

# Effective Handheld Knife sharpening System for Professional and Amateur chefs.

Efektiivne noa teritusvahend amatöörkokale.

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# Author's Declaration

I have written the Master's thesis independently.

All works and major viewpoints of the other authors, data from other sources of literature and elsewhere used for writing this paper have been referenced.

Master's thesis is completed under ..... supervision

// 2016 Author ..... signature

Master's thesis is in accordance with terms and requirements

// 2016 Supervisor ..... signature

Accepted for defense  
..... chairman of defense commission.

// 2016 ..... signature

# Master's Thesis Objective & Task

2015 / 2016 academic year, 5th semester  
Student: **Arda Semsettinoglu**, 130532MADMM  
Field of study: **Design & Engineering**  
Supervisor: **janno nõu**

Master's Thesis Topic: **Knife sharpener design for chefs with using innovative material and technique.**

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Tasks and timeframe for their completion:

<b>Nr.</b>	<b>Task Description</b>	<b>Completion</b>
<b>Date</b>		
1	RESEARCH AND PROBLEM OPPORTUNITY and POTENTIAL ELECTRONICS and ENGINEERING	
2	CONCEPT GENERATION REFINEMENT DEVELOPMENT	
3	DESIGN PRELIMINARY DESIGN DEVELOPMENT PRODUCT-SERVICE RELATIONS ENGINEERING DETAILS BUSINESS-BRAND	
4	FURTHER DEVELOPMENT CONCLUSION	

Design and Engineering problems to be solved:

**The objective of this thesis is to investigate knife sharpening systems for the chefs, Research investigate knife sharpening basic informations , knife types, abrasives, sharpening equipment's and sharpening products and user needs**  
**The aim is to develop a effective sharpening solution for chefs that sharpen their knife in the kitchen**

Defence application submitted to deanery not later than ? Deadline

Student: Arda Şemsettinoglu ..... Date:

Supervisor: janno nõu ..... Date:

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*Abstract: This research about knife sharpening systems and designing new sharpening solution for chefs. Research investigate knife sharpening basic informations , knife types, abrasives, sharpening equipment's and*

*sharpening products. Interviews are supporting literature review and reveal customer needs and thought. As a result of research new sharpener system designed with using all outcomes.*

## 1) INTRODUCTION:

The knife was an important tool for survival since early man. It plays very important role in some cultures through ritual and superstition. Because of that Knife making and sharpening technics are old and fundamental practice. Even people are using the knife every day these practices passed along enough to the large section of the modern society. Superstitions and wrong practices are still common in that field and researches limited.

Sharp knife still one of the mysteries for many people. Peoples are sharing sharpest knife videos every day but sharpening is not popular as much. Factory edges of knives are around 50 degree which is the edge of the limit between sharp and dull knife. Companies using those angles to stay knife edge longer but it also mean that customers never experienced really sharp knife even if it is new. However when the case comes to companies high-end knives, edge angle lower than 50 and it creates the perception on the user that that knives are sharper and they deserve to be expensive. It is one of the illusions the companies are using these days. Rather than material and edge, there aren't any difference between knives to effect sharpness so if the metal same they can be sharp as expensive one. Differences between price tag just coming from sharpening.

All the facts that pointed out the importance of knife sharpening but at the same time how it is making wrongly. In this research knife sharpening process is going to be investigated in literature review part and customer research part, results from the research will be converted in new design solution for sharpening systems to revitalize them.

One of the main motivation makes this research is 3M lapping films. Lapping film is using in fiber optic cable edge sanding. However using lapping films in sharpening is new for that area. Lapping films have similar or better grit size as other sharpening materials. In this thesis feasibility and implementation of sharpening is going to research.

## 2) METHODOLOGY:

Due to process depend on the scientific methods we more focus on the literature review in our thesis. Sharpening basics, proper techniques, abrasive materials, sharpening equipment's and sharpening devices are going to be investigated by helping scientific data and professional practices. Traditional practices and scientific data are compared to relief truth. Limitations and Abilities of Abrasives and sharpening equipment's are going to be defined. A literature review is going to include sharpening basics which are the initials for sharpening technique.

Customers' opinions about different sharpeners are investigated by online website reviews. Positive and negative reviews are helped to understand advantages and disadvantages of products. Market price index

investigated by searching local shops and websites. Market positioning made by this information to identify product targeted customers.

Questionnaire tried to support information and understanding customer opinions deeply, however, it's failed to reach targeted customer. Because of that interviewing used rather than a questionnaire. In interviewing part, I talked with 4 professional chefs, 2 students studying in gastronomy field and one food Passions who took some cooking courses. The answers and important point in the interviews are recorded for using in design development.

Also, observation method used for visiting knife makers town in Turkey. That town has been producing own steel because of that it was good opportunity to see how sharpening effect knife quality and value. During observation, we figure out some important mistakes which are also recorded also.

### 3) RESEARCH:

#### 3.1) Literature Review:

##### 3.1.1) Introduction to Knife Sharpening:

###### 3.1.1.a) Definition of the Sharp knife :

Sharp knife can be described as, the less effort required to cut with it the cleaner and smoother the just-cut of surface. (Hock 2010)

Even different type of sharpness testers exists .there isn't any standards or units for describing sharpness degree of the knife. Commercially available testing systems typically involve using the test blade to cut through successive layers of abrasive material to evaluate how well a blade will hold an edge. (McGorry et al. 2005).

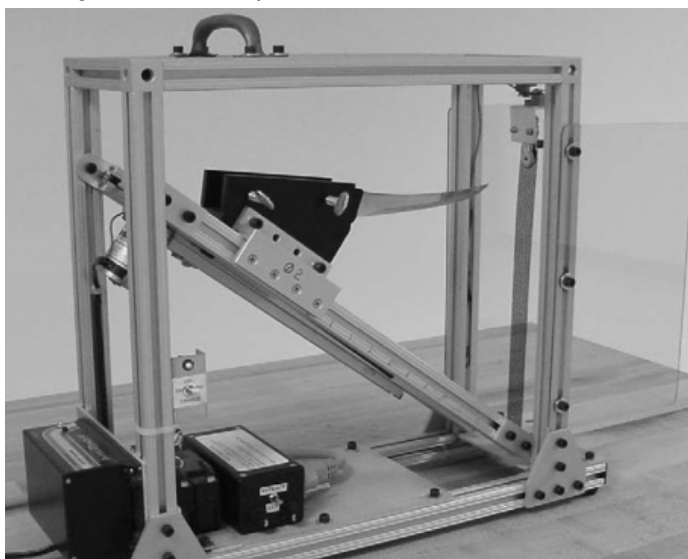


Figure 1 Sharpness Testing Machine

As shown in the figure 1 these machines are simulating only one direction of cut with one type of material. According to Juranitch (Juranitch 1985) : "In numerous cases knife will cut differently in different materials. For instance, an edge that feels super in cutting leather may not feel so great when you're cutting meat. As Hock State: "A blade is sharp when it cuts what it is supposed to cut according to the specifications of the person doing the cutting" (Hock 2010)

### 3.1.1. b) Difference between sharp and dull knife:

Perfect Sharp edges requirements can be described with two parameters ,correct intersection angle between two faces and polish degree of surface quality(Hock 2010).

These two are the main parameters to differentiate dull knife and sharp knife.

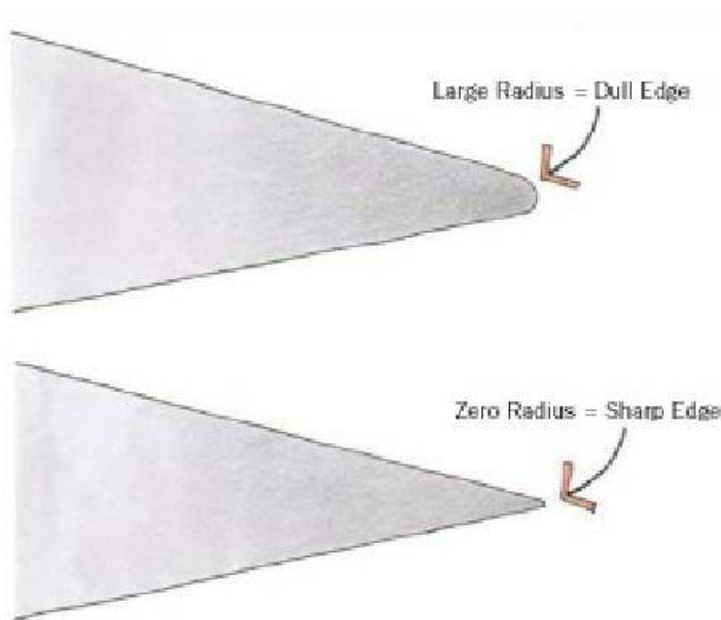


Figure 2 sharp and dull edge

Zero Radius edge intersection is theoretically describing sharp edge however due to knife made by molecules it's just phenomenon. For instance If that edge is honed as close that zero radius, the edge became sharp as it can be (Hock 2010). Oppositely when the radius increasing during time knife become duller and losing sharpness

### 3.1.1. c) Knife Edges

#### 3.1.1.c.1) Edge types:

Common kitchen knives on focus of our research have been flat ground that blade tapers directly from the spine to the edge. Occasionally Hollow ground, convex ground and saber ground blades used in kitchen knives (Ward 2003). Figure 3 shows the most common edges in kitchen knives. Double beveled edge is going to be main focus of this research topic due to most commonly using in western knife however the product which will be designed at the end of research is the cover all knife type, so authors are going to take into consideration other types of knife requirement while designing.

