get in touch with manufacturers, in those areas where the answer frequency was too low, by calling and asking to talk to concerned parties.

The answer frequency was really low in both the manufacturer and the store segment, however, the latter did not pose any bigger concerns with the authors since this segment from the beginning was planned to be of use mostly if there were any ambiguous answers from the other two more important segments. It was also thought that these answers could enforce too feeble notions caught from the other two groups. Nonetheless, the importance of a high return on the circular from the manufacturers put a focus on this segment instead, and an attempt was made to firstly send out reminders and then also try to get a hold of employees that possess knowledge important to the project at hand. This effort was foremost made with the manufacturers of the parts that, after a quick

overview of the musicians' answers, seemed most interesting for the purpose of the project.

The final numbers of the answer frequency in the different segments can be found in Figure 43. The answer frequency of the musicians is as high as 81.3 %, whereas the same number for the manufacturers is 36.2 % and for the stores 16.7 %.

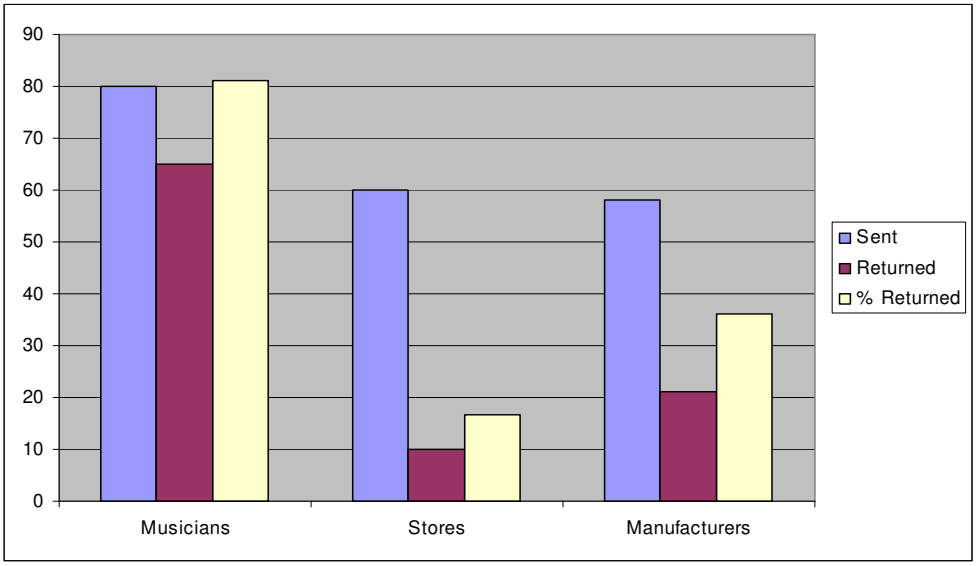


Figure 43 the Answer Frequency within the Different Segments: musicians, stores and manufacturers

Since most of the stores depicted wishes from the market and its customers as a highly important factor when purchasing new instruments, they will be only briefly explained before the musicians' answers, since these consequently are of definitive importance.

An interesting notion that some of the stores answered was that problems with their customers' instruments were not necessarily a problem since many of them also act as restorers and repairers of the same instruments. This implies that they actually would profit from selling instruments with which problems occur after some amount of time. Another fascinating interpretation from these answers is that the stores either have no apprehension of the problems that arise with the different instruments or answer accordingly with the musicians.

The answers of the most important questions will now be compiled to be available for further use in the next chapter,
6.7 Selection Process Part II. Firstly, problems will be presented and described, followed by an illustration of the average answer of influencing parameters on material choice when buying an instrument or a part of an instrument. The diagrams have a range from 1, where the parameter has no influence on the musician's choice, to 5 where it has great influence. Finally, the willingness of the musicians to a change of material will be noted.

6.6.1 Fretted Instruments

None of the musicians had had any problems with neither the truss rod nor the slides, so only the answers of the frets will be presented. Out of the seven answers four had experienced problems with the frets. The common problem among these was wear. Musicians seem to change them with various time frames depending on how often and how intensely they are played. The important parameters of the material affecting them when buying new frets or a new guitar are acoustic properties and quality. Price was not very important as can be seen in Figure 44. All of the guitar players who answered were interested in testing new materials and articulated that the feel and sound of the guitar is a lot more important.

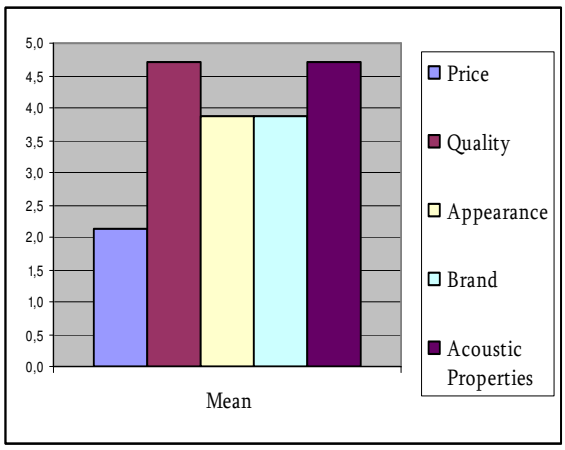


Figure 44 the Average Answer of Influencing parameters on the choice of material

There were finally five manufacturers out of twelve who answered our questions in some way. Among these only two produced frets and the others agreed with the musicians that they could not see any real problems with their products. Between the fret manufacturers the answers were different. Petillo Masterpiece Guitars do not see any problems with their frets. They custom

install frets into guitars and use their patented frets on their own guitars as well. They currently use some sort of stainless steel alloy. They have tried many alloys in the last 40 years and are currently testing a titanium alloy. While the other manufacturer – Kriz Guitars use ordinary steel for their frets but do not see a problem with this.

6.6.2 Keyboard Instruments

Six out of ten piano tuners agreed on problems with the piano pins. However the problems could often be connected to the pins' attachment in the pinblock which is made of wood. This part goes through most change when exposed to humidity which affects the pin's hold of the string. Most important factors were quality and corrosion resistance while price and acoustic properties are less important which can be observed in Figure 45. This segment showed to be quite reluctant and sceptical when it came to buying pins in another material. The tuners were conservative in their answers and only three could consider using new materials, and even they showed scepticism by expressing that they could not understand how it would be possible to find something better than the current solutions.

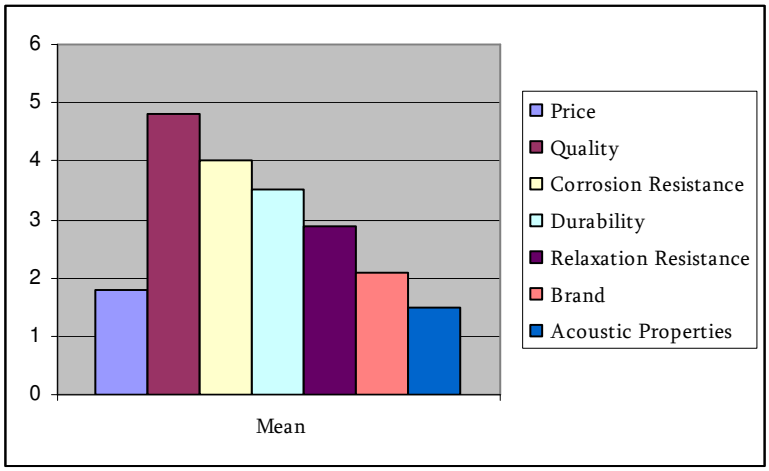


Figure 45 the Average Answer of Influencing parameters on the choice of material

Out of the six manufacturers of tuning pins that were contacted only two answered, and both agreed with the tuners interviewed. They cannot see how anything could be better than the existing solutions that have been used for 150 years and are not curious about testing anything new.

6.6.3 Percussion Instruments

With the drums five out of seven musicians had problems with the tuning lugs and the tom brackets but only three noted problems with the memory locks. The common problem was wear on account of cheap parts in materials with low durability and high probability of breakage. Materialistic factors that influence them most when buying new parts are quality, durability and acoustic properties while price is of less importance (Figure 46). Moreover, three of the musicians also implicated that weight, size and solutions of how to place the brackets are of importance. None of the drummers were reluctant to testing new materials as long as it results in better functionality.

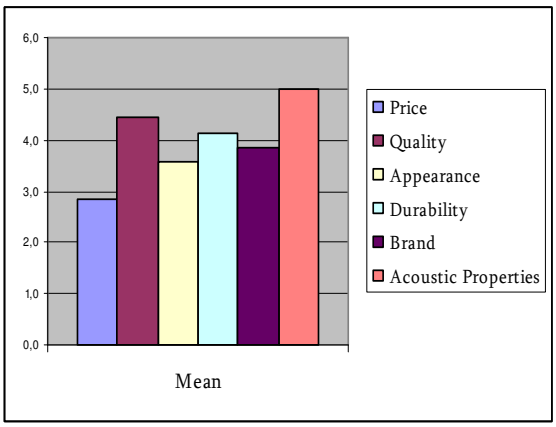


Figure 46 the Average Answer of Influencing parameters on the choice of material

Two out of the six drum manufacturers that were contacted answered the questionnaire. The answers revealed knowledge of problems with parts lacking in quality. However, they currently do not see this as a problem since they sell more parts this way. Nevertheless, an interest might grow in the future, especially since the need and wishes from the market are increasing.

6.6.4 Woodwind Instruments

Out of the ten answers, eight indicated that they had had problems with the mechanics or the apparatus on their instrument. Some problems were that springs weaken and break, mechanical wear, and low durability of the material used in the parts. Important factors influencing the musicians when buying a new instrument were quality and acoustic properties. Brand and appearance were those parameters least interesting for the musicians' choice. This

information can be found in Figure 47. They could all consider buying parts in a new material.

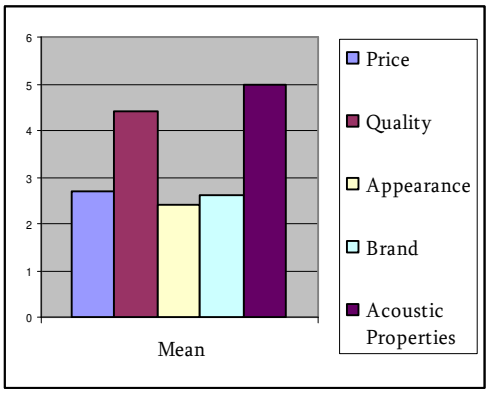


Figure 47 the Average Answer of Influencing parameters on the choice of material

The three manufacturers that answered in this instrument segment, use materials like steel, brass and nickel silver for the details in the apparatus today. These materials are used since they have the advantages of being cheap and easily formed, but possess the unwanted properties of low corrosion resistance (rust) and low durability.

6.6.5 Brass Instruments

Eight out of the eight musicians that answered acknowledged that there were problems with their trombone slides. The common problems were sensitivity of bumps which led to buckles on the outer slides and wear and friction between the inner and outer slide. These problems had led to repairs in all cases. Important factors for this segment are quality and acoustic properties. Price and appearance were identified as less important parameters when choosing which new instrument to buy, as seen in Figure 48. However, only six out of the eight could consider buying parts in new materials.

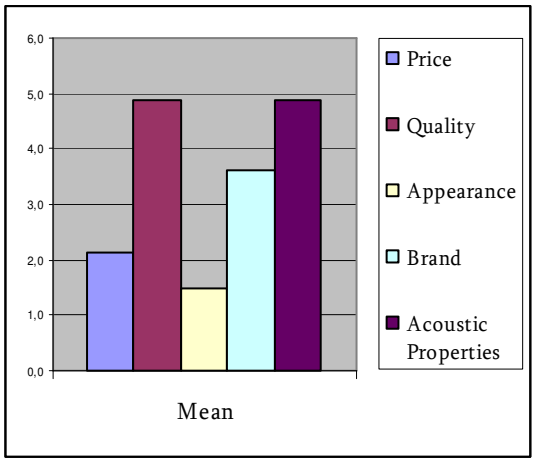


Figure 48 the Average Answer of Influencing parameters on the choice of material

Three trombone manufacturers answered and one mute manufacturer, out of respectively ten and four manufacturers. The common opinion about important parameters was here that they were quality and durability, closely followed by acoustic and materialistic properties, whereas price and especially supplier relations were insignificant. The trombone slides are most often made from brass or nickel silver and the inner slides are plated with chromium. The great disadvantages are partly that the chromium plating often is of an uneven quality and partly that the chromium flakes off. The advantage is that chromium is very hard and slides easily against the brass in the outer slide. A thin-walled tube of stainless steel in combination with an outer slide in brass would be of preference if this tube could be made with high finish and precision. With this type of precision tube the chromium plating could be skipped, which is an expensive and difficult operation to pursue with controlled measures.[147] [148]

When it came to mutes for brass instruments only 50 % of the eight answers had experienced problems with their accessory, and they all recognised intonation as the problem. Important factors were here stated to be quality and acoustic properties, while price and appearance got the lowest points (Figure 49). Some even put intonation as their own highest parameter regarding material choice. Only two of them were interested in new materials and further stressed that they had to have positive effects on the acoustics and the intonation. Moreover, they should be easily played.

[147] Lars Gerdt AB, Sweden
[148] Besson Trombones, UK

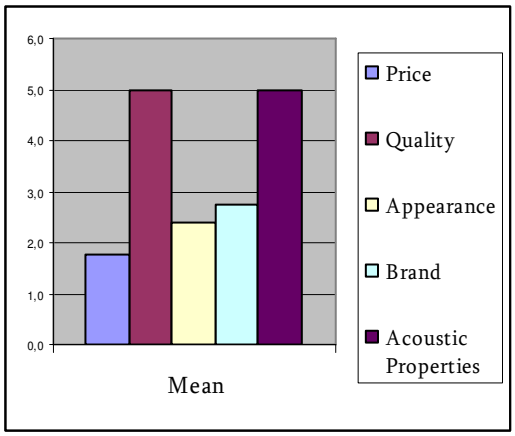


Figure 49 the Average Answer of Influencing parameters on the choice of material

The mute manufacturer is presently making their mutes in ABS plastic, with which they see no disadvantages, but with the advantages of being hardwearing and unbreakable. They express their satisfaction with their product and they feel that the unceasing interest from their customers supports this opinion.

6.6.6 Stringed Instruments

In total, ten answers were collected from cello and contrabass players. Out of these five had had problems with their endpins. Problems described were complaints about dull screws, being too heavy and that they get caught in the instrument. Two of them also had problems with rattling sounds and the inability to extend endpins in some materials. The factors noted as important when buying a new endpin were quality and acoustic properties. Additionally half of them put weight as an important factor. Brand and price were parameters of less significance. This information is presented in Figure 50. The musicians could all consider buying an endpin in a new material if it showed positive effects on acoustics and improved their working situations. How often the musicians bought new endpins varied a lot, from once in a lifetime to a new one every five years.