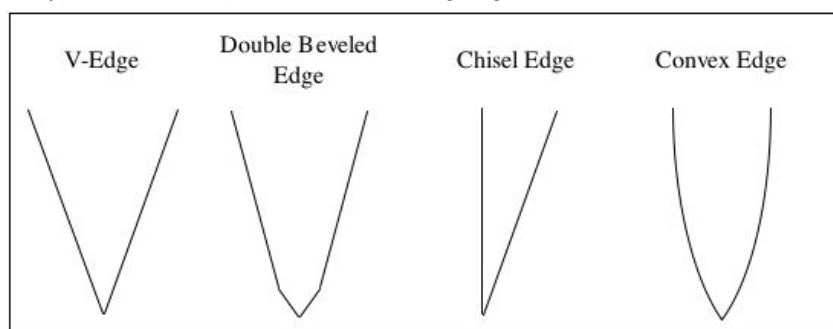
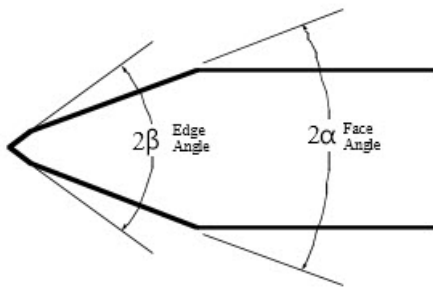


Figure 3 Common kitchen knives Edge types





**Figure 4 Double bevel edges**

A double bevel Edge: These kind of knives have two specific sharpening angles. Grind angle for major face is named to alpha also called as back bevel or relief angle and final angle named to beta. (Verhoeven 2004)

The aim is to add thin, acute edge behind cutting edge(B) in order to create greater cutting ability but at the same time due to major cutting edge is narrow than B its protecting to knife to impact, chipping or rolling. According to Juranitch (Juranitch 1985) : "This is foolproof method of sharpening.

Other advantage of this edge over V shape edge, It is not getting thicker during re sharpening If following sharpening angle.

### 3.1.1.c.2 ) Edge angles

The force is reduced the sharpening angles and the knife thickness are decreased. Because of these sentences perfect knife can be understood that knives have a smallest cutting angles and thinnest blade however there is an opposite factor depend on the use of application this can cause plastic deformation due to mechanical stresses. (Verhoeven 2004) This is also reveals why commercial knives are waives sharpness with standardized thick 50 degrees edge to extend product lifetime. (Ward 2010)

Part of knife sharpening experts reject to giving exact angle for application. They claim it should be define by experiments. In an article by Verhoeven (Verhoeven 2004) , recommended angles for applications these are:

Blade	$2\alpha$	$2\beta$
Razors for shaving*	11-12°	15-19°
Knives for kitchen* and filleting knives	3-10°	20-30°
Utility knife blades*	13-20	30
Chopping knives [1]		30-60
Wood chisels [3]	$\alpha = 20-25$	$\beta = 25-30^\circ$

**Figure 5 edge angles**

Razors for shaving:  $2\alpha$  11-12  $2\beta$  15-19  
 Knives for kitchen\* and filleting knives:  
 $2\alpha$  3-10  $2\beta$  20-30  
 Utility knife Blades:  $2\alpha$  13-20  $2\beta$  30  
 Chopping knives :  $2\beta$  60

According to the research (Ciulică and Rus 2011) research recommend that 15 angle for cutting vegetables for improving efficiency and for providing

energy consumption.

This information shows that different applications require different angles. This is creating design requirements to adjustable angle for our knife sharpening design. Even Designers can provide some angle guidelines for users to improve usability.

### 3.1.1. d ) Surface quality:

All Knife edges appears like a row of teeth at microscopic level. The finer abrasives create smaller teeth but coarse grit sharpeners create large and deep teeth because tooth has indirect dimension to the size of abrasive particle scraped away the steel beside it. Large teeth cuts aggressively at first however because their sharp points exposed entire cutting force they become dull in short time. Continuing Honing with finer abrasives decrease the teeths size and increase teeth quantity. Because Cutting force share with numerous small teeth, force requirement for cutting operation decrease and create sharp experience and sharpness will stay longer. Another advantage of small teeth knives don't leave pattern on surface and leaving smoother surface behind.(Hock 2010)

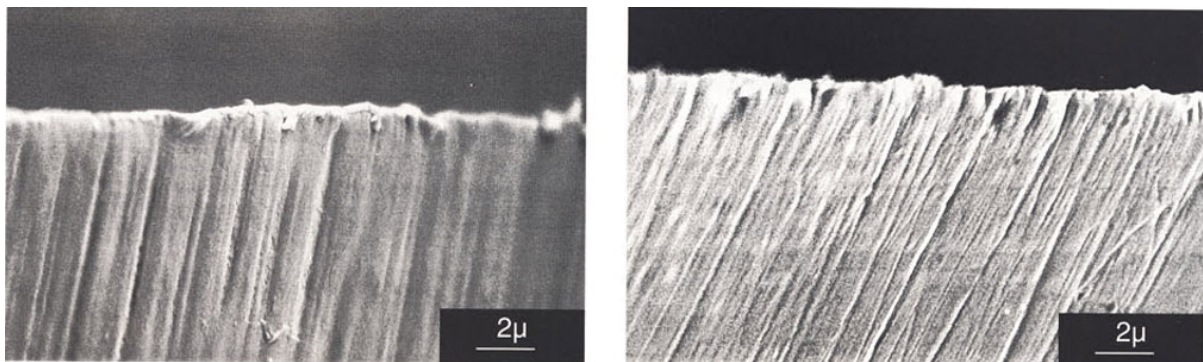


Figure 6 microscopic teeth

Research of Meat packaging industry also proves this information. According to Research “The blade edge angle had little effect on the gripping force exposure or the time requirements for either of the cutting operations evaluated However Blade finishing did cause a significant difference in all of the dependent variables during the lamb Y-cut operation. For all measures, the difference between finish levels was incremental. Cutting time, peak and mean grip force and cutting moment decreased with increasing quality (decreasing coarseness) of the blade finish. Peak grip force was reduced by 19.4%, peak cutting moment were reduced 18.0% and cutting time was reduced 21.5% by implementing the Smooth finish protocol. Further significant reductions in force exposure and improved productivity (as measured by cutting time) were found with adoption of the Polishing protocol. The use of a finer stone for honing and introduction of a polishing agent produced reductions in cutting time— 25.3%, mean grip force—21.2%, peak grip force— 25.5%, mean cutting moment—28.4% and peak cutting moment—26.9%, as compared to the Coarse finish condition.(McGorry et al. 2005).

During researching these topic Author face many arguments about microscopic teeth and surface finish. Some knife experts believed large teeth is better some others believed small teeth is better. Even some experts don't believe existing og microscopic teeth. Academic researches mentioned before proving existing of them and proving benefit of small teeth and surface finish quality Because of that these opinions will not being argued in this topic.

In conclusion, Surface finish is very important factor for knife sharpness. Good surface finish reduces force and working time, provides controlled, precise and smooth cutting experience at the same time, remains angle sharps for a longer time. This is creating design requirements to improving surface quality with using wide range of grit adhesives.