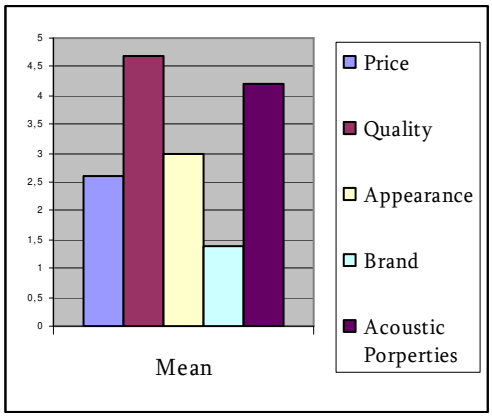


Figure 50 the Average Answer of Influencing parameters on the choice of material

One out of the initial three chosen manufacturers of endpins answered. This manufacturer stressed that the important parameters when choosing material for their products was first and foremost quality followed by acoustic properties and market demands. Less attractive were parameters such as price, appearance and supplier relations. They also shared that they currently make their endpins in both titanium and steel and what they are lacking in the one material they gain in the other, and contrary. They are currently not interested in testing new materials, however they indicated wishes from the market as their first choice when it comes to which material to use, so that may change in the future.

6.6.7 Free Reed Instruments

The results gathered from harmonica players were unanimous, even though only five answers were gathered in total. Problems that were suggested were wear, rust and exhaustion. Most musicians buy new harmonicas instead of exchanging the reed plates when worn out, since a change is quite difficult. The most important factors for the musicians when buying a harmonica or new reed plates are quality and brand whereas price and appearance are not parameters that influence them in their choice, as seen on the left in Figure 51. All of them were willing to buy new reed plates in another material.

The manufacturers of reed plates for harmonicas were those who both showed most interest in the project and most concern for their products today. In total four answered out of the original eight. Whereof most use brass today but some forms of stainless steel alloys exist on the market. The advantages that the

manufacturers see with brass are that it has long life duration and it is easily milled and cut. There are, however, problems with both rust and increasing costs. Two of the manufacturers complained about not getting the precise material that they want depending on their small production sizes. They all agree on that quality and durability are the most influencing parameters that affect them when choosing material. Supplier relationships and price are the parameters that affect them the least. This information is compiled on the right in Figure 51. The smaller brands put conditions of material and minimum order size as an important factor in addition to those already exemplified in the questionnaire.

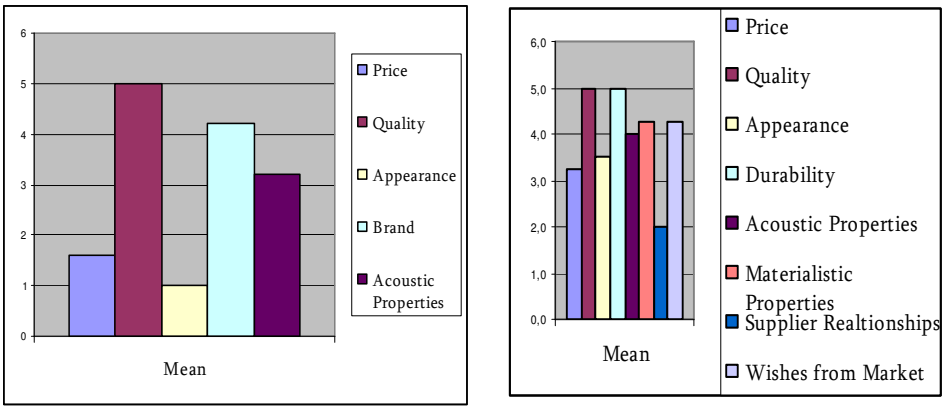


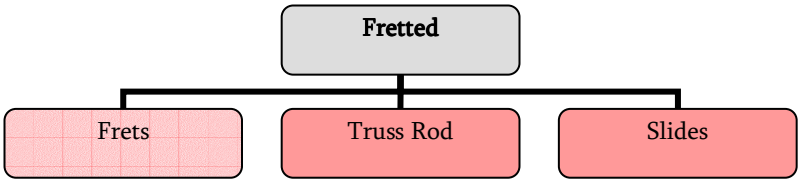
Figure 51 the Average Answer of Influencing parameters on the choice of material – musicians on the left and manufacturers on the right.

6.7 Selection Process Part II

The information gathered from the questionnaires pointed in some directions that were evident enough to perform a second selection process. The received knowledge about each part will be described below and the decision if the part still is a possible candidate will conclude each section. The remaining parts after this selection will be taken to the next level where more information about their dimensions, materials, manufacturers and market sizes will be assembled and a Concept Sheet, according to Sandvik's structure, will be made.

6.7.1 Fretted Instruments

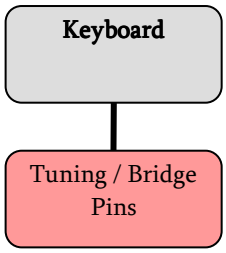
The information received from the musicians was that they had practically never had any problems with their truss rod or their slides. The stores confirmed these statements. A general guitar player does not change the truss rod and only buy a new slide if it is lost. That information made it clear that these parts will not continue to the next phase.



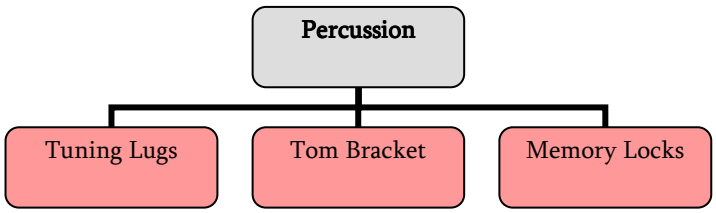
Worn-out frets seamed to be a common problem among the guitar players. The information from the stores said that a guitar player has to change the frets every ten years if the guitar is played a lot. The tone quality of the guitar is damped if the frets are worn-out. Nowadays the frets are generally made of steel but guitar manufacturers have started to produce frets made of stainless steel as well. This is one reason to why the frets will not continue to the next step. For Sandvik to be successful and obtain market shares they have to offer a solution that is superior to the competitors. Even though Sandvik probably can offer better solutions than those of the existing stainless steels, it is not worth the time and effort it would take. Stainless steel is already on the market and the problems with the frets are not severe. The frets are changed too rarely to be a good candidate for Sandvik.

6.7.2 Keyboard Instruments

The common opinion among both stores and piano tuners is that the pins currently function properly. Since most problems have to do with the wood properties in the soundboard and in the pin block and not actually have to do with the material in the pins, they all agree on that there is no actual call for developing something new. Moreover, a change of pins today, may last for 60-70 years which makes them less of a consumer good. Therefore the decision was easy to make: the trip for tuning- and bridge pins, in this research, ends here.

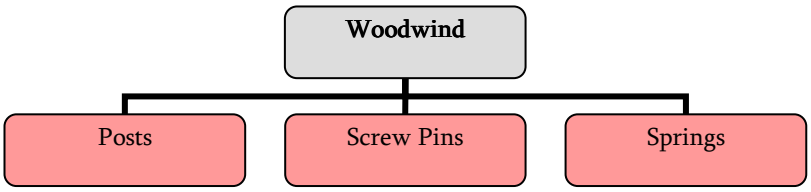


6.7.3 Percussion Instruments



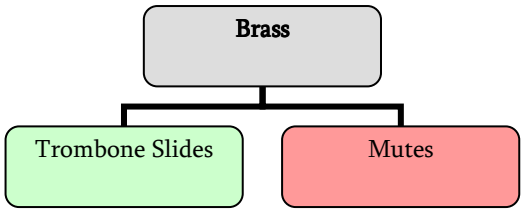
The general attitude against the three parts selected from the drum kit - tuning lugs, tom brackets and memory locks – was that there obviously exist problems. This view is shared by both musicians and stores. However, given that the interest from manufacturers has been quite low and unenthusiastic; a decision to continue investigating these parts is quite hard to make at the moment. Since Sandvik mostly want to have an interested manufacturer present from the beginning of a new project, these parts are presently not interesting enough to continue on through a more detailed study.

6.7.4 Woodwind Instruments



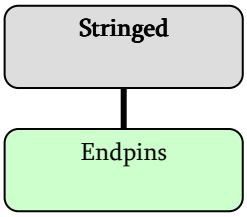
Regarding the woodwind instruments the musicians were divided in their judgements. Although many of them had had repairs done due to problems with low durability and mechanical wear, there was a discussion with Sina Vosough after which the conclusion was made not to keep these parts under investigation. The decision was taken on the basis of a common agreement that these parts are seldom manufactured of the music instrument manufacturers themselves but purchased from large suppliers. These suppliers' production of e.g. springs for woodwind instruments is only a small part of their whole production, which makes them companies similar to Sandvik. This makes them harder competition than if the instrument manufacturers themselves would produce the parts. In addition to this, the fact that Sandvik in this case would be forced to deal with yet another middleman, which is not to prefer, pushed these parts off the list of potential candidates.

6.7.5 Brass Instruments



All trombone players that answered the questionnaire had had problems with their trombone slides. The most common problems were: wear on the slide, caused by too much friction between the outer and inner slide; and buckles. Many repairs had been made due to the buckles. The trombone slide is generally made of brass which is a material that is easy to work with and the buckles are fairly easy to repair. A general interest for new better slides is interpreted from the questionnaires. Both musicians and manufacturers have showed their interest for an improved material. The factors that seem to be most important for a trombone player are quality and acoustic properties, and less important are price and appearance. This combined with the existing interest on the market, are the reasons to why the trombone slides will continue on to the next step. The mutes will not be further examined since the common opinion among the brass players was that there do not exist any problems with the mutes.

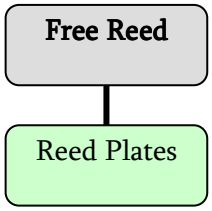
6.7.6 Stringed Instruments



Only 50% of the musicians' answers supported the statement that there are problems with the endpin for cellos and contrabasses. However, together with the information gathered from manufacturers and stores, a general assessment could still be made.

The common problems with endpins are that they are too heavy and that the resonance properties are poor. These are also the two most important factors when it comes to which material to use. There already exists a solution to the weight problem, which is the usage of carbon fibre. This is a material that is both light in weight and possess excellent acoustic properties. Nonetheless, this is a very exclusive material and therefore extremely expensive. With Sandvik's exceptional knowledge in the development process of new materials, there is a strong belief that they have the capacity to find a material that acquire the same properties as carbon fibre but with the advantage of a lower price. Consequently, this part is not to be discarded just yet.

6.7.7 Free Reed Instruments



There is a clear trend showing an interest in material innovations when it comes to reed plates for the harmonica as well as for the accordion. Musicians agree on problems like wear, which lead to exhaustion, and rust. These problems could lead to lack in acoustic properties and ultimately even breakage. What is also interesting is that the manufacturers who have answered have also expressed their curiosity within this area, and their common need for newer improved materials for these parts. They all provided their contact information and conveyed their interest in trying the Sandvik materials to see if a deal can be made. All these factors make the reed plates a highly attractive candidate for the next part of the selection process.

6.8 Detailed Information about the Chosen Parts

The parts that in the previous section proved to be interesting enough will continue on through a more detailed study that firstly will result in the Concept Sheet and finally, if still found attractive, in a Business Case made by the research department at SMT, according to Sandvik's Lean Product Development System. Here a more detailed description of these parts will take place, subsequently, information about the different concerned stakeholders and the relative market sizes will be presented.

6.8.1 Trombone Slide

As mentioned in a previous chapter the inner slide is made of chromed nickel silver and the outer slide can be made of either nickel silver or brass. To receive a perfect inner slide the material used is drawn two times in a drawing machine. The first procedure is performed to obtain a tube in one thickness that is straightened out. The second draw is completed to make one end of the inner slide a bit thicker. This part, 120 mm long and normally 0.47 mm thick, is called stocking or sliding. The rest of the inner slide is generally 0.33 mm thick. After receiving an inner slide with a sliding on one end, the nickel silver tube is chromium-plated.

Another important fact to be aware of when constructing an inner slide for a trombone is that the tolerance between the trombones inner and outer slide is

0.3048 - 0.3556 mm (± 0.02 mm). There exist many different sizes of trombones and a manufacturer has to be able to produce all of them, both concerning length, thickness and diameter. A common measure of the inner slide's diameter is 13.84 mm. The weight of an inner slide for a small trombone is around 90 grams and it is important that using another material does not make the inner slide heavier.

Two other important features that need to be fulfilled with an inner slide are that the glide between the inner and outer slide should be easy and very quiet, and it must be possible to tin solder it to the instrument's body to be able to easily repair the instrument.

The price an end-customer pays for a trombone generally varies between ten and thirty thousand Swedish crowns. [149]

6.8.2 Endpins for the Cello/Contrabass

The *endpin* is the component of a cello or contrabass that makes contact with the floor. It is made of metal, or in some cases wood, carbon fiber or titanium, and is extensible from the bottom of the instrument, and secured with a thumbscrew.

Generally, endpins are parallel to the long axis of the instrument, but some cellists fit their instruments with a Tortelier-style endpin, which angles more towards the floor, improving mobility at the expense of stability. Also, some endpins have a secondary extension for tall musicians. The endpin also may have notches cut in it, allowing it to have extra holding strength at these points. Most of them have a length of 35, 45, 52 or 62 cm, and they can be either massive or tubular. Some examples can be seen in Figure 52.

One example of an endpin is Les Bois d'Harmonie's classical pear shaped endpin in wood that has a carbon fibre rod. The endpin has a very hard and sharp tungsten point and the length of the rod is 60 cm. The carbon rod is more rigid and three times lighter than a steel rod, and therefore lightens the weight of the cello by 130 grams. [150]

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[149] www.musikborsen.se, 2007-09-24

[150] http://www.harmonie.net/us/index.html, 2007-06-29

Figure 52 cello endpins from left: Adjustable steel endpin, straight or in angle; titanium with cork gasket; Carbon fibre with cork gasket; Nickel-plated with ebony hold and cork gasket

A titanium rod weighs half as much as a steel rod but is just as tough. The standard version has a diameter of 10 mm and if an even lighter rod is desirable, the 8 mm rod could be a choice. An 8 mm titanium rod is still sturdier than a normal steel rod.[151]

The prices for endpins differ a lot depending on size and material. A cello endpin made of stainless steel cost around $100 while an endpin made of carbon fibre generally cost between $200 - $300. The prices for contra-bass endpins are often a bit higher.[152]

6.8.3 Reed Plates for the Harmonica

As for the trombone slides, there exist a lot of different geometrical data for reed plates. Many variants of harmonicas exist on the market today. One example is Hohner's Richter Classic Harp that is 100 mm long, 25.6 mm wide and has a thickness of 0.9 mm. The thickness of a reed plate is generally 0.9 mm but Hohner's 270 Deluxe Chromatic Harp has a 1.2 mm thick brass reed plate that gives a full, powerful sound.

Brass is the general material used for the reed plates and there exist different types of brasses as well. One example is CuZn37 that has a hardness that is

[151] https://www.tonewood.sk/15.php?od=4&avail=22&ia=1, 2007-06-29

[152] http://www.violins.ca/fittings/endpins/endpins_cello_bass_professional.html, 2007-09-24

about 150 HB. The raw material price of brass is currently 46.65 SEK/kg [153], and the density is 8500kg/m^3. One reed plate therefore weighs around 20 grams which can be calculated from the density and the size parameters.

The cost for a harmonica differs a lot depending on the quality. The prices ranges from one hundred to ten thousand Swedish crowns.[154]

6.9 Manufacturers for the Chosen Parts

This section will include large manufacturers present on the music instrument market today, but presentations of the manufacturers interested in this project, in one way or another, will also take place. In these descriptions general information will be followed by data over for example production sizes.

6.9.1 Trombone Slides

The impact of lower priced imported instruments has led to consolidation within the industry, leaving Conn-Selmer, Yamaha and Jupiter as the top three remaining competitors.[155]

Yamaha Corporation

One of the largest manufacturers of musical instruments is the Yamaha Corporation. They started to produce musical instrument, high quality reed organs, for over a hundred years ago. Over the years they have grown to become one of the most successful manufacturers of musical instruments in the world, and are today manufacturing practically every existing instrument on the market. Yamaha's headquarter is still located in Japan. They have a network of subsidiaries and joint ventures located in around 20 countries in the U.S., Asia, the Pacific and Europe. Their manufacturing facilities are spread over 15 locations in 7 different countries.[156]

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[153] http://www.tibnor.se/C1256EF1005D76CD/0/55BB7FE0ED3077C3C1256EF1007200E8?open&overridehref=/nep/nepnews.nsf/news/5140A30E8B9D7668C1257146002AF97B%3Fopendocument, 2007-07-03

[154] www.musikborsen.se, 2007-09-25

[155] Steinway Musical Instrument Inc, *Annual Report*, 2006

[156] http://www.global.yamaha.com/about/index.html, 2007-06-07

Conn-Selmer
Conn-Selmer has three of the largest U.S manufacturers of orchestral instruments, United Musical Instruments, Selmer and G. LeBlanc. These companies include large trombone brands such as Conn, King and Bach.[157] Conn-Selmer manufactures instruments in ten facilities located in the U.S. and one in France. It also enjoys an extensive relationship with a variety of suppliers from around the world.[158] Their sales of woodwind and brass instruments accounted for 67 % of the orchestra division revenue in 2006. Historically, over 80 % of the orchestra sales have been in the United States but they believe in a growth in both the Asian and the European markets.

Jupiter
Jupiter is still producing their brass instruments in their own factories located in China and Taiwan. Jupiter began in 1930 in Taipei, Taiwan, when its parent corporation opened an educational products company. Today they are still mainly producing instruments for the school and educational segment but they have upgraded instruments as well.[159]

Lars Gerdt AB
Lars Gerdt is a small Swedish manufacturer of trumpets, situated in Stockholm, which just started manufacturing trombones. They have expressed there keen interest in a collaboration, even though they understand that their modest annual production size is too small for Sandvik. They have started drawing the tubes in brass and have enlightened us with all the problems arising with this operation.

6.9.2 Endpins for the Cello/Contrabass

It has proved to be quite tricky to find information about different endpin manufacturers. Cello retailers gave examples of endpin manufacturers that they order from but no information was found about either Stahlhammar or Ullsperger Musikzubehör.

Les Bois d'Harmonie
Twenty years ago, Eric and Francoise Fouilhe, founded les Bois d'Harmonie, which is an enterprise that produces accessories for stringed instruments. They

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[157] http://www.steinwaymusical.com/, 2007-06-08
[158] http://www.conn-selmer.com/content/about.php, 2007-06-14
[159] http://www.jupitermusic.co.uk/rdas/papp.asp?cmd=FA, 2007-06-11

have clients all over the world and offer everything from simple pieces to finer reproduction pieces and from standard to individual requirements. Their classical endpin is made of carbon fibre with a hard and sharp tungsten point but other model can be found. [160]

6.9.3 Reed Plates for the Harmonica

The harmonica manufacturers are in general located in the United States, Japan and Germany. The most interesting parties will now be briefly described.

Hohner Musikinstrumente GmbH

Hohner, founded in Germany, is a world leading company with a yearly production of 1 Million harmonicas, meaning 2 Million reed plates, which is their most significant product. The harmonicas are still completely handmade, produced in Trossingen, Germany, and live up to the high expectations from the market.[161]

Suzuki Musical Instruments

The Suzuki Corporation is a large manufacturer of musical instruments, founded in Japan. It was established in 1953 and the first musical instrument made by Suzuki was the harmonica. Today, Suzuki has the most technically advanced harmonicas in the world. Their assortment ranges from casual player harmonicas to world top harmonicas.[162]

The company has grown tremendously and has evolved into the world's largest manufacturer of musical instruments for education. They are today manufacturing just about every instrument on the market. They are an international manufacturer with major production facilities in Japan, Korea, China and the United States.[163]

Lee Oskar

Lee Oscar was born in Copenhagen in 1948. He was one of the founding members of the jam band WAR, and he got his first solo album in 1976. He wanted to play a harmonica that had higher quality than the ones on the market and decided to partner with Tombo, one off the oldest and most respected harmonica manufacturers in the world. The Lee Oskar Harmonica

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[160] http://www.harmonie.net/us/index.html, 2007-08-07

[161] Mattias Keller, R&D Manager, Hohner Musikinstrumente GmbH

[162] http://www.suzukimusic.com/harmonicas/about_suzuki/, 2007-05-28

[163] http://www.suzukibandinstruments.com/about.php, 2007-06-07

was born in 1983 as a result of Lee's ideas and Tombo's manufacturing process, and is today one of the largest harmonica brands.[164]

Tombo Musical Instruments Ltd

Tombo has a history in the harmonica business of 90 years since it was established in 1917. The quality of the harmonicas produced with Japanese craftsmanship and esteemed tradition is highly valued by players all over the world. They are continuously advancing towards further quality upgrading in close association with harmonica players around the world. Tombo has an existing production size of 600.000 harmonicas which can be interpreted to about 1.200.000 pieces of reed plates. They produce their harmonicas in brass, but it is originally combined with several materials. Since they are located in Japan they currently have problems with shipping costs, right materials- they want special and original ones which at the moment is a problem for them to get, due to production size. However, they express their willingness to change if any company can solve these problems.[165]

C.A. Seydel Söhne

C.A Seydel is a German company and the world's oldest harmonica company. They have been producing harmonicas since 1847. Seydel wants to produce harmonicas for the individual customer and they have a yearly production of around 50 000 harmonicas (100 000 reed plates). The possibility to order different custom tunings is upgraded.[166]

[164] http://www.leeoskarproductions.com/, 2007-07-12

[165] Mr Yasuharu Mano, R&D Manager, Tombo Musical Instruments Ltd

[166] Mr Lars Seifert, Managing Director of Operations, C.A. Seydel Söhne GmbH

7. Analysis

In this part of the thesis, the analysis tools presented in the theoretical framework and the information presented in the previous two chapters will be used to form a trustworthy analysis based on the authors' interpretation of the results.

7.1 Strategy at SMT

The subject of this thesis concerns a niche market. When evaluating whether or not to enter such a market it is important to estimate if Sandvik can offer considerable superior solutions than the existing ones. This since it is in line with Sandvik´s strategy to offer value added products and outstanding customer relations, to enable a higher price-setting.

An analysis of how the five forces framework can be used to fit SMT's organisation and strategies will first be made, followed by a consideration of the strategic position that SMT should try to obtain if entering a new market. The potential and market of the three remaining parts will then conclude this part of the analysis.

7.1.1 Entry Barriers

Sandvik need to have an established contact with a company if they are going to invest heavily in research and development. This is needed since they operate in close contact with their customers to enable producing a material that fulfils all of the customers' demands and wishes. Sandvik is prepared to take the expenditures for the research if they have established such a relationship with a certain customer.

How SMT perform faced with the six entry barriers is described below and presented in Figure 53. A green dot indicates that SMT has no problem overcoming that barrier, a yellow dot point out that efforts need to be made in order to overcome the barrier, but that it is not a severe problem, whereas a red dot means that it is a very hard barrier to defeat. Figure 53 also gives the reader a clearer overview of which part that has the best chance of succeeding in overcoming these barriers.

1. Economies of scale

SMT do not have to produce in larger scales since they are focusing on becoming the supplier of only one manufacturer. SMT can offer their product to a higher price, and consequently not obtain a cost disadvantage, since the product they will be offering will have outstanding and one-of-a-kind properties and produced in close contact with the customer. The relation to this barrier of entry is the same for all of the remaining parts, and the dots are consequently green.

2. Product differentiation

Since SMT will offer a product that will be differentiated and will provide the customers with extra value, SMT will be in the position of being able to overcome customer loyalty to other brands. Their strategy has always been to be first in an industry and that will be the case with these three products as well.

- The *trombone inner-slide* is currently made of chromed nickel-silver and there does not exist a trombone slide made of stainless steel on the market presently.
- *Endpins* exist that are made of both stainless steel and titanium. The steel used for the endpins are currently very heavy and do not possess the superior properties that SMT's materials do. The preferred materials used for the endpins today are titanium and especially carbon fibre but they are both very expensive and these products' adjustability is limited. Since this makes it less differentiated this dot is yellow.
- The *reed plates* are generally made of brass, which is a fairly soft material. There is a need for a material that is both more durable and more corrosion resistant than brass.

3. Capital requirements

High investments in research and development need to be made in order to produce a material with all of the desired properties the customers demand. SMT have the capital needed and initiates new research projects on a regular basis. If the selected parts will become new research projects depend on their likely profitability and how well they fit SMT's strategies and material solutions. However, the needed capital to start whichever project, if chosen to do so, exists, which is the reason as to why all of the dots are green.

4. Cost disadvantage independent of size

This is a barrier that is hard to enter for many companies, since the established companies often have access to the best raw material sources, proprietary technology, favourable locations and patents. However, this is not the case for SMT. They have considerable material knowledge, access to the best raw material, production units, distribution centres and sales departments spread all over the world to enable easy supply of material to practically every country in the world. Since they do not want to imitate an already existing product they will not have any problems with existing patents. As a consequence, the dots are green for all parts.

5. Access to distribution channels

SMT have access to distribution channels through their customers. SMT only produce products if they have a contact with a direct customer. In this case, SMT currently have contact with three reed plate manufacturers (Hohner, Tombo Musical Instruments and C.A. Seydel Söhne) but efforts need to be made to get direct contacts with trombone and endpin manufacturers. Thus, it can be seen in Figure 53 that the last two parts get a yellow dot.

6. Government policy

Since SMT already have access to the raw material needed and follow the standards and rules that are set up by the government, they do not have any problem to produce material for the musical instrument industry. The first effort to enter that industry has already been made when SMT started the research project with the guitar strings. As a result all dots are green.

	Trombone Slide	Endpin	Reed Plate
1. Economies of Scale			
2. Product differentiation			
3. Capital Requirements			
4. Cost disadvantages independent of size			
5. Access to distribution channels			
6. Government Policy			
Ranking	**2**	**3**	**1**

Figure 53 the Entry Barriers that SMT have to Overcome

How the existing suppliers of material will react when a newcomer enters their industry are of course significant to have in mind. However, it is hard to see that they will pose a serious threat, since SMT have, when entering a new industry, established a close contact with a customer and offer superior service and a product that is extremely hard to imitate.

7.1.2 Suppliers and Buyers

A supplier is powerful when the product they are offering is unique. As mentioned before, it is only interesting for SMT to enter niche markets if they can offer superior products with a significantly increased value for the customer. This is one of the reasons for the initiation of SMT's new pricing strategy. They set a price not only depending on the material cost. The benefits received by the customer also play an important role in SMT's price setting. The product made by SMT should enable the customer to set a higher price toward their end-customers. The general way to split the profit is to divide it 50/50. The dots for the price competition are red (Figure 54) since SMT will offer a higher price towards the customer. However, it is not to forget that the customers may be able to set a higher price towards their customers as well.

Other aspects that make SMT a strong supplier is that they have a well-known

brand, offer high-quality products and outstanding service to its customers. These facts are concluded in Figure 54 and show green dots regardless of product.

The results obtained from the questionnaires was that the reed plate manufacturers saw supplier relationships and price as the least significant parameters influencing them when choosing what material to use, and quality and durability was the most important factors. Even though the manufacturers of the other two parts, the trombone inner-slide and the endpin, were more or less unanimous in their answers regarding these parameters, too few answers were gathered and no significant contacts were established. The dots for those two parts are therefore yellow (Figure 54) both regarding bargaining power and changing suppliers, since more effort must be made to get a clear view over these situations.

	Trombone Slide	**Endpin**	**Reed Plate**
SMT as suppliers			
Price competition			
Quality			
Service towards the customer			
Bargaining power			
The potential customers willingness to change suppliers			
Well known brand/ Good reputation			
Ranking	**2**	**2**	**1**

Figure 54 SMT's Power as Supplier

SMT is a strong buyer since they have a good cooperation with their current suppliers. None of the three selected parts demand any extensive changes and the existing contact with SMT's suppliers can remain the same (Figure 55). Subsequently there are no barriers to overcome and the dots are green for all three parts.

SMT as buyers			
Relationship with suppliers			
Changes			
Ranking	**1**	**1**	**1**

Figure 55 SMT's Power as Buyer

7.1.3 Substitutes

SMT's product will enter the instrument market as a substitute product. In order to be a successful substitute product it must be cheaper to purchase or have better quality and value adding features. The three different parts will now be studied in detail (Figure 56).

The information obtained from Figure 56 is that both the trombone inner-slide and the reed plate have obvious problem with its current material. Changing material can be a solution to these problems and the perceived value would augment significantly, whereof they get a higher ranking than the endpin, which is made of a high-end material. However, this makes the endpin very expensive and the final product is not adjustable.