### **3.1.1. e)Steeling:**

Probably most of us seen chefs are using steel rods(honing steel) and making some cool shows before they starting cutting. Because of that, steeling has the huge amount of fame in the food industry. At the other side, there is a huge argument going on about its effectiveness. According to (Szabo et al. 2001) Steeling is a process of lining up tiny microscopic teeth on the blade and straightening a wire edge. Uranic against these definition because of steel rods have some abrasive surface on them same as other sharpening materials(Juranitch 1985).Another problem about steeling; steel rods don't have specific grits on them so it's difficult to identify which one is finer which one is coarse. These will cause even more dullness or damage on the knife edge(Lee 1995).Researches under electron microscope prove that steeling process should be operate with light pressure and few strokes. Steeling knives against these guidelines as chefs make cause roughing of the edge by break-off of ledges along the edge of the blade. Another result of these researches show us steeling process can't improve edge quality with respect to edge straightness, roughness and width. (Verhoeven 2004)

### **3.1.1. f)Stropping:**

Stropping is also another very popular techniques used in knife sharpening. Strops are usually used in razor blade to give a finest polishing look with the help of leather. As other sharpening techniques, there are different guidelines for using leather strops these are: using natural abrasives inside hard or soft side of leather or using some abrasives like chromium oxide. Researches showed that clean hard or soft leather strops have little effect the knife edge and surface quality. However, leather loaded with abrasive compounds has the dramatic improvement in edge and surface quality. According to researches, this is an excellent method for final finishing and polishing. These information show that stropping should be operated with abrasive compound at the final stage.(Verhoeven 2004)

### 3.1.2) Knife types

Knives are amorphous tools because of partially handmade. Similar to sunglasses, jewelry there isn't any standards for them. Because of that, This topic will be investigated knife types by general specifications and approximate dimensions to identify some design qualifications.

#### 3.1.2.a) Knife Anatomy:

##### 3.1.2.a.1) Structural Parts:



Figure 7 Structural Part of knife

Tang: The part of the blade that entering into the handle and provides balance. There is %50,%75 or full tang blades. Full tang blades are considered better than other because of added knife balance and longevity; %50,%75 knives are increased stress level to hell so it can cause cracking.

Bolster: Bolster is one of the signs showing knife is forged in fact today some companies soldier bolster to their machined blade as part of marketing. It is a thick belt of steel between the heel and handle. The main purpose of the bolster is protecting user's hand from slipping across the blade. This prevents accident call stubbling. At the same time, the bolster helps balance the knife. The balance issue is still in argument some experts said it can be cause overweighting. Finger guard is one of the parts of the bolster. One of the disadvantages of the bolster is making the sharpening process harder.

Rivets: Rivets used for attaching the handle to tang for improving joint strength.

Butt: End of the knife

Tip: Front point of the blade

Spine: The top of the blade opposite side of the edge.

Edge: Sharpest and thinnest part of the blade.

Handle: Provide better gripping during operations. Handles are generally made by wood, plastic or stainless steel.

Rear hand guard: Prevent slipping accidents.

### 3.1.2.a.2) Functional Parts:



Figure 8 Functional Part of Blade

Belly of the blade: It is most using part of the edge. It can use for a cut firm or soft food however due to its thin edge extremely firm objects can cause damage.

Tip of the blade: Tip of the blade using for small cutting jobs like chopping mushroom, garlic or other small vegetables.

The spine of the blade: Can be used to break up small bones or shellfish or cracking crabs.

The heel of the blade: It is the thickest part of the blade because of that used for chopping extremely firm food objects because of its more resistance to stress.

Cheek/Face of the blade: That can be used to flattening and lifting of the chopped product.  
(The anatomy of knife), (The Parts of a Knife 2015)

### 3.1.2.b) Knife Types by Handle Designs :

Knife can be grouped by their handle design. There are 3 common types of handle design in commercial knives. These are shown in figure 9.

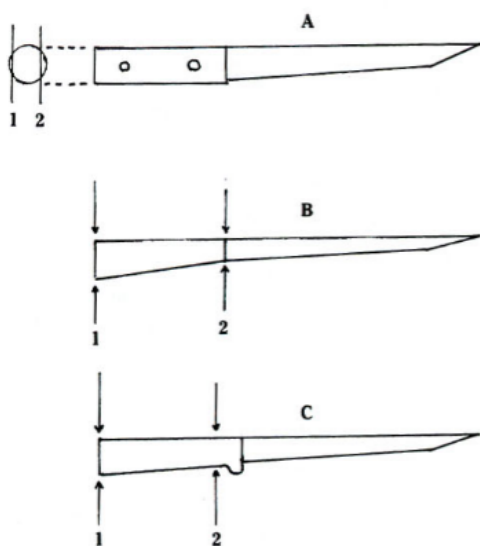


Figure 9 Handle Types

#### Type A:

Type A has a straight line design which generally filleted sides. Type A described as poor design because it has not designed guide to fit user's hand and most importantly hasn't had guard for slipping up the blade. Type A also called Broom handle.

#### Type B:

Type B has a round design and generally without a guard. This types of design outline seriously increase the chance of slipping accident. Some type B design taper through the

blade. This type of blade, even more, dangerous because of its increase chances of the accident which called stubbing. According to Juranitch; This is the worst type of handle design.

#### Type C:

Type C is most common handle and It described as working well. The back side of the handle is taper is greater than front side so it is easier to hang on. At the same time, Type C has a guard for preventing slipping accidents it is the most important improvement of the design. Today most of the industries which use labor intensive cutting operation insisting on using big guarded knives. One of the disadvantages of this type of design is hard to use in sharpening machines we should consider this in designing part. (Juranitch 1985)

### **3.1.2.c)Kitchen Knife types:**

#### **3.1.2.c.1)Chef Knife:**

Chef knife which also known as French knife is the most popular type of knife in the kitchen. According to ward (Ward 2010): "The chef's knife is the first knife you pick up in the kitchen and the last one you put down and It is not just the most important knife in the kitchen; it is the most important tool in the kitchen. Chef's knife is not just about cutting; it is also using for scoping, good for smashing garlic, spine part of the knife can be used for cracking crabs or if you are making precision cutting like Julien cut it can be used as a ruler to compare the thickness of the cuts.



**Figure 10: Chef Knives**

90 percentages of operations made by chef knives in the kitchen because of that it is a most important tool in the kitchen. There is 3 common type of Chef Knife named according to country produced. These are German, French and Japanese chef knives. Each chef knives have different dimensions; thickness and design outlines. According to these differences each of them have different advantages and disadvantages. German-style knives have more belly that curve a bit starting from about three-quarters of the way up the blade to the tip. This type of outline creating the rounded area which is good for rocking motion technique used when slicing. French-style knives have a straighter outline line between heel and tip this is making a more uniform triangle with less belly. This outline designed to fit Fussy cut technique which is generally used in classic French

cuisine. Japanese style(Gyuto) stands between German and French style chef knives, slightly similar to French style. One of the differences between Japanese style and french-german style knife is distal taper. Distal taper is thick spine tapers down to thin edge at the same time narrows toward the tip. Distal taper makes German and French knives heavier which is helping reduce cutting force. Rather than that, most importantly distal taper create thick and wide heel which prevents risk of the damaging knife during heavy duty work. Because of that German and French style chef knives better for chopping middle hardness material rather than light and thing gyutos.Gyuto means a beef knife in English. Features perfectly fit its name.Due to Gyutos are thin and light and sharpened 15-20 degree(typically Japanese knights sharpened 20 degree) they are better Y-axis cutting operation like filleting.(Ward 2010)

Dimension range of the chef knives between 15 cm to 30.5 cm. Most common commercials are between 20cm and 25 cm. Japanese chef's knife(Gyutos) available in 210 mm, 240 mm 270 mm, and 300 mm size variations. Price range for good chef knife is between 85 to 100 dollar. There are some expensive ones also go more than 250 dollars.(Ward 2010)

**3.1.2.c.2)Paring knives:**

Paring knives can be described as the small version of the chef knife. They are used for precise small works such as trimming peeling and shaping fruits and vegetables. They are the second essential knife in the



**Figure 11 Pairing Knife types**

kitchen with chef and paring knives all kitchen cutting stuff can be done.(Ruggiero )

The blade is from 6cm to 10 cm (Ruggiero ).Some paring knives taper to point like we mentioned in the chef knives, some others have a straight edge and sheepsfoot blade edge which curves radically down to meet it at the tip. Most fancy one is called tourne knife or birds parer which mean to turn in French. It becomes handy when

peeling round surfaces. Other types which spearpoint pairing knife and petty knife are a pretty much smaller size of the German and French type of chef knives.

### 3.1.2.c.3)Boning and Fillet Knives:



**Figure 12 boning and fillet knife**

Boning and fillet knives have thin narrow blades that curve getting higher to tip. Both of them generally 15 cm to 20 cm, however, some special knives can be longer. The only difference between them is flexibility. Fillet knives are more flexible than the boning knife. Each of them can be advantageous according to the hardness of the material and type of operation. Fillet knives

are better in soft foods and y-axis cutting operations. Boning knives are better in stiff foods and x-axis cutting. (Ward 2010).

Figure 12 boning and fillet knife

These knives edges have the same level or even lower level higher with handle. These increase the risk of accident call stubbing. Because of that bolster or finger guard is a very important role in these knives. (Hock 2010)

### 3.1.2.d)Knife Types by Materials Used in Knife Making:

#### 3.1.2.d.1)Steel

Steel is the most common material used in the knife industry. The main Receipt of the steel is mixing iron with the small percentage of carbon. Carbon percentage define a type of the steel. Mild steel has 0.15% to 0.25%carbon,medium carbon steel 0.25% to 0.50% and high carbon steel above 0.60%.Most of the tool steels using 0.80%to 1.20% due to carbon increase strength of the steel. For centuries, carbon was the only alloying element due to the difficulty of finding pure iron. After improvement in production and mining, new term alloy steel come out. Alloy steel is iron mixing with two or more alloying elements to add new features to steel.