	Trombone slide	Endpins	Reed Plate
Current best solution	An inner slide made of chromed nickel silver	A carbon fibre endpin that is light and provide an excellent sound	Reed plates made of a brass alloy
Features SMT's substitute product can bring	An inner slide that are more durable and that does not buckle as easily Wear from the friction between the two slides will be reduced Added value for the customers in terms of a superior relationship	A cheaper material An adjustable endpin made of a material that is as light as carbon fibre Added value to the customers in terms of a superior relationship	A reed plate made of a material that is more durable A product that is corrosion resistant Added value to the customers in terms of a superior relationship
Ranking	**1**	**2**	**1**

Figure 56 Features Offered by the Substitute Product

7.1.4 Industry Rivalry

Access to information regarding the companies that are suppliers to the instrument manufacturers are very limited since the manufacturers do not want to share that information. The general opinion received from the manufacturers is that the cooperation with their current suppliers is not hard to break if a better alternative is offered. The concentration of the manufacturers producing the different parts are therefore of most interest for SMT, since they offer a close contact with one large customer. SMT always want to create a good cooperation and offer the customer something the other companies on the market do not have. It is therefore important for SMT to find a customer that

holds a large part of the market. Analysis regarding the different market sizes will be described under chapter 7.2.2 Estimation of the Market and Sales Potential

7.1.5 Obtaining a Strategic Position

It has now been analysed if the entry barriers are hard for SMT to overcome and if the three parts have the potential of becoming successful substitute products or not. SMT's relationships with their current suppliers have been analysed, as well as the potential relationship they might initiate with an instrument manufacturer. Now an analysis regarding which strategic position that fit SMT the best will take place.

Since it is not in line with Sandvik's strategy to enter a market with low prices, the no frills, low price and hybrid position strategies will not be considered. The choice stands between the differentiation and the focused differentiation position strategy. However, since SMT want to be able to set a higher price than its competitors, in view of the fact that the solution SMT is offering should bring a significant higher value, the focused differentiation strategy is chosen. This position fits Sandvik strategies the best. The focus is on a market segment where SMT can offer a product with high quality, value-added benefits and great service. The target customer has the will-power and capability to pay a higher price for the received befits. The risk with this strategy is that the reached segment might be to narrow. A more comprehensive analysis of the different parts' markets and the market that SMT has the potential to reach will be described in chapter 7.2.2 Estimation of the Market and Sales Potential, where the market potential will be analysed.

7.2 The Potential and the Market of the New Product

This section will provide an analysis of the potential of a future product produced by SMT and an estimation of the three different parts' markets. The market size is of high importance when deciding weather or not to invest in a project.

7.2.1 The Potential

The benefits, the changes in comparison to the existing products and the risks

the new product that might be produced by SMT have, are concluded in Figure 57. If the relative advantages of the three parts are compared to each other, it is found that the trombone inner-slide and the reed plate have advantages that better suit SMT than the advantages of the endpin, for the same reasons that are described in chapter 7.1.3 Substitutes. The reed plates currently possess an additional benefit since contacts with direct customers have been initiated.

	Trombone slide	**Endpin**	**Reed Plate**
Relative Advantage	More durable product with less wear caused by friction	Cheaper and adjustable product	More durable and corrosion resistant product
Compatibility	The changes will not be enormous so the market should adopt the new products fairly easy		
Risks	Since SMT will invest in R&D a contact with a direct customer need to be established to reduce the risk taking	Since SMT will invest in R&D a contact with a direct customer need to be established to reduce the risk taking	Contacts with direct customers have been established but need to be maintained in order to reduce the risk taking
Ranking	**2**	**3**	**1**

Figure 57 the Potential of a New Product

When the adoption process of SMT's strings for the guitar is completed, they ought to compare it to these selected parts to get an understanding of how the industry might adopt them. Since the strings have not been initiated on the market yet and they are the first product SMT produce for the musical instrument industry a comparison will not be made in this thesis. When performing a comparison analysis it is important to keep in mind that two products are never perfectly comparable, but important indications can be received.

7.2.2 Estimation of the Market and Sales Potential

To receive the size of a potential market for SMT several assumptions and estimations will be made. The value of the parts' whole markets, their addressable markets and the weight of the purchased materials will be

illustrated in Figure 58. SMT want to start to cooperate with one large manufacturer per part and not with several manufacturers, so they can offer an outstanding service and tailor-made product to that manufacturer. This is an aspect that will play an important role when the addressable markets will be estimated.

The trombone market

As written in chapter 5.8.8 Wind and Stringed Instruments, the sales of wind and stringed instruments augmented with 7.5 percent to over 1 million units sold in the United States during 2004. It is now assumed that the trend has continued and that the exact number sold during 2004 were 1 million units, which means that 1 242 000 units are going to be sold during the current year, 2007. Out of the total market 37.53 percent were brass instruments. An assumption is moreover made that these shares will stay the same, which means that around 466 000 units of brass instruments is going to be sold during 2007. Chapter 5.8 shows that the United States accounted for 42.7 percent of the musical purchases in 2004 and this statement is believed to stay the same in 2007. This means that the total market for brass instrument will be 1 091 000 units during 2007.

A final assumption need to be made in order to receive the number of trombones that will be sold during 2007. There exist four large groups of brass instruments; the trumpet, the trombone, the tuba and the horn. The total market is divided among these four instruments, which means that 273 000 units of trombones will be sold during 2007.

Many small trombone manufacturers exist but the ones that are of most interest for SMT are the three largest companies (6.9.1 Trombone Slides); Yamaha, Conn-Selmer and Jupiter. Information about their production sizes has not been obtained. Therefore more assumptions need to be made. To estimate the potential size of the market SMT can reach, the total amount of trombones sold will be divided into four. This since it is believed that Yamaha, Conn-Selmer and Jupiter comprise around one fourth each and the smaller companies share the final quarter of the market. The addressable market for SMT is therefore estimated to be around 68 000 units. Chapter 6.8.1 Trombone Slide describes the inner-slide in more detail and it is claimed that a small inner-slide weighs around 90 grams. It is therefore supposed that a mean value of the inner-slide weight is 100 grams. This means that the 68 000 units of trombones weigh around 6 800 kilos.

The endpin market

As described for the trombone market, the sales of wind and stringed instruments augmented with 7.5 percent to over 1 million units sold in the United States, during 2004 (chapter 5.8.5 Wind and Stringed Instruments). With the same assumptions made in the trombone case, the sales of wind and stringed instruments were around 1 242 000 units in 2007. Out of the total market 15.09 percent were stringed instruments. An assumption is made that these shares will be the same, which means that around 187 000 units of stringed instruments will be sold during 2007. The United States accounted for 42.7 percent of the musical purchases in 2004 as mentioned in the previous section. That trend is believed to stay the same in 2007, which means that the total market for stringed instruments will be 438 000 units sold during 2007.

The major groups of stringed instruments are (5.6 Stringed Instruments): the violin, the viola, the cello and the contra bass. The total market for stringed instruments will be divided into two parts. One of the parts concerning the instruments: cello and contra bass, that use an endpin and the other part comprises the violin and the viola. These two parts are 219 000 units large.

Every cello and contra bass player has an endpin. The quantity of new instruments purchased each year are obtained but estimations need to be made regarding how many players that exist and how often they buy new endpins. The answers received from the questionnaires regarding how often the player bought a new endpin were not unanimous. Some players bought a new one every five years, while others just changed endpins once or twice during a lifetime. An assumption is therefore made that a mean value is that a general cello and contrabass player buy a new endpin every ten years.

Since the information about the endpin market is very limited rough theories will be made. It is already estimated that the purchase rate of cellos and contrabasses are 219 000 units annually. Which makes it safe to say that the sales of the endpins are at least 219 000 pieces annually. If this variable is put as x and the amount of cello/contrabass players is put as y, a general equation of how many endpins sold per year should be: $x + 0.1y$, due to the fact that the normal player buys a new endpin every ten years. However, since no information, about how many musicians that exist playing these instruments, has been retrieved, no such equation can be solved. A guess could be made that at least 300 000 pieces are sold every year.

As the authors do not possess any information about the amount of cello players there are in the world the information retrieved that a normal cello player buy one new endpin.

The addressable market for SMT is hard to estimate since none of the manufacturers has shared valid information. Since endpins exist in a lot of different models and materials, it is hard to imagine that SMT can reach more than a tenth (at least 30 000) of the market by just offering a cooperation with one manufacturer. The weight of an endpin varies a lot just since it exists in several shapes and material and will therefore not be calculated.

The reed plate market

The NAMM report did not give much information about the harmonicas. The received information was that the United States imported 377 000 harmonicas and exported 47 000 units (5.8.6). Since this information does not say anything regarding the units sold in other countries another way to estimate the market potential will be used.

One obtained fact is that Hohner produces 1 million harmonicas annually (6.8.3 Reed Plates for the Harmonica). They are, among Suzuki, Tombo Musical Inst. Ltd and Lee Oscar, one of the largest harmonica manufacturers in the world. Tombo Musical inst. Ltd has shared the information that they produce 800 000 harmonicas every year. Since no information is received regarding the other two manufacturers it is assumed that they produce approximately the same amount of harmonicas as Hohner. Smaller Harmonica manufacturers exist as well and it is believed that they comprise one fifth of the market, 950 000 units. This means that the total market for harmonicas is 4 750 000 units, that is 9 500 000 units of reed plates.

SMT prefer to establish a deep relationship with one big manufacturer. The two largest manufacturers that have showed their interests are Hohner and Tombo Musical Inst. Ltd. Hohner are currently fairly satisfied with their reed plates but are open for improvements. Tombo are not as satisfied with their reed plates and might be a better candidate to initiate a contact with. This is assumed since it is believed that it is easier to obtain a larger part of their market share than it is to receive the whole market of Hohner.

Each reed plate weigh around 20 grams (6.8.3 Reed Plates for the Harmonica), which means that Tombo produce reed plates with a total weight of 32 000 kilos.

	Total Market	Addressable Market	Weight sold of the current material
Trombone inner-slide	273 000 units	68 000 units	6 800 kilos
Endpin	>300 000 units	>30 000 units	-
Reed Plate	9 500 000 units	1 600 000 units	32 000 kilos

Figure 58 The estimated market for the remaining parts

7.2.3 Customer Analysis

There are different roles that exist in a purchase situation that are important to have in mind. This subject will not be deeply analysed since SMT do not sell directly to the end-customer. However, since SMT offer high quality materials it can be assumed that the main target end-customer group is preferably the professional musicians. It is believed that a professional musician decides for him/herself which instrument to purchase and that they find quality and acoustic properties more important than price and appearance.

7.3 Concept Sheet

In this analysis a variant of the SMT concept sheet (chapter 6.3.1 Segment and Technology Strategy and Concept Generation) will be made. There is not enough information regarding the wanted properties specifications at this point and it is therefore of no value to complete an entire concept sheet. The three remaining parts will be placed in the project potential matrix (Figure 59), where they are put depend on their value creation

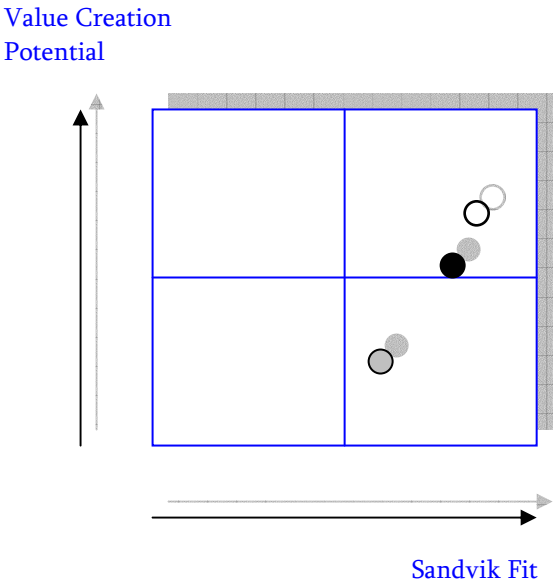

Figure 59 the Project Potential Matrix

potential (what value the innovation has for the customer and the potential of the future market), and how well they fit SMT, concerning innovation possibilities and existing material and production equipment.

The problems with the existing trombone inner-slides fit SMT very well. The current material has first and foremost problems with both buckles and wear caused by friction. A material produced by SMT might be a solution to those difficulties. Tubes for the trombone inner-slide must be produced in different sizes. However, investments need to be made in order to find a material that can be tin soldered. The inner-slide marked black in the concept sheet are therefore put in the middle, horizontally, of the right side. The market for trombones is not as large as first believed. SMT has to consider if it is large enough to invest in. The black dot is therefore put in the middle, vertically.

A lot of materials are used for the endpin today. Both expensive materials such as titanium and carbon fibre are used as well as some kind of stainless steel and regular steel. An endpin with light weight, which is presently obtained by expensive materials, is desired. An endpin that is exchangeable and adjustable is also preferred, which is the case with the heavier materials such as the steels. The innovation possibility for SMT is to produce an endpin that is both light and adjustable. Nanoflex is the most durable and light material among SMT's stainless steels, and might be suitable for this purpose. Efforts need to be made in order to find a direct customer. SMT's market potential for the endpin seems to be smaller than for the other two parts. It is currently roughly estimated and the numbers cannot be completely trustworthy. The endpin, marked grey, is therefore put to the left, in the right bottom square.

The current different brass alloys used for reed plates have obvious flaws. The reed plates need a material that is durable and corrosion resistant. These are properties that many of SMT's materials possess. It is therefore assumed that a strip product, suitable for reed plates, can be obtained from some of the existing alloys. The market share that can be obtained is much larger compared to the other two parts' markets and direct customer contacts have been initiated but need to be maintained. The reed plate, marked white, is therefore put in the right top square.

7.4 Categories of Competitiveness

The most important part, when competing on a certain market, is to identify and understand the demands of that market. Through the study that the authors have performed the demands of the market, in the form of buyers, users and manufacturers of musical instruments, have been acknowledged and documented. A review over the internal resources of Sandvik Materials Technology has also been prepared to ensure that these support how SMT choose to compete on this market.

7.4.1 Weaknesses

To be successful in its strategy it is crucial for SMT to acknowledge its limitations, because how strong a competitor SMT ever might be, there are some obvious weaknesses that they must circumvent. This can be done through creating a strategy that overcomes these weaknesses or shift competition away from these specific factors. In the case of SMT breaking new ground at the musical industry market one weakness is its novice position on this market. Being novice conveys not having a well-known brand within the specific market, which for Sandvik might be curious since they are used to being involved with customers in markets where they have already made a strong name for themselves. Moreover, being novice brings a lack of knowledge about both the specific market and about its customers. The competition may also possess a customer loyalty that SMT as a newcomer lacks (Figure 60).

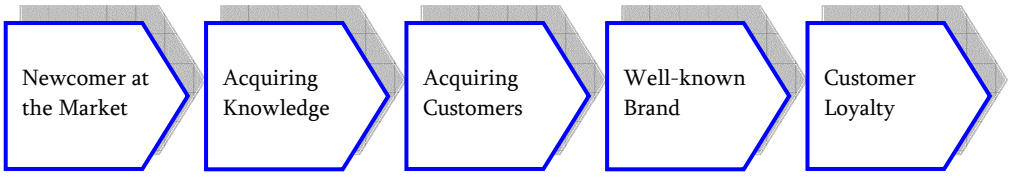

Figure 60 Steps to Gain Customer Loyalty from a Novice Position on the Market

These are the greatest corporate weaknesses that the authors with the help of the empirical studies have identified. To circumvent these weaknesses a strategy must be developed to make them less important to competitive success. However, if treated in the right way these weaknesses could be transformed into strengths. For example, if investments were made to obtain the information needed of the market and its customers, SMT could in its competition with companies possessing high customer loyalty put a higher

focus on what the customer actually demands and customers might be won over. Companies holding loyal customers might become lazy in continuously developing the products to their customers' best interest, since the customers might stay with them regardless of how well the products meet their demands. However, when it comes to winning customers without having a brand to push the products out on the market, a higher effort must be put on identifying the actual demands of the market and its customers, and to not only meet the demands but to exceed these wishes.

Concerning the different selected instrument parts, interesting in this thesis, other weaknesses must be defeated (Figure 61). With the trombone slides, one weakness that can be seen, on the part of SMT, is that the material that the inner slide must be made from has to have the ability of tin soldering. There is currently a lot of research and trials done with soldering stainless steel at SMT. There has been some improvements in the area, however, this research is far from finished, and to be able to manufacture a material that can meet the present demands from the trombone manufacturers, more investments in research, both monetary and time, must be made. Furthermore, this research should preferably be made in close cooperation with a manufacturer, and at present there is only a small Swedish manufacturer who has expressed a keen interest in this project.

Regarding the endpins, the largest weakness is that the manufacturers are difficult to locate and get in touch with. A contact has been established with a French manufacturer, who with enthusiasm has offered their cooperation in the matter, however, with a lot to do; they could not help for the time being. The product per se, is not an intricate item; nonetheless, detailed information is needed to fully understand the market demands.

When it comes to reed plates for harmonicas, the authors cannot see any apparent weaknesses to overpower for SMT. The materialistic properties and the process of making them seems to be very much alike the products and processes already used at the product area of SMT strip. Moreover the reeds fasten on the plate is simply fastened with rivets or bolts, which does not place any strange or high demands on the material in question. Moreover, more than one contact has already been commenced, with manufacturers who have articulated their interest in cooperating towards developing a superior material for their end-products.

There is one weakness that goes for all three areas, which is market size, and potential production and sales volume for SMT, which might be too low. This is a factor that can not be accounted for just yet, however, SMT should be aware of the risk of this happening.

	Trombone Slide	Endpin	Reed Plate
Ability to Overcome Identified Weaknesses			

Figure 61 SMT's Ability to overcome their Weaknesses with the Different Products

Finally, it is important to stress that strengths and weaknesses and the resulting core competencies are relative to the competition and require a clear understanding of both the company's and its competitors' capabilities. Benchmarking is consequently an important tool for SMT, in order to achieve "world class" in all their operations.

These factors form the basis for developing a competitive advantage in the market place. This will now be depicted in the next section.

7.4.2 The Powers of Sandvik

Since SMT already have a focus on advanced materials, strive towards constantly breaking new ground and towards being leaders in new applications, they are already prepared to put the needed attention on the weak corporate areas, identified within this market segment. Their clear customer focus conveys success, since this entails development of competitive and innovative solutions based on a close and creative relationship with already targeted customers.

Since SMT have chosen to keep all **strategic** operations within the Group it provides a great advantage compared to the competition since SMT when having developed a new product are fairly immune to copies. When being a world-leader they will always stand by their word, towards the customers, that they will strive to continually seek solutions that provide optimum quality, availability and cost-efficiency. This power is of great interest for the contacted manufacturers of reed plates, as for those of trombone slides and endpins (Figure 62).

	Trombone Slide	Endpin	Reed Plate
Accordance to SMT strategy			

Figure 62 the Accordance of Each Product to the SMT Strategy

Since the ambition is to only focus on segments where they have an opportunity to be world-leaders, the project needs to go through all the different steps in the lean product development system before the decision is taken if there actually are incitements for SMT to commence the project. However, it could also be useful having business in such an industry as the musical instrument industry since different business cycles provide SMT with a smaller risk of fluctuations. Nonetheless, great effort must be put on the business case to assure that the right projects with the right requirements, such as high profitability and market share, will be focal points in the organisation, and in the R&D department.

As with all new projects, the basis of the **R&D investments** is to have direct contact with the market. Several reed plate contacts with the market have already been established. Moreover, these contacts have acknowledged their problems and uttered their interest in cooperating with SMT in a potential future project. Additionally, only a modest stake of investments is needed, since the desired material should be something that in some form already exists within SMT strip, and the processes and tools used for the manufacture of the product is something that SMT have existing, deep and explicit knowledge about. As for the other parts, more investments must be made, not only on account of learning more about the wanted material but of acquiring customers needed to get a hold of this desired information, to be able to assure themselves, that the material will perform as intended when applied by the end user, which is the reason to make the dots for endpin yellow (Figure 63). Since there is an additional need for research in tin soldering stainless steels regarding the trombone slide, this dot is marked red.

	Trombone Slide	Endpin	Reed Plate
R&D investments needed?			

Figure 63 the Figure Shows if the Part Need Much, Little or No Investments in R&D

Building strong **customer relations** is crucial for the success of SMT. This factor is another reason to why an apparent customer focus is so important in the organisation, and therefore also a requirement when starting a new project.

Relations with correctly targeted customers should be established and nourished through really listening to and not only meeting but exceeding the customers' demands and wishes. The ambition of Sandvik is namely to always offer their customers an added value, which, in the case of reed plates, can be interpreted in offering the customers a material that has a longer life duration and higher corrosion resistance. The same value concerning the endpin is to offer the customers a product that improves the musicians' work environment and the quality of the instrument's sound. Whereas the added value with trombone slides is to offer a material that withstands bumps and that has a high resistance to wear, however, this must not be made on the expense of an excellent glide between the slides. Since customer contacts are only established with reed plate manufacturers the other dots are yellow (Figure 64).

	Trombone Slide	Endpin	Reed Plate
Investments in Customer Relations			

Figure 64 the Need to Invest in Customer Relations

SMT's utilisation of, and know-how about, increasingly advanced techniques and instruments has provided them with great in-depth knowledge about various materials, combinations of different materials and their respective properties. This knowledge is invaluable in the efforts to develop new and even better materials for their customers, old as new, and makes it easier to believe that they will succeed in most projects that they decide to implement. This can therefore count as an advantage on SMT's part if and when they decide to commence a new project regarding one of the products proposed in this thesis (Figure 65).

	Trombone Slide	Endpin	Reed Plate
Advantage of Current Know-how			

Figure 65 the Advantage of Know-how of Materials and Processes

Quality is one of the factors that seem to be critical for the success of SMT in this thesis. Regardless of which instrument part that has been under investigation, one of the highest material properties desired has been quality. Quality is something that SMT is continuously seeking to increase, and is currently one of the key initiatives in their strategy, which has made the cost

of non conformance the lowest ever. This is of course highly desirable when taking on new businesses, whichever it may be. Another advantage that SMT have is that they use the optimum starting material for each steel type, the latest technologies- as mentioned before- and efficient quality control, which makes it possible for them to control material properties throughout the manufacturing process. Having a comprehensive and long experience, in the manufacture of demanding materials, has made this exclusive control possible (Figure 66).

	Trombone Slide	Endpin	Reed Plate
Advantage of long experience and Quality Control			

Figure 66 Advantage of Possessing a Long Experience in Demanding Materials and Quality

Top delivery performance is the SMT goal regardless of where the customers are located, and with production units and **distribution** centres at strategic locations, the customer is assured to receive short lead times and even immediate delivery in some cases, wherever they are sited in the world. The reed plate manufacturers with which a contact has been established are located in Germany and in Japan, and with a SMT production unit in China and a distribution centre in the Netherlands these customers are located ideally. Most trombone manufacturers are located in Asia, Germany, France and the U.S. and similarly the endpins are mostly manufactured in France, China and the U.S. so distribution wise, all the customers' locations are more than acceptable. Moreover, since the objective is to optimise the distribution channels, SMT will always make an attempt to offer warehousing, cross docking and forwarding services to improve lead times and time to delivery, when they meet important customers in locations that are presently hard to reach. In clarity, that means that no future customers will be discarded only on the basis that their location is "presently unattainable", and this goes for all the three current products (Figure 67).

	Trombone Slide	Endpin	Reed Plate
The Importance of Customer Location			

Figure 67 the Importance of the Customer's Present Location

SMT continuously make **competitor** analysis to be aware of how the market

and the competition develop. None of the existing competitors in stainless steel products have broken these new grounds, interested themselves in the musical industry market which so far has been working to a competitive advantage for SMT. This is also a competence that works as an advantage regardless of which of the three products SMT choose for a future project. Furthermore, as SMT work towards constantly breaking new ground these projects would be in line with their objective (Figure 68).

	Trombone Slide	Endpin	Reed Plate
Powers of the Competition			

Figure 68 the Positive/Negative Impact of the Powers of the Competition

With the **sales** organisation kept in the Group, a better control over the quality of the customer relations can be assured. With sales offices all over the world easy and reliable communication is guaranteed, irrespective of where in the world the customer is positioned and whichever language they would prefer communicating in. This is for the same reason as with the widespread distribution organisation, an advantage irrespective of which of the products that is chosen for a future project. This is illustrated in Figure 67.

Most of the inherent core competencies provide, as presented in this chapter, the same advantages regardless of which of the three possible projects that is chosen. The core competences that, on the contrary, convey dissimilarity between the different products will now be presented together in Figure 69.

	Trombone Slide	Endpin	Reed Plate
Ability to Overcome Identified Weaknesses			
R&D investments needed?			
Investments in Customer Relations			
Ranking	**3**	**2**	**1**

Figure 69 Ranking of the Compatibility with SMT and the Sandvik Fit

7.4.3 Marketing Assets

When it comes to the marketing orientation of SMT on this specific market, SMT do not share the product orientation since they want to produce custom designed products for their potential future customers. This study started with a pure marketing orientation in the sense that SMT thought the musical instrument market was attractive and wanted to investigate this market without knowing anything about their long-term ability of serving it. An asset-based approach could in the continuation be interesting since it attempts to match the assets or the core competencies of the organisation to the needs and wants of its chosen customers. In Figure 70 these choices are illustrated, the product orientation is discarded, and is therefore red, while it started out in a market orientation and ended up with an asset-based marketing orientation, which will now be proved.

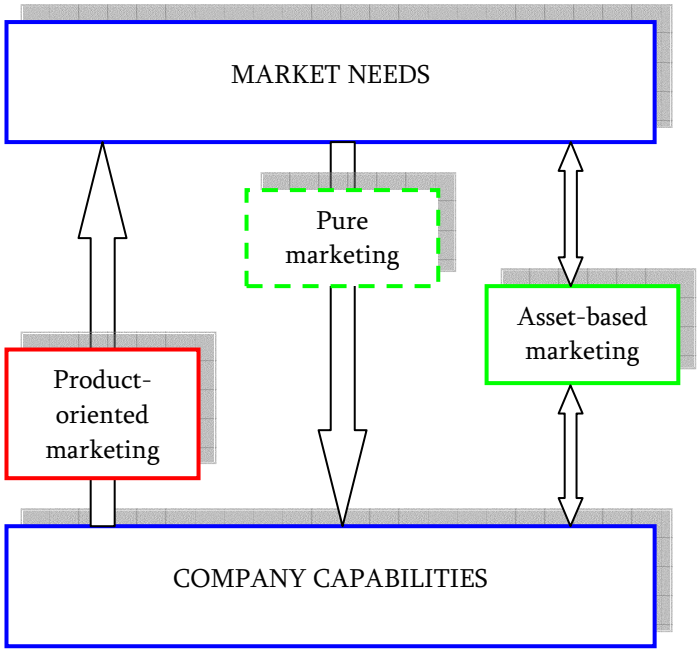

Figure 70 Chosen Approachs to Marketing

The most important and visible assets valued by the potential future customers of SMT are superior products when it comes to meeting their demands in quality and performance. These entail, in addition to the obvious one – quality, having a superior R&D organisation that work in close cooperation with the customers.

Distribution-based assets could contain the ability of SMT to deliver in time, and faster than the competition. Moreover, the capability to increase the convenience of use and guarantee supply of the desired product can be major assets. Since SMT have retained their distribution organisation within the Group, the team work provides a well-planned distribution network. They also have distribution centres strategically located which enhances their chance of reaching their potential customers quickly. Moreover, even though their knowledge about this specific market currently is on a need-to-know basis, they have an exclusive knowledge about producing steel, which will be a major asset in responding quickly, at no compromise to quality, to the market's demands. Conserving the sales organisation in the Group also support and reinforce these advantages.

Since SMT have no existing customer-base within this market segment, internal assets are such as cost advantages, technological skills, production expertise and patents, which are assets that SMT use regularly and successfully. Their expertise in both technology, and production and R&D of stainless steels make them a world-leader in the steel business and there are only few who can compete with their excellent knowledge.

7.4.4 Order Winners versus Order Qualifiers

There were a couple of basic conditions, recognised by the authors in the empirical studies, that Sandvik need to fulfil when competing on this market. When in the process of finding these criteria, the market was divided into segments whereof each segment was one of the chosen instruments: the trombone, the cello, and the harmonica. As learned previously these order qualifiers vary depending on segment and customers. However, as seen in this study, the segments differ but the customers are the same – manufacturers wanting their instruments to function, without changing the acoustics, to a reasonable price. Consequently the common order qualifiers are acoustic properties, easily played instruments and to the right price.

These are factors that SMT only need to be as good as their competition in providing. However, to obtain competitive advantage they need to be better than the competition in providing order winners, which are the criteria that tip the scale in SMT's direction. Through the process of identifying these criteria SMT got a better knowledge of the market. Each one of the criteria will presently be specified and the direct and end customers will be identified.

Representative customers/manufacturers have been chosen for the specific products in each segment and production size and sales volume have been noted for each customer. The direct customers were in this case the manufacturers of the selected instrument parts, and the end customers are the relevant musicians. From the empirical studies a number of order winners could be identified for each segment.