Alloying materials rather than carbon are:

Chromium: Increase high-temperature strength, hardness, and shock resistance. Reduce tendency to twist during heat treatment.

Cobalt: Increases red-heat hardness of high-speed steel; refines the grain; increases tensile strength

Manganese: Increase hardness, tensile strength, and resistance to wear

MolyBdenum: Increases hardness and tensile strength; easier to machining.

Nickel:Increases toughness hardness and corrosion resistance.

Silicon: Increase hardness, tensile strength, and elastic limits

Tungsten: Refines the grain; increases heat wear and shock resistance as well as tensile strength.

Vanadium: It is not used by itself just used with combination with other elements often chromium to increase hardening ability, refine grain and resist softening on tempering.

Stainless steel is one of the types of steel made by using alloying materials. Kitchen knife makers mostly used stainless steel because high acid contains foods like fish or citrus fruits aggressively attack steel and



accelerate rusting process.(Lee 1995) Stainless steel has an undeserved bad reputation against high carbon steel.

According to Juranict (Juranitch 1985) personal experiences and tests, this is wrong even stainless steel is better than high carbon steel. Juranict thinks that knife producers using their steels as a marketing strategy to customer thinks they have unique steel have not found in the earth and prove that with surgical steel. Ward against this idea he thinks that Modern high carbon steels which have almost same alloy elements as stainless steel and have stain resistance are better than stainless steel. They are easy to sharpen, harder than stainless steel due to molecules and have a keen edge. Ward claims that stainless steel is better for average users not for chefs.(Ward 2010).However another research finishing this argument with claiming that same hardness stainless steel and carbon steels have the same quality of edge after sharpening.(Verhoeven 2004)

#### **3.1.2.d.2)Laminated steels:**

These steels were common when steel is expensive and not mass produced. Basically, that technique is welding two different metal together with the help of heat. There are two advantages of this technique. First it will reduce to cost because the knife can be produced by iron in the core and little amount of steel for cover it. These will create superior advantage because soft metal improves structural strength and brittle metal for cover create the superior edge. Secondly soft metal in the core absorb vibrations and prevent damages during chopping stiff materials. Because of that laminated steels still widely used for Japanese chisels and axes. There is one disadvantage of this technique that is they are not suitable for sharpening and steeling with standard devices such as wheels need special equipment care during sharpening or steeling.(Lee 1995)

#### **3.1.2.d.3) Ceramic:**

Another type of material used in knife making is ceramic. Ceramic knife is new in the market. According to features of ceramic, They are very hard, hold an edge for a long time, easy to clean and have a good resistance for chemicals. On the other hand, because it's very hard they are too brittle and not suitable for hard cuttings at the same time they are not suitable for hand sharpening they need to send to professionals to sharpen. According to the ward, ceramics knife factory edges is also not sharp as steel knife edges probably due to the limitation of material.(Verhoeven 2004)Ceramic knives are not going to be in consideration in our designing part due to low demand and not suitable for hand sharpening.

### **3.1.4) ABRASIVES**

Abrasives are materials have grit which are harder than grinding or sharpening material to dig and stretch material. Abrasives can be dived natural and man-made(synthetic) adhesives. Through history humankind uses natural adhesives used to sharpen tools. Only last century with the help of developments in metallurgy man made abrasives started to use.

Elements use in Abrasives can be Garnet, cerium oxide, cubic boron nitride, chromium oxide, iron oxide, zirconium dioxide, etc However major materials used in sharpening are silicon dioxide, silicon carbide, aluminum oxide or diamond.

### **3.1.4.a) Silicon Dioxide:**

Silicon dioxide (SiO<sub>2</sub>) is the richest mineral in the Earth's crust. Silicon dioxide Knoop hardness is about 820 which is slightly higher than 780 Knoop hardness tool steel. However these difference enough to described SiO<sub>2</sub> is medium honing abrasive.

Silicon dioxide can be found in a different form in nature. Novaculite rock form is most important and most used form of silicon dioxide in knife sharpening. The crystal structure of novaculite provides density and hardness which make it an excellent candidate for sharpening. The best novaculite mining from the Ouachita (pronounced "Washita") Mountains near Hot Springs, Arkansas. Washita stone, Arkansas stone are the common name of that novaculite rock form.

Commonly known as Washita stone, Arkansas stone, etc., these are the naturally occurring oil stones that were the standard sharpening media until man-made stones became popular over the last few decades. More about using oil stones shortly. These natural oil stones were standard sharpening equipment until man-made stones became popular.

Waterstones abrasive grits also formed by silicon dioxide. Rather than oilstones, silicon dioxide particles suspended in clay matrix in water stones. That structure makes them softer and fragile. Even it seems disadvantage It is actually advantage for sharpening. During sharpening with under pressure cause wearing and new fresh grit came out with the help of these and stone never become dull.

The average size of the particles in the stones determines coarse(at o), medium(Mankato and fine(shito). These natural stones are becoming rare day by day because of highest quality deposits are being mined out. Because of that fine stones are expensive and rarely find in the market. This is also can be described why these stones become more expensive day by day.(Hock 2010)

### **3.1.4.b) Silicon Carbide SiC:**

Silicon carbide rarely found in nature. Same as diamond Silicon carbide become popular after figuring out manufacturing synthetic silicon carbide.

SiC grains are very sharp and hard but at the same time, they are very friable. Because of that SiC does not use in cutting hard materials like hard steel. They are generally using for sanding due to the fact that wet and dry sanding papers contain SiC. Another disadvantage of SiC is it load up and quit sanding or cutting when using in soft materials .Because of that wet sand papers are using with water to prevent load up problems.(Hock 2010)

### **3)Aluminum Oxide Al<sub>2</sub>O<sub>3</sub>**

Aluminum oxide(alumina or simply AO) contain over %15 of the earth's crust. Alumina is most common natural abrasive until man made greater purity and uniformity synthetic ones developed.(Lee 1995) Synthetic Aluminum oxide became successful enough to completely replacing natural ones. There are eight or more different crystalline forms of AO manufactured today. Each of them has different degrees of friability. Some

crystalline forms have friability to refresh its sharp points as silicon carbide some forms don't have. AO tougher and harder to crush than SiC but it is not mean that never dull.

Synthetic AO features can be adjustable with desired size and friability which makes AO is one of the desired abrasive in sharpening industry. (Hock 2010)

#### **3.1.4.c) Diamond:**

Diamond hardest material in the earth(Wikipedia diamond).Using diamond as abrasives become popular after synthetic diamonds marketed. After diamonds become cheaper with the help of synthetic diamonds They become most used abrasive. Diamonds are made by carbon. due to a fact that they cannot use power grinding because in a high temperature carbon can dissolve into the steel. Because of that Diamonds are generally using in hand sharpening.

Diamonds can be formed as Polycrystalline or Monocrystalline. Polycrystalline diamonds have many crystals of diamonds attached to each other via carbon bonds. Those bonds are weaker than the monocrystalline diamond's bonds. During sharpening, those weaker bonds break apart more easily than monocrystalline diamonds bonds. Because of that poly crystalline, diamonds are well suited for the paste to use in lapping compounds. Monocrystalline diamonds are better for bench stones or hones where the diamond grit should be fixed in place. They will continue cut efficiently as a long time.(Hock 2010)

#### **3.1.4.d) Cubic Boron Nitride (cBN)**

Cubic Boron Nitride has almost same features as diamond. It is almost hard and expensive as diamond. The only difference between diamond is There are not carbon inside molecules so it's safe for using high temperatures without afraid of dissolving inside the steel. It is rarely used in sharpening.(Hock 2010)

#### **3.1.4.e)Chromium Oxide:**

Chromium Oxide used for stropping or buffing. It is also known as "knifemaker's green" due to content green pigment. It can be using with applied to felt or muslin wheel or rubbed on a leather, felt, cardboard or wooden strop. It is generally used for final mirror finish polishing.(Hock 2010)

### **3.1.5) Sharpening Equipments:**

#### **3.1.4.a) Bench Stones:**

Bench Stones are sharpening materials especially for using steel sharpening. Because of that bench stones don't have any spec even synthetic ones. The composition of the man-made bench stones is generally mixing with two abrasive elements which are mentioned the previous section. This mixture generally formulated the secret mixture of the companies.(Hock 2010)



**Figure 13 Sharpening stone types**

However, people don't get used to synthetic sharpening stones because they have a traditional background. Even synthetic ones have superior advantages like controlled grit size, don't need to operate with water or oil, no need to care or flattening (Hock 2010). The replacement of natural stones is slower and grudging. People also think that man-made bench stones are not as clear cut. People don't have much argument about coarse bench stone. They choose regarding efficiency, cost and predictability. This argument is basically about fine finishing stones. People who use fine natural stone against switching man-made stones. This behavior caused increasing natural stones price abnormally. Today natural stones can go up to 500 euros and they are really hard to find in finer grids. Because of these strong bonds and market advantage manufacturers start to replicate natural stones as much as possible. At the same time, they start to sell these replica fine stones high prices after seeing customer trends. Today synthetic stones can go up to 150 euro. People still think that replicated stones cannot be soft as top quality Japanese natural finishing stones. (Lee 1995)

Hardness and friability range of bench stone is wide and extend from very soft Waterstones at one, extreme to steel-plate diamond stones at the other. Ceramic and oilstones are hard, Waterstones are soft side of a scale. The softness of Waterstones provides faster cutting. As we mentioned before new sharp particles came out when surface worn away by sharpening pressure that is accelerate sharpening. Harder stones don't wear as much as soft ones. On the other hand, these will cause depression in the center of softer stones because of that they need to be flattening frequently.