For all the chosen parts, the found order winners are superior properties in acoustics and materials. That is, to be able to win orders from the customers SMT must sell value added products to a reasonable price. Moreover, to sell products in a quantity that is in line with what the customers want could also be an order winner. Additional order winners can be found under the next chapter since there has been an assumption that order winners in this sense can be interpreted as critical success factors.

7.4.5 Critical Success Factors

A great focus was also put on the reasons why a customer would choose the SMT product over another already existing one, to guarantee a successful approach / marketing strategy.

It is crucial to a company's success to correctly identify the critical success factors that will provide differentiation between SMT and other potential providers. The differentiation should be in areas that the customers particularly value.

The threshold factors or the product requirements needed solely to be a part of the industry in question are somewhat different for the various parts. With the trombone slides, one major threshold is that the material used must hold the ability to be tin soldered to the other material used in the tubing and the bell, without any unwanted chemical or physical processes occurring. When it comes to the endpin one threshold factor is that it needs to be made so that it is easily adjusted to the height of the musician playing the cello, moreover it must not get stuck in the cello. A threshold factor concerning the reed plates is the order size, since many of the manufacturers want a high-end material but buys in order sizes, not currently accepted on the market. This conveys that they end up with materials not possessing the desired properties. This could also be counted as a critical success factor.

When it comes to the parameters affecting musicians' and manufacturers'

choice of material when buying a new instrument or for a part of an instrument a discussion will be held about critical success factors instead. The different parameters and their relative average answer for musicians and manufacturers are illustrated below, in Figure 71 and Figure 72. The numbers for the manufacturers of the trombone inner-slide and the endpins will not be presented in such a form, although the content can be found in 6.6.5 Brass Instruments and 6.6.6 Stringed Instruments. Following, the analysis of these will take place. The answers are on a scale from 1 to 5 where 1 represents a parameter that affects the musician or manufacturer very little when buying a new instrument or a new part for an instrument while 5 represents a parameter that affects them very much.

Mean **Musicians**	Price	Quality	Appearance	Brand	Acoustic Properties
Trombone Slides	2.1	4.9	1.5	3.6	4.9
Endpins	2.6	4.7	3	1.4	4.2
Reed Plates	1.6	5	1	4.2	3.2

Figure 71 the Weighted Impacts of Different Parameters on Musicians

Manu-facturers	Price	Q	Appea rance	Dura bility	Acoustic Props	Mtrl Props	Supplier Relations	Market Demands
Reed Plates	3.3	5.0	3.5	5.0	4.0	4.3	2.0	4.3

Figure 72 the Weighted Impacts of Different Parameters on Manufacturers

Critical success factors for SMT are those criteria that will make the customers choose an SMT product instead of the products that are already on the market. This entails being so good that a customer will consider changing suppliers and thereby leave already established relationships where high loyalty may be considered a barrier, which even more stresses the importance of fulfilling these requirements. In the performed investigation questions were posed to understand what impacts there are on musicians and manufacturers when buying or manufacturing the musical instrument or its accessory. Moreover the interviewees were asked to rank different properties of a material in their instrument.

With trombone slides the critical factors that SMT should strive to fulfil, in order to succeed in their quest of winning over customer, is partly to make a material that is less sensitive to bumps, which would be interpreted into possessing a higher tensile strength than the current material, which is nickel silver or brass. The other part is to prevent wear caused by friction between the slides, which can be interpreted into providing the customers with a material that has higher resistance to corrosion. These improvements will enhance the quality of the product but must be made without any negative impact on the acoustics. However, the customers have noted that price is not an important factor which is positive. This means that if SMT can develop a material that meets these demands but with a higher price than today, customers are prepared to pay that higher price for the value that SMT added for them. Other properties that the material must have are hardness, at least as high as the normally used chromium plating, and a need to glide as easily as chromium against the outer slide. The material should also be of an even quality and of fine tolerances.

To be able to compete and to assure that the SMT material for endpins will be a success on the market there are some factors and requirements that need to be met. A lot of complaints about the weight and rattling sounds have been noted, which means that being able to provide a material that is light but strong and that directs the sound down, towards the floor, would be two important factors for winning orders from customers. Moreover, already existing light endpins made of titanium or carbon fibre have other problems such as the inability of extension and excessive pricing. The quality of the endpin should therefore be enhanced; however, it must not be done on the expense of the desired level of the acoustic properties. Then and only then, the customers could be persuaded to try the new material.

Critical success factors that SMT must see to, concerning reed plates, is firstly to provide the customers with a material that have superior corrosion resistance than the existing solutions in brass. Moreover problems have been noted of exhaustion, so a higher durability should also be possessed by the new material solution. Thus, the most important factor to be addressed is quality. Price and appearance are not of great significance for the customers which is an advantage since a reed plate in a Sandvik stainless steel, would both change appearance and have a higher price, nonetheless bringing a guarantee of the preferred higher quality. The questionnaires did not show any reluctance of choosing a new material, which also works to SMT's advantage. Other important features that the material must possess are long life duration and being easily milled

and cut. Some of the manufacturers complained about not being able to order materials that they prefer because of small order sizes, in this case a major critical success factor would be to offer these customers the material they want in the order size they desire. Price is not an important factor, nor is existing supplier relationships, which are two aspects that could support the success of SMT.

Interesting and important for SMT when entered this new market is to keep a close watch on the current CSFs and threshold factors, because in an ever changing industry with new products entering continuously, new CSFs enter and competition to deliver these features arise. A former CSF can all of a sudden be seen as a threshold factor instead.

8. Conclusion

The final recommendation will be illustrated and highlighted in this part of the thesis. Moreover, there will be a discussion about recommendations for future investigation and future potential markets.

8.1 Recommendations for SMT

It is believed that sufficient knowledge is achieved from the analysis chapter to enable making a strategy plan that will fulfil the purpose of the thesis. Various analysis have been made throughout the thesis and the three parts; the trombone slide, the endpin and the reed plate, were found to be the most promising pieces that had obvious flaws with its current material. A conclusion of the results from the analysis will be presented as well as a suggestion for future strategies and for how SMT should continue with the information gained from the thesis.

Throughout the analysis it has been argued that the establishment of a close contact with a direct customer is crucial if SMT is going to be a successful player. It has been elucidated that SMT has the resources, both regarding material knowledge and financial assets, to be able to develop a new material that will have a higher quality than the existing ones.

8.1.1 The Trombone Slide, the Endpin and/or the Reed Plate

The analysis chapter made it clear that the reed plate is the part with the most potential for SMT. A lot of different analysis tools pointed in the same direction. The reed plate either showed the best result in each analysis method or was equal to the other two parts. The results gained from the analysis chapter are summarized in Figure 73 below. The numbers are put out to get a clearer overview of the parts potential. The three parts have been ranked from 1 to 3, where 1 implies that the part best suits SMT's strategies and requirements.

	Trombone Slide	Endpin	Reed Plate
Entry Barriers	2	3	1
Suppliers	2	2	1
Buyers	1	1	1
Substitutes	1	2	1
Potential of a new product	2	3	1
Obtainable market size	2	3	1
Concept Sheet	2	3	1
Compatibility with SMT and the Sandvik Fit	2	2	1
Total Ranking	**2**	**3**	**1**

Figure 73 Summary of the Results from the Analysis Chapter

It is here evident that the reed plate is the part that is the likely best product to start a research project on. The recommendation the authors want to give to SMT is that they continue to follow up the initiated contacts and evaluate if the reed plates can be a profitable project. This does not mean that the other two parts, the trombone slide and the endpin, should be rejected. But since it is time consuming to collect information, develop a new product and to maintain a close contact with a customer SMT's resources should first and foremost be put on the reed plates. When and if the project has been initiated and an estimation of its future potential have been made it might be an idea to follow up the trombone slide and the endpin segments as well. Conclusions about the three parts will be discussed below.

The trombone slide could be a profitable product for SMT. It is not to forget that even though the market is smaller than the harmonica market, a trombone cost significantly more than a harmonica. This means that SMT can set a higher price and thereof recieve high returns. The trombone market has a need for a material that is more durable, meaning that it does not get buckles and wear caused by friction so easily. The challenge is here to develop a material that has properties so it can be tin soldered, which is a necessary requirement. There is currently only one direct contact with a manufacturer and this is a small manufacturer located in Sweden. But this manufacturer can help SMT develop a material that is suitable for a trombone slide. Efforts need to be made in order to get in contact with larger manufacturers for this segment to be profitable.

The endpin is a product that SMT can make adjustable and in a better material that the existing stainless steels, which are currently too heavy, but still in a

cheaper material than the excellent carbon fibre. The con with this part is that it is believed that there exist many small manufacturers which make it hard for SMT to just establish a direct contact with one manufacturer to enable volumes that are high enough to be profitable. It is not in line with SMT's strategy to cooperate with many small manufacturers since it is harder to offer exclusiveness and a superior collaboration. However, a French manufacturer has showed its interest but further investments must be made to get in contact with more manufacturers.

The third remaining part, the reed plate, is the product that seams to be most successful for SMT to start a project on out of these three parts. The question that need to be answered is if is profitable for SMT to initiate a project for producing a material for the reed plates. The existing reed plates have several problems with its current material. A product developed by SMT can therefore offer added value to the manufacturer as well as to the end customer. There have not been found any difficulties for SMT to produce a suitable material for this part as for the case with the need of tin soldering the trombone slide. Contacts have furthermore been initiated with interested customers. The reed plates are from the markets point a very interested product to start a research project on. The addressable market size is estimated to be 32 000 kilos which is large enough to be profitable for SMT but might be smaller that other possible projects SMT can initiate in other areas. This is a decision the management at SMT must take when they compare this product to other possible projects they can put in their portfolio.

8.1.2 Strategies for the Future

This thesis will be a ground for further examinations and a decision for starting a research project. The first action SMT should do is to follow up the initiated contacts that have been made with a few reed plate manufacturers. It is recommended that SMT first get in contact with Tombo Musical Inst, which is a harmonica manufacturer that currently has problems with the material they use for their reed plates. As claimed in the analysis chapter, it is believed that SMT has a higher chance to supply Tombo Musical Inst. with material to their whole material need for their reed plates than to gain the whole material supply of Hohner. Hohner is however a second alternative since they also have showed their interest for a cooperation. They are nevertheless pretty satisfied with the material they use today and a cooperation with SMT would probably only lead to change of material in some of their harmonica models.

The cooperation that SMT should offer to Tombo Musical Inst. must be preferable for both parties. The focused differentiation strategy was argued, in the analysis chapter, to be the most suitable strategy for SMT to use. If SMT decide to invest in this project their research should lead to developing a material that is superior the existing ones, which can lead to increased profits for the customer. It is therefore a fair deal that SMT set a high price since they supply a high quality material developed with the customer's demands and wishes in mind. This service SMT offer their customers is also a reason for setting a higher price.

8.2 Recommendations for Future Investigations at SMT

In this section an effort will be put on describing the areas in which the authors believe a profit could be made after additional investigation and hence retrieving supplementary input from the market and its customers, which at present is lacking in this project.

8.2.1 Stands

Some studies have been made and input has been obtained from different orchestra workers who in their daily work carry around all the stands for the musicians of all the different instruments in a symphonic orchestra, and the stands for their music sheets. A request was made of making these parts in a lighter material but with the same strength and stability as the currently used material, which more than often is carbon steel.

8.2.2 Drum Parts

Even though the authors had to discard the different drum parts in this thesis on account of a lack of interest from manufacturers, a strong complaint about the existing weak and low-quality materials was expressed from musicians, store assistants and local drum enthusiasts. Moreover, a demand for better materials and parts of higher quality was put forward by the same customers. This implies that if a relationship can be established with a drum manufacturer of high market share an investment and focus on this project would be sure to be a success. Moreover, since the drum market is much larger than the investigated parts' markets this would actually be to prefer.

8.2.3 Guitar Frets

Even frets are recommended to have another look at, at a suitable time. This is a part of obvious corrosion problems and even though there currently are frets on the market made from some kind of stainless steel. SMT employees are certain that their materials are of superior properties than the existing ones, not only superior in corrosion resistance but in tensile and fatigue strength as well. A contact has already been initiated with a U.S. manufacturer of frets. This manufacturer is currently already producing frets in stainless steel; however, if SMT can provide them with a material with these superior properties a project might be able to be instigated.

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Mattias Keller, R&D Manager, Hohner Musikinstrumente GmbH

Pasi Kangas, Sandvik Materials Technology, Manager- Project and Product Development

Yasuharu Mano, R&D Manager, Tombo Musical Instruments Ltd

Appendix I – Musician's Questionnaire

Instrument Player:	**Date:**

This investigation is made by Sandvik Materials Technology, with the purpose to map the current musical industry to see if there is any possibility to improve some part of the instruments after your and the manufacturers wishes.

A current-state investigation about musical instruments

1. How long have you been playing this instrument?

2. Which group do you belong to?
Mark the alternative that is most correct in red.

- ❑ Kids between 12 and 20 years
- ❑ Parents of kids between 12 and 20 years
- ❑ Professional musicians
- ❑ Institutions such as churches, schools and nightclubs
- ❑ Adult amateur players
- ❑ Other _____

3. Have you had any problems with this part of your instrument?
Mark the correct alternative in red

❑ Yes	❑ No
	❑ Do not know

If answered yes, describe the problem:

4. Does the acoustics change when this part is worn out?
Mark the alternative that is most correct.

❑ Yes	❑ No
	❑ Do not know

Motivate your answer and if answered yes, try to describe how:

5. How often do you change this part of your instrument?

6.

a) How much do these parameters affect you when buying this part of your instrument?
Mark the alternative that is most correct in red. (1- do not affect me, 2- very little, 3- little, 4- much, 5- very much)

Price:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Quality:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Appearance:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Brand:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Acoustic Properties:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Other_____

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

b) Rank the alternatives from 1 to 6 after how important you think they are when buying this part of your instrument.

___ Price
___ Quality
___ Appearance
___ Brand
___ Acoustic Properties
___ Other_____

Do you have any comments to add?

7. Would you buy this part of your instrument made in a different material than you are used to?
Mark the alternative that is most correct in red.

❑ Yes ❑ No
❑ Maybe

Motivate your answer:

Appendix II – Manufacturer's Questionnaire

Manufacturer:	**Date:**

For manufacturer of this part of the instrument.

This investigation is made by Sandvik Materials Technology, with the purpose to map the current musical industry to see if there is any possibility to improve some parts of the instruments after your and the end-users wishes.

A current-state investigation about musical instruments

1. For how long have you been producing this instrument?

2. What parts of the world do you sell to?
Mark the alternative/alternatives that are correct and rank them after sales volume.