#### **3.1.4.a.1) Man-made (synthetic) bench stones:**

Synthetic stones can be divided as ceramic, water stones and diamond plate stones.

Oil Stones:

Common man-made oil stones are made by silicon carbide and aluminum oxide stones with vitrified bonds. Silicon carbide stones are better for hard steel for other steel aluminum oxide better serve.

Man-made Oil stones cut slower than water stones. They are better for fine honing but can be used rough grinding at coarse grid as well. Their grid ranges very wide due to aluminum oxide feature as mentioned previous section.(Lee 1995)

Water stones:

Japanese stones have resin bond, cut very quickly but wear more rapidly than oil stones. Even they can be cut quickly than twice coarser grit oil stones. Their surface quality is also finer than any equal grid man made the stone.(Lee 1995)

Reconstituted stones:

Reconstituted stones are generally not recommended.

Ceramic stones: They are in the middle of the hardness spectrum. Shapton and Naniwa's Super stones are the examples of the ceramic stones. They are harder than natural or synthetic water stones. They can be washing in dishwasher and no need oil or water to operate sharpening(Hock 2010). The only disadvantage of the ceramic stones is they cannot cut well when they getting old because of abrasive particles become rounded in time. Due to the fact that they should be lapped or refaced periodically. (Lee 1995)

Diamond plate stones: Diamond is the hardest material so it can be used any kind of steel(Lee 1995). They don't require flattening cleaning after the operation is enough for care. Their disadvantages are price due to containing diamond they are expensive than other stones however they are more durable than others.(Hock 2010) Diamond stones can have relatively coarse grits so they are use flatting other stones.(Lee 1995)

#### **3.1.4.a.2)Natural bench stones:**

Most commonly natural stones can be divided two group which are Arkansas oil stones and Natural Japanese water stones(Lee 1995).Arkansas is the most popular natural oil stone even there are Belgian and welsh slate stones. Different Arkansas stones named with coarse to fine which also cause confusion sometimes. Name order from coarse to fine Arkansas are: Washita, Soft Arkansas, Hard Arkansas, and Black Hard Arkansas. There is an argument about People thinks that old Norton lily white washitas better than minded hard Arkansas last 20 years. Similar arguments going on in translucent Arkansas also. These can be true because of the best part of the deposit were mined over years. Because of that, it's difficult to find top quality Arkansas stones on the market today.

Arkansas stones give better result after used for a while. Freshly lapped stone can cut faster but Well used Arkansas create the better edge.(Hock 2010)They should be operated by oil which will create some mass in work. Soapy water can be used instead of oil for preventing that mass.(Hock 2010)

Other most popular type of natural bench stone is Japanese Water Stones. Japanese Water Stones have the similar particle size as Arkansas stones. The difference is water stones are not tightly fixed and large as Arkansas ones. They are cut quickly but create fine finish in the edge. According to Hock, Japanese Natural water stones have a wonderful feel and they are top quality stones.(Hock 2010)

### **3.1.4.b)Coated Abrasives:**

Sandpapers, sanding belts, and films are under the category of coated abrasives. Ironically sandpapers or sanding belts are generally not contained sand. Silicon Carbide or Aluminum oxide main abrasives used in coated abrasives. Sandpapers generally contain silicon carbide however silicon carbide is not good for sharpening because of it breaks down very quickly. After silicon carbide breaks down its burnishes rather than abrading it. Burnishing processes can be noticed easily with shining effect on the scratches. During finishing process silicon Carbide also not good as aluminum oxide. Mousepad sharpening technic is one of the technic sharpening knives with sandpapers.(Hock 2010)Author observe and test these sharpening technics and find it really difficult to operate and not satisfied result.



**Figure 14 Coated Abrasive types**

Belts are usually made from woven fabric coated with aluminum oxide grit. Zirconium and high-performance minerals are also available however they are significantly expensive.

Coated abrasives become high tech these days with the help of development in metallurgy. Manufacturers claim that their new sheets contain % 90 stated size grains. As mentioned before aluminum oxide features like grain size can be controlled in manufacturing. These sheets are available in a variety of sizes, waterproof and long lasting (Hock 2010).3M lapping film is one of the examples of these impressive films.3M lapping films generally using in fiber optic grinding which require precise sanding. Their grit size range is from 60 micron (approximately 240 grit) to 0.05micron (approximately 500.000 grit).If you compare finest top quality bench stone is 120.000 grid these paper definitely has more advantages. Using the wide range of grit sizes can produce the super fine finish in the edge. They are also significantly cheaper than bench stones one 3m lapping film approximately cost less than 1euro.These create super price advantage compare to expensive bench stone.3m lapping films disposable and no need to care about or before an operation. Lapping films are new material in knife sharpening but it gain some fanatics already in knife sharpeners.(Technical Data of 3M Lapping Films 2007).Recently user of the expensive sharpeners hacking their devices to change their expensive abrasives with cheap lapping films.(EliteEdges.com 2014)

### Shaped Stones:

There are too many shaped stones on the market these are gouge cones, slip stones, round, triangular and square-section stones. They can be made by hard Arkansas, resin-bond aluminum-oxide water stones, vitrified-bond aluminum oxide and silicon carbide and an increasingly large number of diamond-coated shapes. Water stones and slip stones are not preferred in these shaped stones because they wear quickly and they are too soft for sharpening some tools like the crosscut saw teeth. Using hard stones like oil stones better in that stones.

### 3.1.4.c)Wheels:

Aluminum oxide is the most used abrasives in wheels. Wheel has systematic grit size labeling obviously better than other sharpening equipment. These are like A60-I8-V: A describing Aluminum oxide,60 is gritted size, I am the hardness grade,8 is describing spacing of the grits in the bond and lastly V indicates the wheel is held together with a Vitrified bond.

Wheels are risky you can be burn metal or hurt yourself because of that they need intensive attention.(Hock 2010)

### 3.1.4.d)Polishing Compounds and Stropps:

Strop both word or noun is coming from leather barber's stropps. As we mentioned before they are used with an abrasive compound used as a final to reduce burr and give a super fine polish. As we mentioned before one of the research showed that it is the best way to reduce burr on the knife and give the super fine finish. As all technics Stropping also has danger which is rounding over the edge. This risk is an increase in leather strop which is flexibility can cause uncontrolled pressure. Stropping is significantly cheapest part compare to others. Any kind of leather or wood can be used with aluminum oxide compound.(Hock 2010)

### 3.1.4.e)Leather Stropps:

Knife sharpeners believe that leathers contain a natural abrasive which it seems like silica under a microscope. However as mentioned before these is the just myth without compounds leather have little effect on the edge which not significant enough. Flexible Leather can be common stop material for barbers because they are using a hollow ground razor, however, they are not suitable and risky for kitchen knives because of rounding edge possibility. Leather stropps which fixed in wood are better for kitchen knives.(Lee



1995)

Figure 17 leather stropps 1

Charging leather strops with chromium oxide is the most effective method to reduce burr and giving the finest surface finish.(Verhaegen 2004)

#### **3.1.4.f)Wooden Strops:**

Similar to Leather Strops Wooden strops also loading with aluminum oxide. Wooden strops have one advantage which they can be cut different shapes. These provide to use them any type of knives shapes. This method is most cost efficient than buying different shape of strops. Sharpeners can cut V edge, circular or any type of strops easily and can charge them with different grid aluminum oxide and avoid to buy shaped stones.(Lee 1995)

The polishing compound can be defined by colors. Aluminum oxide compound appears as white, chromium oxide compound appears as dark green and if its contain both of them it appear as light green. Some manufacturers can add some compounds or pigments to change color in that situation user should be read the spec. Some polishing compounds can be formulated for working on softer materials. In that case, the process will be very slow.