- ❑ ___ Europe
- ❑ ___ North America
- ❑ ___ South America
- ❑ ___ Asia
- ❑ ___ Australia
- ❑ ___ Africa

3. What is your annual production size of this instrument?

4. What is your annual production size of this part of the instrument?

5. Which are your main target groups?
Mark the alternative/alternatives that are correct and rank them after size.

- ❑ ___ Kids between 12 and 20 years
- ❑ ___ Parents of kids between 12 and 20 years
- ❑ ___ Professional musicians
- ❑ ___ Institutions such as churches, schools and nightclubs
- ❑ ___ Adult amateur players
- ❑ ___ Other _____

6. Do you have any problems with this part of the instrument today?
Mark the correct alternative

❑ Yes	❑ No
	❑ Do not know

If answered yes, describe the problems:

7. Which materials do you use for this part of the instrument today?

8. What advantages can you see with these materials?

9. What disadvantages can you see with these materials?

10.

a) How much do these parameters affect you when choosing which material to use for this part of the instrument?
Mark the alternative that is most correct. (1- do not affect me, 2- very little, 3- little, 4- much, 5- very much)

Price:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Quality:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Appearance:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Durability:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Acoustic Properties:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Properties; easily worked etc.

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Supplier Relationships:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Wishes from the Market/Musicians:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Other _____

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

b) Rank the alternatives from 1 to 9 after how important you think

they are when choosing which material to use for this part of the instrument.

___ Price
___ Quality
___ Appearance
___ Durability
___ Acoustic Properties
___ Properties; easily worked etc.
___ Supplier Relationships
___ Wishes from the Market/Musicians
___ Other_____

Do you have any comments to add?

11. Have you considered changing material for this part of the instrument?
Mark the alternative that is most correct.

❑ Yes ❑ No
❑ Maybe

Motivate your answer:

12. Can you consider changing material for this part of the instrument?
Mark the alternative that is most correct.

❑ Yes ❑ No
❑ Maybe

If answered no, motivate your answer:

If answered yes or maybe, describe what would make you change material:

Appendix III – Store's Questionnaire

Store:	**Date:**

For Sales Personnel of This Part of the Instrument

This investigation is made by Sandvik Materials Technology, with the purpose to map the current musical industry to see if there is any possibility to improve some parts of the instruments after your, the manufacturers and the end-users wishes.

A current-state investigation about musical instruments

1. For how long have you been selling this instrument?

2. What is your annual sales volume of this instrument?

3. What is your annual sales volume of this part of the instrument?

4. Which are your main target groups?
Mark the alternative/alternatives that are correct and rank them after size.

- ❑ ___ Kids between 12 and 20 years
- ❑ ___ Parents of kids between 12 and 20 years
- ❑ ___ Professional musicians
- ❑ ___ Institutions such as churches, schools and nightclubs
- ❑ ___ Adult amateur players
- ❑ ___ Other _____

5. Do you see any problems with this part of the instrument today?
Mark the correct alternative

❑ Yes	❑ No
	❑ Do not know

If answered yes, describe the problems:

6. Do the acoustics change when this part is worn out?
Mark the correct alternative

❑ Yes	❑ No
	❑ Do not know

Motivate your answer:

7. Which materials are used for this part of the instrument today?

8. What advantages can you see with these materials?

9. What disadvantages can you see with these materials?

10.

a) How much do these parameters affect you when choosing in which material to buy this part of the instrument?
Mark the alternative that is most correct. (1- do not affect me, 2- very little, 3- little, 4- much, 5- very much)

Price:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Quality:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Appearance:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Durability:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Acoustic Properties:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Properties; easily worked etc.

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Supplier Relationships:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Wishes from the Market/Musicians:

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Other _____

❑ 1	❑ 2	❑ 3	❑ 4	❑ 5	❑ Do not know

Do you have anything to add?

b) Rank the alternatives from 1 to 9 after how important you think they are when choosing in which material to buy this part of the instrument.

___ Price
___ Quality
___ Appearance
___ Durability
___ Acoustic Properties
___ Properties; easily worked etc.
___ Supplier Relationships
___ Wishes from the Market/Musicians
___ Other_____

Do you have any comments to add?

11. Can you consider buying this part of the instrument in another material?
Mark the alternative that is most correct.

❑ Yes ❑ No
❑ Maybe

If answered no, motivate your answer:

If answered yes or maybe, describe what would make you change material:

Appendix IV – Organisation Charts Showing the Selection Process

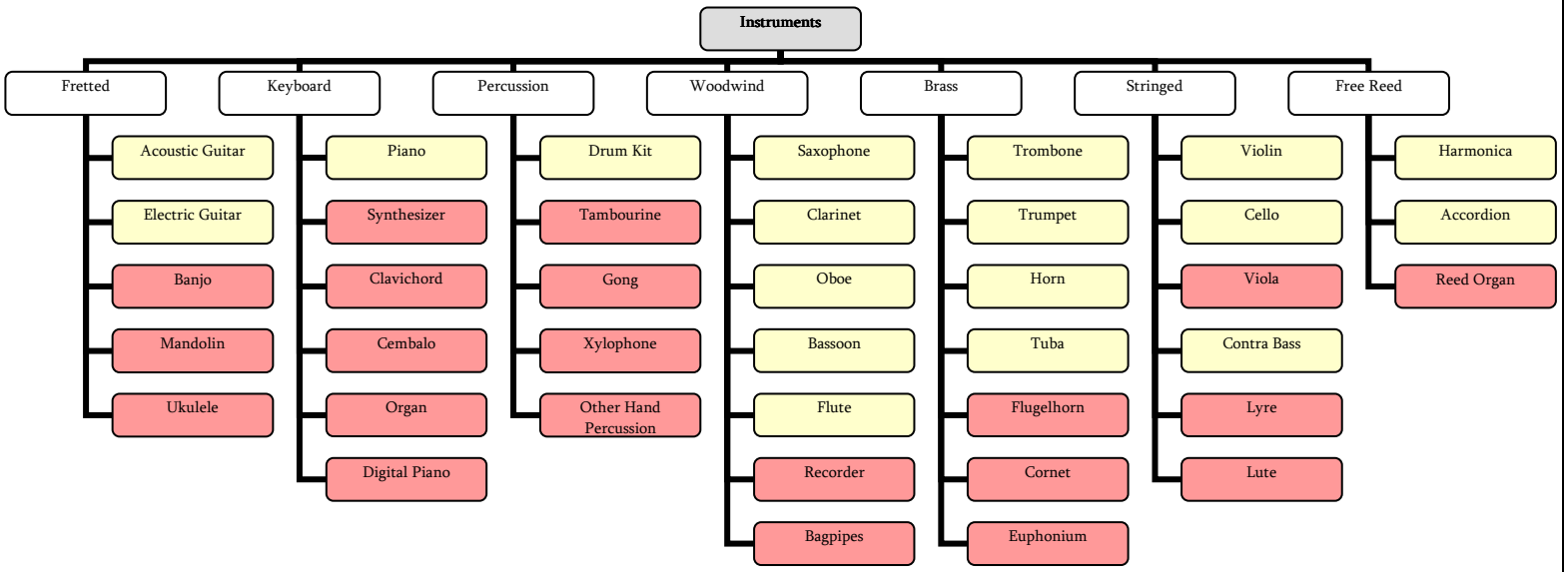

Figure 1 Initial limitation – which instruments to include in the mapping section (Chapter 5)

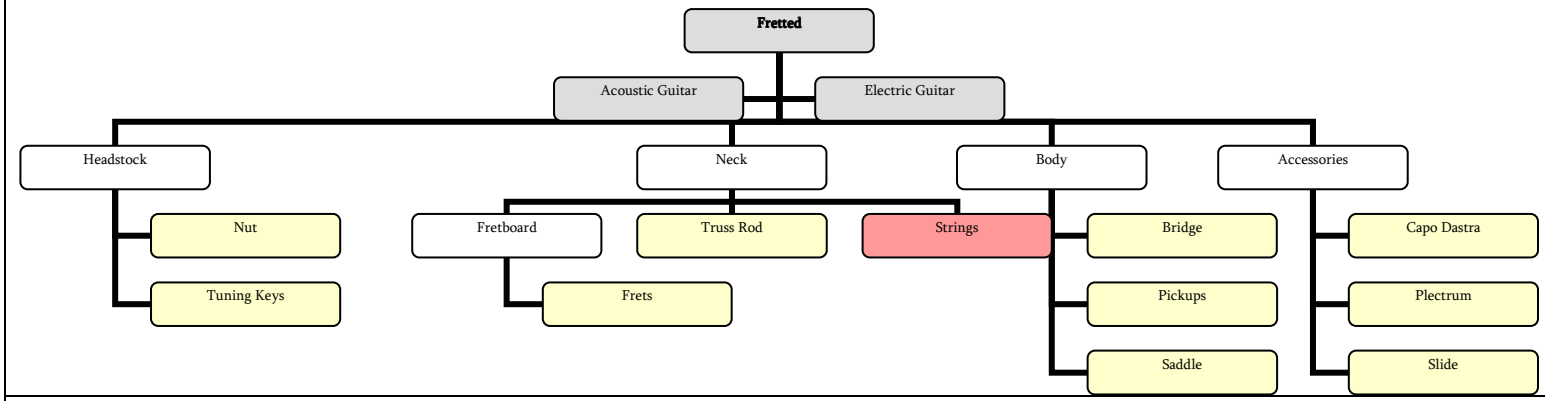

Figure 2 Initial map of potential guitar parts (5.1.1)

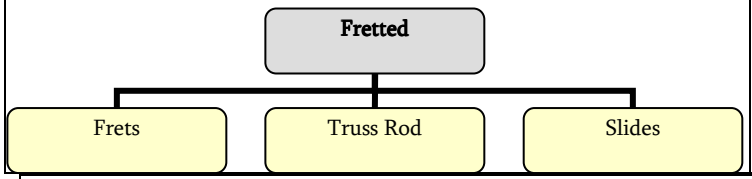

Figure 3 Potential parts after the initial selection process (6.1.3)

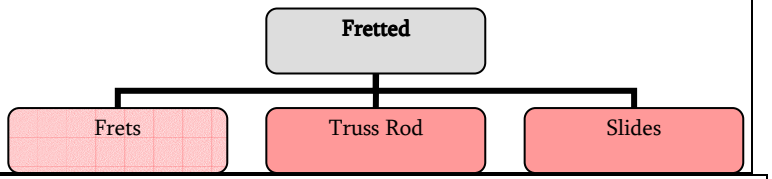

Figure 4 Result after selection Process II (6.7.1)

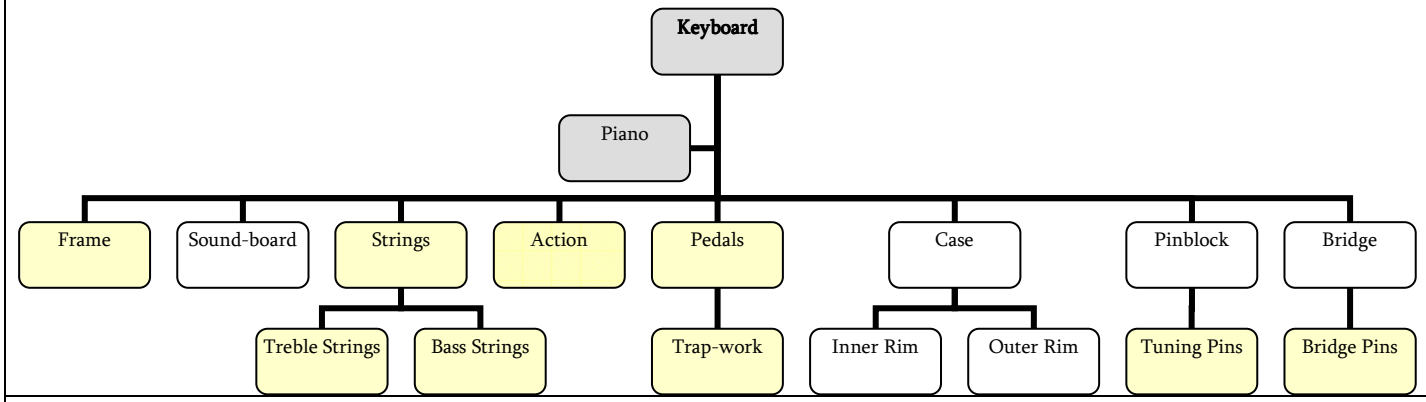

Figure 5 Initial map of potential piano parts (5.2.1)

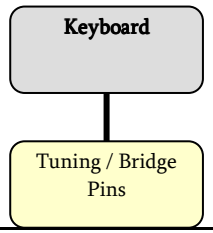

Figure 6 Potential parts after the initial selection process (6.1.3)

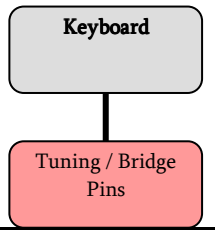

Figure 7 Result after selection Process II (6.7.2)

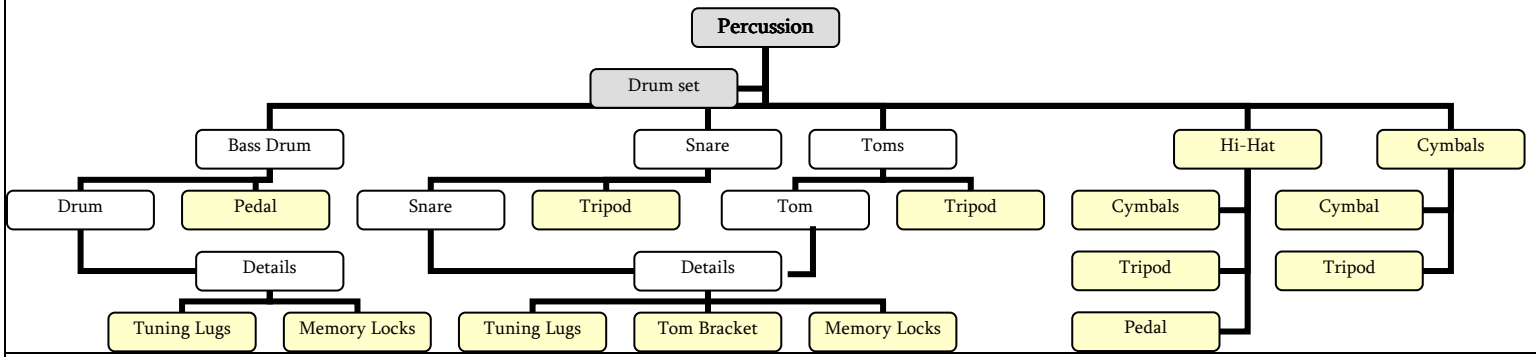

Figure 8 Initial map of potential drum parts (5.3.1)