#### **3.1.4.g)Steel Rods:**

Steel Rods are using for steeling which reshape edge by flowing edge line. They are different than abrasive rods which are in the group of shaped sharpening stones for sharpening knife as mentioned before.(Hock 2010)

Even edge is sharp and smooth can be dull in a short time because of roll covering on the edge, periodic steeling fixing roll over problems and extend knife sharpness almost a year. This problem can be observed by under strong light. If the some part of the edge reflect light it is mean that knife has not straight anymore and need steeling because normally edge should not reflect light and visible for naked eyes.

Knife steels and honing rods can be different size, shapes and flavors. Round steels, oval steels, grooved steels, smooth steels, diamond steels and ceramic hods are the type of steel rods.(Ward 2010Diamond coated steel or ceramic rods are steel-like abrasive rods which are actually shaped sharpening stones however under light pressure they can be used during the steeling process.(Hock 2010)



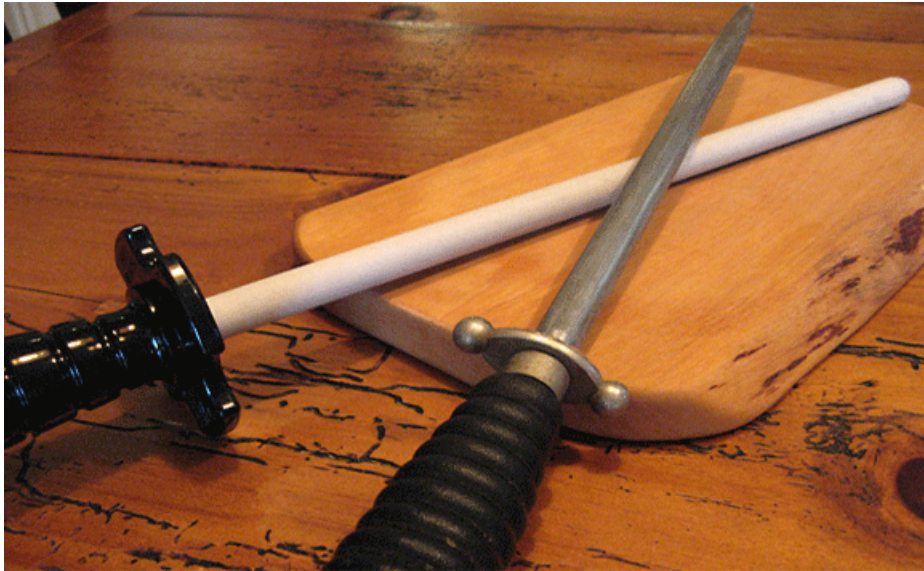


Figure 15 steel rods

Round and grooved steels are most common steel types because they generally come with knife sets. Grooves in the steel create tiny points of contact with the edge because of smaller contact area makes greater pressure on the edge. Using these type of steels under light pressure can realign the edge however Under too much pressure grooved steel will act as a file and increase a size of microscopic teeth. As we mentioned the first section these will create fake sharpness which will won't last very long. Japanese -made knives shouldn't be steel with grooved steel. Grooved steel will be cause chipping in harder Japanese steel.

Smooth steels which also called butcher steels gently push metal of the edge back into alignment. Steeling with smooth steels will take longer than grooved steel however they are less risky and easier to use.

There is also pull through steel which always mixing with fixed slot sharpeners because their designs are so similar. Even Pull-through steels popular for home users they have a bad reputation along knife experts due to some bad features. First bad effect is they are creating aggressive edge however it won't last very long. Secondly, they are still limited to factory angles which are wider than sharp edges and These angles can be not fit custom blades. Lastly, they generally groove coarsely than best of your edge. Rather than these bad facts, they are still most practical and most used steeling version for basic users.(Ward 2010)

### 3.1.5)Sharpening Systems:

#### 3.1.5.a)Rod and Clamp Systems:

Rod guided sharpening systems are new different direction of the knife sharpening. Rather than gliding the knife these systems using stones which attached to rods that fixed preset holes and washing face with fixed angle.

### 3.1.5.a.1)Wicked Edge:



Figure 16wicked edge sharpener

Wicked edge is the one of the market leaders in professional knife sharpeners. They are targeting professional knife sharpeners, chefs and musicians with their expensive and very effective products. Wicked edge website describing their concept with these sentences: "Poorly formed edges, like those created on electric sharpeners, will quickly dull. Controlled-angle sharpeners work decently, but clamps often fail; the vises don't have enough clamping power to be truly effective and the whole process comes to a halt while the knife is replaced and the vise is reset. You may also find the need to recreate the edge from scratch (which requires a considerable amount of time) when only a touch up is needed.

The combination of mechanical problems and poor performance finally led our founder Clay Allison to take a closer look at sharpening to create something that would address these issues. "Wicked edge promises to solve these problems by their patented design. They also claim that their design easy to use for every user.

Web sites showed us they create their own community which is relatively large. They are giving advises, broadcasting tutorial videos, sharing researches and fundamentals for knife sharpening. At the same time, they are describing knife and knife sharpening basics and even giving excel sheets for people to record their data. Most interestingly they are giving advises who wants to start knife sharpening business in their forums.

They are really active in social media marketing also. They are sharing pictures which customers sent them during using products also in YouTube there are a lot of sharpening videos which contain wicked edge sharpening test.

Wicked edge is focusing on USA market also, they have international dealers in New Zealand, Russia, Germany, Israel, United Kingdom, South Africa, The Netherlands, Hungary, Switzerland, Slovakia, Czech Republic, Croatia, Singapore, Sweden, Australia, Canada also. However, it seems they have international marketing problem because internationally they don't have big dealers. Existing dealers are just a person, website or single shops, not big retailers.

Basic kit include 17 part these are: Knife Sharpener Base, Fixed Vise Jaw, Free Vise Jaw, Hinge collar and Guide Rod assembly(2 piece), Depth Key, Vise Key, Base Rod, Alignment Tool, Knife Brace, Upper Vise Screw, Lower Vise Screw, Upper vise screw, Lower vise Screw, ½ inch socket head cap screw, 1 inch socket head cap screw, thumbscrews(2), Red coarse 100 and orange medium coarse 200 grit diamond block 200(2), Yellow medium 400 and Green fine 600 grit diamond block(2). It seems really confusing but setting up actually more complex. First you have to drill platform using template if you were not going to purchase pre-made the base. All the screws tighten by a user. The blade should be mount in the middle and tight with the screw. Edge should be marked with a marker. Adjusting angle should be made on the guide rod and observe with where removing. Positioning knife is making with observation and manually. All setting should be recording for second sharpening and finally, you can start sharpening knife with place stones. Personal opinion about the process and setting up seems really complex and not easy use for a regular user. It is seems setting up against company promises about usability.

Sharpening packages are starting from 300 dollars going up to 1799 dollar. Accessories also seem expensive for example a pair of abrasive stones are starting from 70 dollars and going up to 245 dollars. Even strops which should be cheapest devices as we mentioned before are starting from 31 dollars going up to 50 dollars. Customer behavior of changing stones with cheap lapping films can be reasonable in that case (Wicked Edge Pro )

### **3.1.5.a.2)Edge Pro**

Edge Pro is one of the market leaders in the market. According to ward they are kings of the rod guided systems.(Ward 2010)Same as wicked edge it is using rod however edge pro has one rod. The operation made on one face which will create disadvantages during fine sharpening phases. Knife holding flat not vertically. Rather than Wicked edge, you don't have to drill holes to fix devices however because of suction cups used for fixing Its needed to operate on flat surfaces. There are 5 different angle options that are marked with different colors on the rod. These angles are 10 degrees with blue, 15 degrees with yellow, 20 degrees with green, 25 degrees with red, 30 degrees with black.(Edge )Stones are contained aluminum oxide abrasives. Because of the knife is not clamped into place during using the user can slide the knife over a little to reach the next section and tip.(Ward 2010)

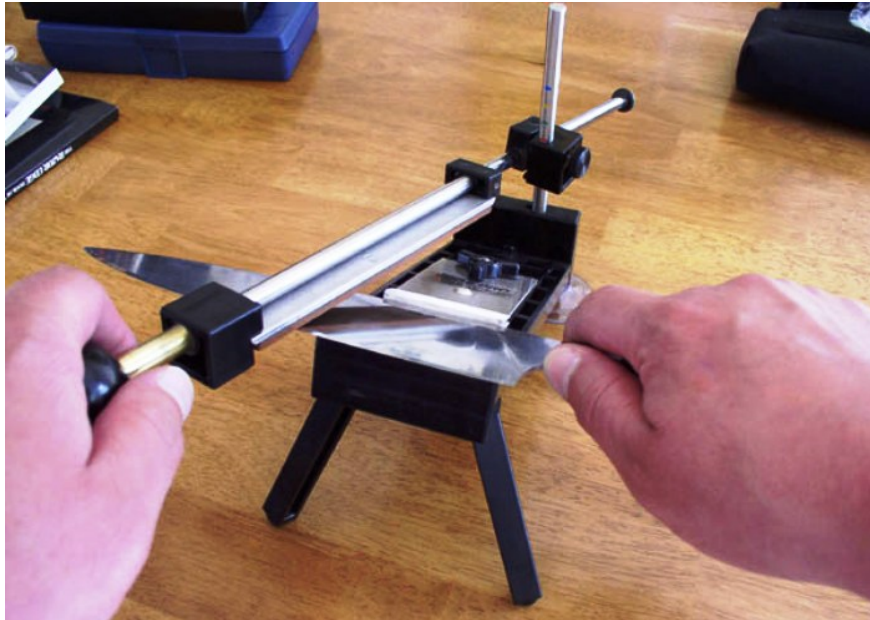


Figure 17 Edge pro sharpener

Edge pro promises secure knife sharpening system. Plastic secure on the stone quite well to prevent touching the sharp edge, however due to the knife is not fixed it can fall down with high pressures but it seems that more secure than wicked edge pro.

Accessory chooses is not so wide. Finest stones are 1000 grit. Company tries to cover these gaps with tapes. They are providing blank bases with 2000 3000 and 6000 grit polish tapes. According to the company, each tape should be used 5 times. Even there isn't any information giving about material by company author identify that these are 3m lapping films.6000 grit which are brown 5 micron 3m lapping films.

Prices of sets are relatively cheaper than wicked edge but still expensive than market average. Basic set starting from 165 dollars; Pro set is going up to 705 dollars.(Edge Pro hand sharpening systems )According to our researches about knife sharpening, at least, 570 dollar set should be used which provide a wide range of grits. According to Ward, their prices are over the price that average home sharpener is willing to spend.(Ward 2010)

Popular mechanic magazine review edge pro knife and describe as an amazing device for sharpening (Palmer 2015).Amazon customers give credit to 4.5 stars for this device. Complaints about this device it's not compatible with fillet knives and thin knives. For using edge pro, you should have the straight spine to fit into knife holder also thin knives can be damaged because of vertical forces so complaints are reasonable.(Edge Pro Apex 4 Knife Sharpener )

Same as a Wicked edge, edge pro also provide sharpening tips videos and materials. However, It seems that wicked edge provides many materials. Edge pro doesn't have a community, blogs and active social media usage which is not good for product experiences. Same as wicked edge they are more focus on USA market

mostly through online shopping. They have also international dealers which most of them are online shopping website. However their international locations are limited to United Kingdom, Singapore, Canada, Russia, Netherlands, Finland, Lithuania, Estonia, Latvia ,Norway, Australia and France.

Another marketing difficulty they are facing with is cloning their design. Because of their design is simple there is a lot of cheap clone version of edge pro which are costs around 30 dollars. Not only copied devices but some brand also using their techniques with different designs such as DMT's Aligner or Lansky sharpening system.

### **3.1.5.b)V system sharpeners:**

V-type sharpeners have two ceramic rods placed into a base which contain holes to provide preset angle. Sharpening made by holding the knife with 90 degrees to ground and stroke up and down to rod which contain abrasives. Because of the user holding knife in a natural position; this system easy to use. (Ward 2010) The sticks (rods) generally made by ceramic or diamond coated metal. There are different grits sticks to help tooth or polish the edge.(Hock 2010)



**Figure 18 spyderco sharpmaker**

Spyderco Sharpmaker described as best v system sharpeners from authors. Spyderco is Cutlery Company producing knives, blade steels, and sharpeners. That Colorado-based Company famous with folding knives. During designing and innovating knives, They collaborate with 30 custom knife makers, athletes and self-defense instructors with the usage of 20 different blade materials. Their design is better than other v systems because they are solving two basic problems which are that plague all crock stick setups, wide angles and round stones. Round stones are better for steeling for sharpening it's difficult to make a flat edge with round

stone. Spyderco solves one of this problem use with triangular rods. (Ward 2010) There are 4 different pieces coming from sharpener these are base at the same time case made by a polymer, 2 fine grit white stone, 2 medium grit gray stone, 2 safety rods. All these components are fitting in around 25x25x4cm small portable box case (Spyderco Sharpmaker Knife Sharpener - ...) There are also 2 accessories available (not included in standard pack) which are ultra-fine ceramic stones for polishing and 2 steel triangles covered with diamond for steeling. There are 2 different pieces of holes which are providing 30 and 40-degree angle equal to 15 and 20 degrees per side. (Spyderco)

Sharpening starting with placing rods to guides base holding with case cover. Because of there isn't any stabilizer, the user should stabilize it with putting a left hand. To protect any kind of the accident to this stabilizer left, there are two safety rods which promise to stop to knife before reach to user's hand. When all setup ready sharpening can start with placing corner of the gray stone. Knife should be held vertical and move up and down each face. Because of there isn't any clip user don't need to count strokes during sharpening. After sharpening finished in the corner of the stone, the stone is turning and placed as faces part contact with a knife. In these, part knife sharpening to provide even and flat surface and these is the difference of Spyderco. These processes continue with the white fine stone and eventually finished in 4 step. These 4 steps named by a company in order: Shaping, utility, honing and razor.

These steps are for kitchen knife however Because of sharpening completely under control to the user (without any clips), Customer can sharpen not only a knife but any kind of device made metal like nail clippers, needles, screwdriver, scissors, etc. These require different steps and methods to sharpening which are described detailed manual. (Spyderco)

According to Ward (Ward 2010) "There are two downsides to the Sharpmaker. It is easy to glide the knife off the honing rod, especially while using the corners of the rods. This will eventually round the tip of your knife. This is easily remedied by taking your time and sharpening in two stages, one for 90 percent of the edge and a second stage concentrating on the tip only. The other downside is that major re-profiling can take a while. The medium stones are not designed to remove a lot of metal in a hurry. The Sharpmaker is better at keeping your knives at peak performance than it is putting a radically thinner edge on a thick knife."

Spyderco targeted American and Canadian market. They don't have any word wide dealership however they have big retailer dealership such as Wal-Mart. (Spyderco 1998) Their Website doesn't have community. Social accounts also seem same. Rates are seemed good for amazon (4.7) and wall-mart (5) website. (Spyderco) Complain about sharpeners are generally coming from knife sharpeners who experience other devices. Generally, they complain about edge quality and sharpness. According to these, we can claim that these knife sharper more for inexperienced regular customers who don't have information about any knife sharpeners or sharpening technics. With an affordable price and compact design Spyderco targeting a wide range of customers and high quantity selling. Wal-Mart dealership is providing that they are widely selling rather than other professional knife sharpeners.

### 3.1.5.c)Slot Styles:

Slot styles probably most common sharpening devices using for regular users. These cheap knife sharpeners can be found everywhere. The logic behind slot style devices putting knife cutting edge inside to slot which contain fixed angle rods to create v shape to scrape off some metal at desired angle, The rod inside the slot sharpeners is carbide, ceramic and metal. As we mentioned before carbide is not good for sharpening and can damaged knife.

Ceramic ones don't cause too much damage and can be used for quick touch ups (Ward 2010).However fixed slot sharpener with crossed ceramic rod is suitable for western knives but not for Japanese laminated steel blades.(Palmer 2015)

Some models have two different grit holes which have the fine and coarse grid. They can be relatively better than single slot devices. According to ward slot, style sharpeners are not suitable for actual sharpening can be used for quick touch-ups in cheap knives (Ward 2010)



**Figure 19 Slot style Sharpener**

Even Slot styles knife sharpeners have a bad reputation. They are probably cheapest and most common knife sharpener in the world. These can be us idea about average price range that customers willing to spend for knife sharpeners. Prices starting from around 1 dollar and going up to 30 dollar diamond rod ones. There is one Brod and Taylor brand flexible slot style sharpeners design different than others however because of it sell less than others there isn't any review about this device and it ironically cost around 120 dollars.(Brod & Taylor Professional Knife Shar...)

Interestingly during amazon research, we found out the average amount of famous knife makers selling their knives with slot styles sharpeners together. If consider that that professional expensive knives generally used

by chefs or knife experts, this selling strategy becomes not logical. There will be only a reason behind it which is slot style sharpeners are cheaper than others.

### **3.1.5.d)Sharpening with Bench stones and Angle Guide:**

Detailed information about bench stones is given in the previous topics. Information about guides and sharpening process with stones is going to be given in this topic. According to Hock (Hock 2010), Sharpening with water stone is slow almost meditation, sharpeners patience will be rewarded with an edge that will be as hard as intended and that will stay sharp as long as possible. It can be one reason why bench stones have huge fans.