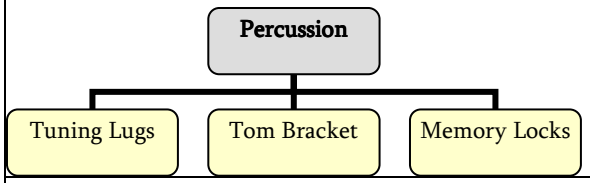

Figure 9 Potential parts after the initial selection process (6.1.3)

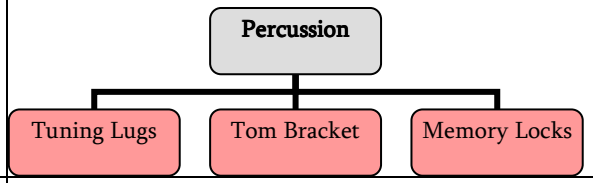

Figure 10 Result after selection Process II (6.7.3)

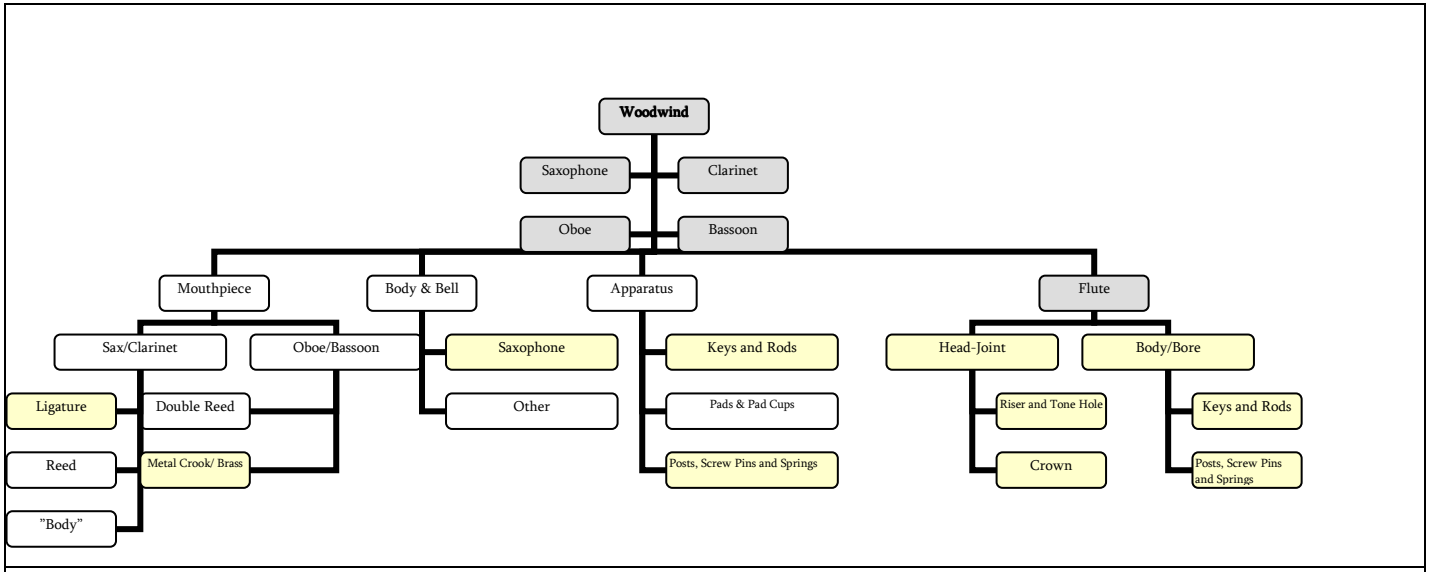

Figure 11 Initial map of potential woodwind instrument parts (5.4.1)

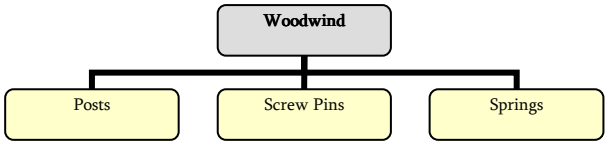

Figure 12 Potential parts after the initial selection process (6.1.3)

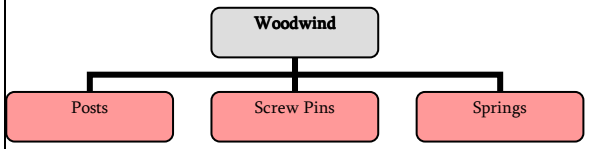

Figure 13 Result after selection Process II (6.7.4)

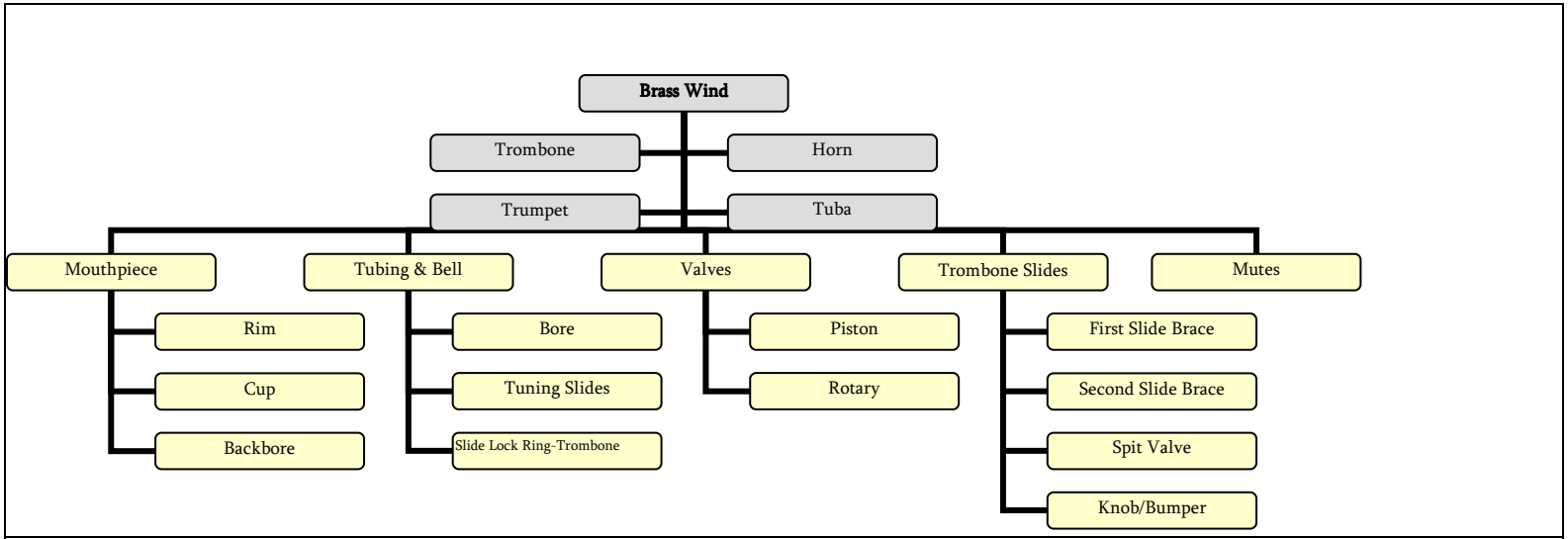

Figure 14 Initial map of potential brass instrument parts (5.5.1)

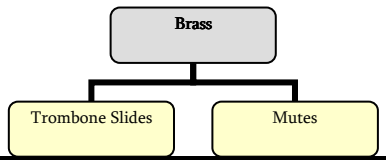

Figure 15 Potential parts after the initial selection process (6.1.3)

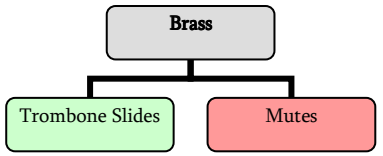

Figure 16 Result after selection Process II (6.7.5)

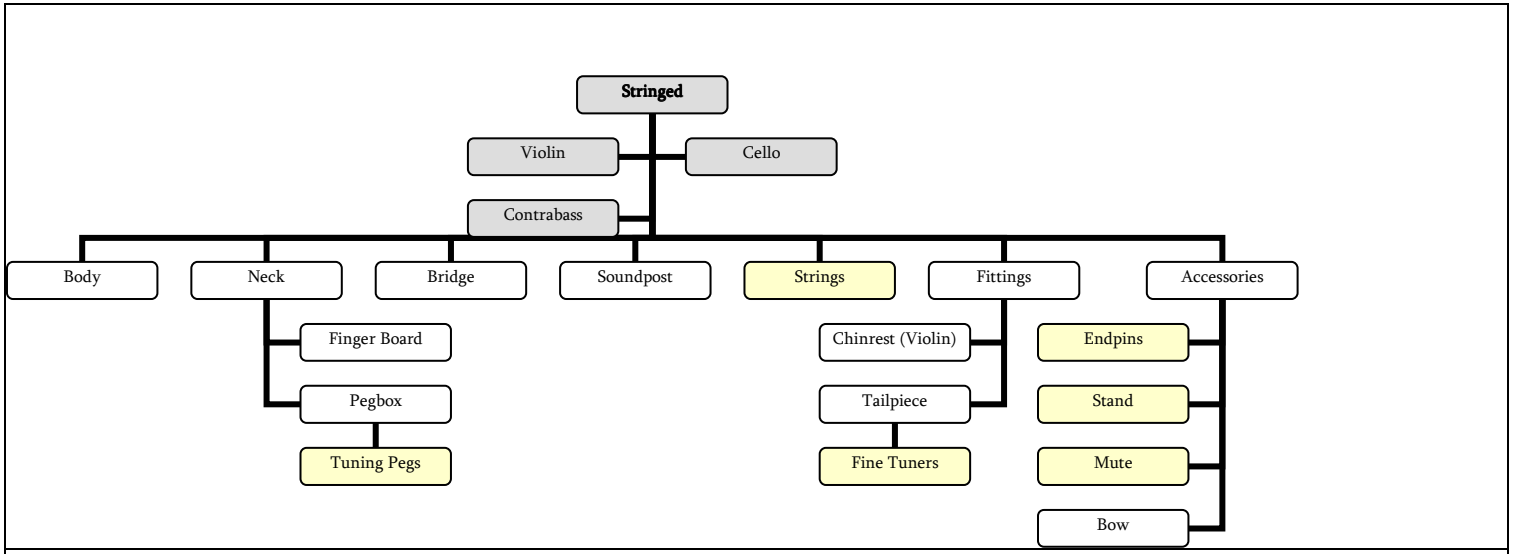

Figure 17 Initial map of potential violin parts (5.6.1)

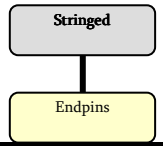

Figure 18 Potential parts after the initial selection process (6.1.3)

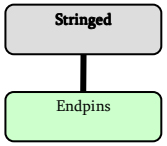

Figure 19 Result after selection Process II (6.7.6)

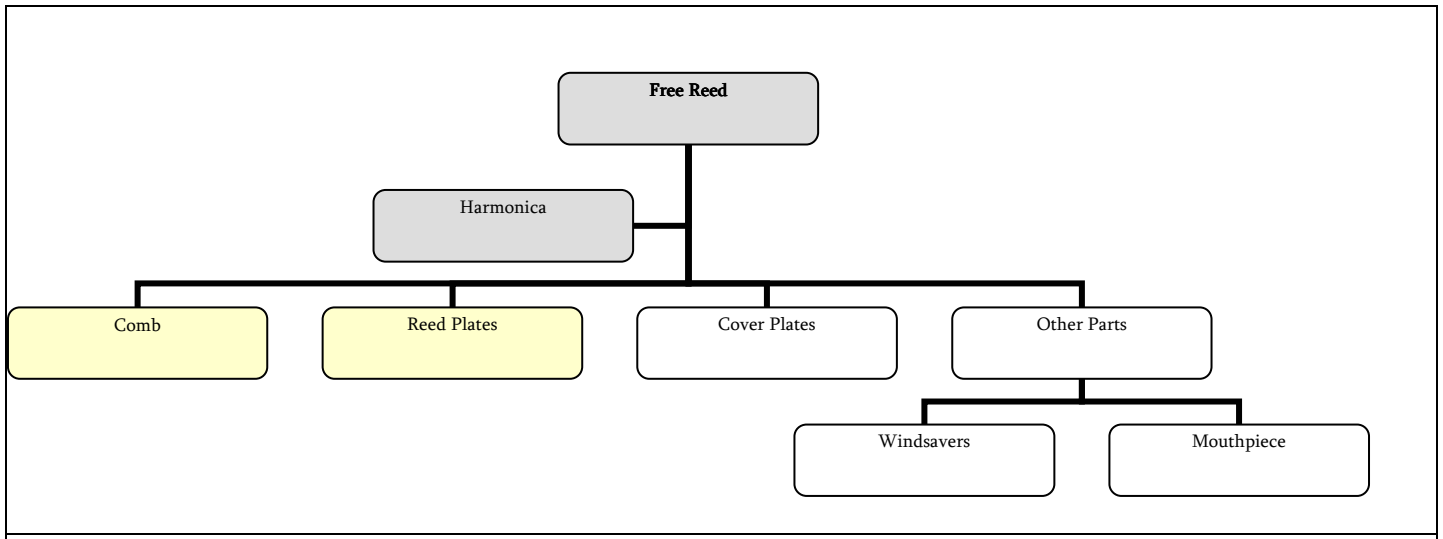

Figure 20 Initial map of potential parts for free reed instruments (5.7.1)

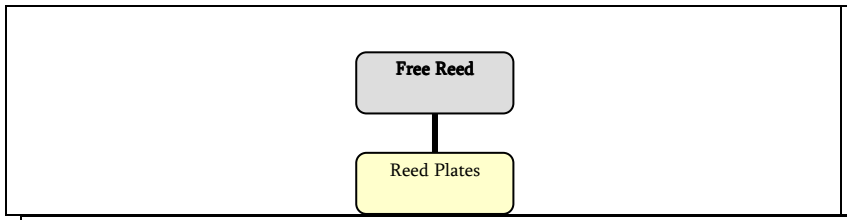

Figure 21 Potential parts after the initial selection process (6.1.3)

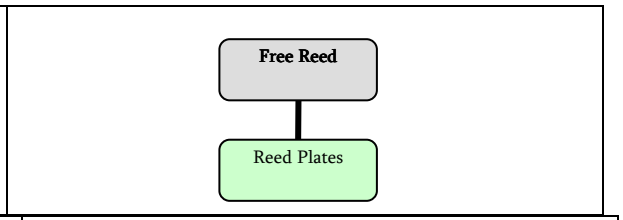

Figure 22 Result after selection Process II (6.7.7)