**Figure 20 sharpening with guide and bench stone**

For starting to sharpening, stones should be prepared for sharpening. First step flattening stone for able to blade sit on stone flat. Glass plate with cover sand paper or another flat stone can be used for flattening. Before starting flattening, the stone surface should be hatched by pencil. These will help to understand which area worn and stopping point to flattening. As we mentioned before flattening process also help to sharpen abrasive particles which will decrease effort to sharpen and increase efficiency. Waterstones need flattening more often than oil stones because of that they need more care. After flattening process finished some water stones should be put inside cap filled with water. Duration depends on grit size of the stone, coarser stones soak water quickly in a few minutes, and finer stones soak water longer duration around 15-20 minutes. Some water stones don't need to fully soak water little Amount of water will be enough to be ready in that situation manufacturer's instruction should be followed in that case. Oil stones should be cover with oil however oil can be messy especially in the kitchen. In that case, soapy water can be used rather than oil. Some experts even recommend soapy water instead of oil. Ceramic



stones shouldn't be stored in water or soaked. Diamond plates and hard ceramic stones can be used dry, water can be used in advanced. Because of preparing stones is toil, messy and complicated companies offer all included package solution with stone ponds. Main stones ponds are includes: water container, case, stones for flattening and sharpening stones. Some of them contain lapping abrasives and strops also. Water container helps clean and wet sharpening but at the same time, these containers become the perfect case for storing stones. Because of company specific flattening stones for included sharpening stones, they are perfectly fit each other's. Their price is starting from around 50 and going up to 230 dollars(amazon).The Sharpton stone pond, veritas stone pond, Norton stone ponds can be some examples for stone ponds.(Hock 2010)

Sharpening should start coarser grit and go up to the finer grit. There is a so much argument going about it which grit size should use during sharpening. Rather than thoughts and rumors author are going to stick scientific researches. One of the research shows that starting grit is not important burred edge will go medium and fine grits. To consider that research set up 1000 or 600 grit coarse grit will be fit for fast cutting abrasives;6000 and 8000 grit can be used for fine finishing and for final finish(polish) 0.5 or lower micron abrasive can be used. Another important point that Stroke should be lighter direct proportion with grit.(Juranitch 1985)

4 different way of stroke cycle investigated. According to Emeritus (Verhoeven Emeritus) blade moving into the stone, called the A direction, would produce less burring than the case with the edge moving away from the stone. Sharpening can continue flipping over faces.

After prepare stone, choosing right grit and orient position of the blade for the last step is adjusting the sharpening angle. Sharpening angle can be decided by the application unless it's under 25 degree. Using over 25 degrees can ruin blade edge. For round edges, the sharpening angle should be rise at the end of the stroke.(Juranitch 1985) Edge guides can be used to hold angle steady. Edge guides clamp onto the spine and keep your sharpening angle steady with rising up.(Ward 2010)According to juranitch (Juranitch 1985) "People can get a good usable edge by sharpening free hand, but there is no way even a professional can match a novice using a guide." Also, clips are helping free hand sharpening with record angle to muscle memory. If sharpening guide going to use in the stone that stone should be longer than 8 inches to proper sharpening. However, there is a big disadvantage of using guides which are you cannot know grinding angle until you make calculations. Experts said that that isn't so much important and does not effecting process.(Ward 2010)Edge guides prices are around 10 dollars which can be considered cheap rather than other devices. There is simple and complex edge guide system up to user favor. Even edge guides are cheap; because of stones are expensive these sharpening systems can be consider one of the most expensive methods.

The sharpening with stones should be cleaned and store in the not too cold or hot temperatures at the end of the sharpening. As we can see sharpening with stone with guide is laborious but at the same time ritualistic

### 3.1.6) Sharpness Testing:

There are many techniques for understanding sharpness. Some of these techniques are professional techniques which require some special tools. At the other hand, there are some traditional techniques which require no tool or tools that you can find every home. Professional techniques are generally for experts or knife producers. Due to we are designing sharpener for home usage traditional techniques will be enough for testing may be even more.

#### Paper Cutting Trick:

The paper cutting trick will be your first step to understanding Is your knife sharp or dull? A sharp edge will slice a sheet of paper even newspaper with light effort. Sharp edge cut should be clean on paper also .If an edge is dull or not sharp enough It will require much pressure to cut and cut will be rough.(Hock 2010) Making these test with thin paper like newspaper will show the better result. If people want really sharp edge they can use Phone book paper for testing.(Ward 2010)

#### Light reflects:

These are another easy and low tech sharpness test. Simply you should look closely at the blade edge under right angle light If edge reflects light, it is dull. As mentioned first chapter zero radius phenomenon, when edge close to zero radii it will be sharp as possible at the same time reflects less light. Also, with these techniques rolling over problems can identify rolling over problems which can show steeling require.(Hock 2010)

#### Shaving hair of your arms:

Shaving hair of your arms one of the classic techniques the identify perfect edge. However these techniques are can be dangerous and cutting hair will be resulting unaesthetic results in the human body.(Ward 2010)

#### Cotton swab test:

These test best for identify nicks or burrs. Simply fuzzy head cotton swab pushing through an edge. If there is some particular of cotton on the edge these spots showing burrs or nicks. Kitchen edge (Ward 2010)

#### Nail test:

Nail test easy and quick test. It's making by placing the knife at 30-45 degree on your thumbnail and pulling across an edge. Sharp and the good edge will bite, the dull and bad edge will be just slight on your nail. These test can be dangerous for beginners, at least, it's harmful for nail polish.(Ward 2010)

#### Plastic pen test:

It is the same principle with nail test. Rather than the nail; plastic pen barrel using for pulling. It's safer and faster. (Ward 2010)

### 3.1.7) Market Positioning:

For understand market position of sharpeners we map current sharpeners. Each sharpener is scaled in price and efficiencies range. Figure 23 showing that there is a gap in the current market which will be used for our product. According to this range, Target audience is going to be amateur chefs (Food Passionist) and Professional chefs. Price and efficiency level will be in that limits.

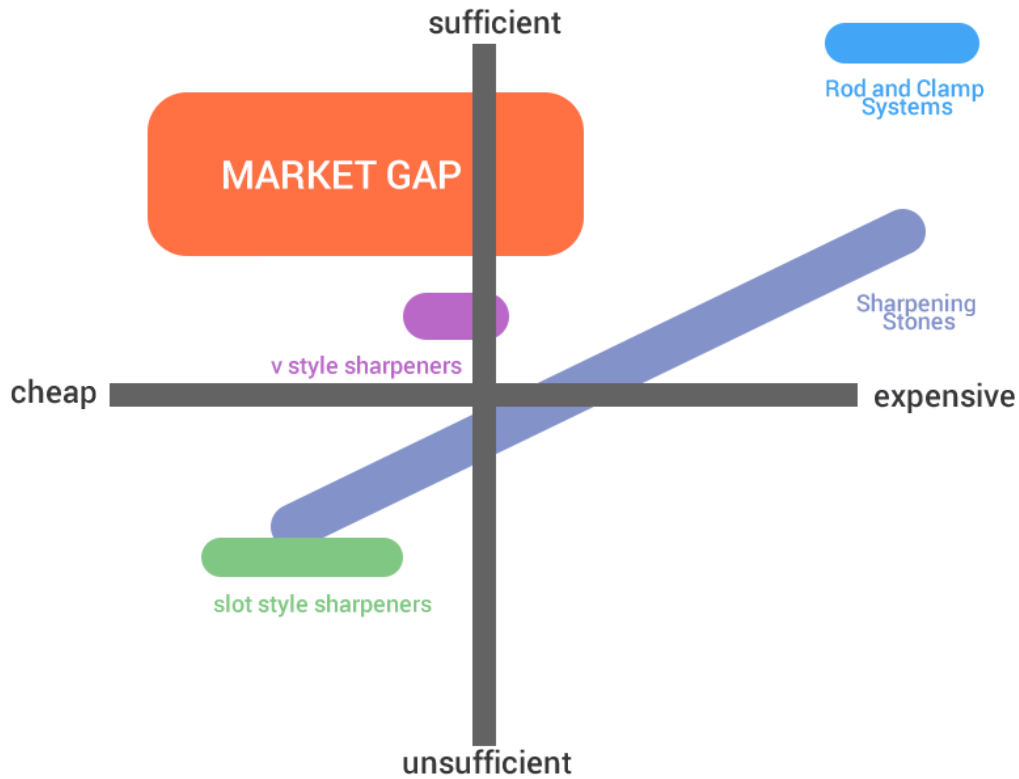


Figure 21 Market Positioning

### 3.2) Field Research to knife markers:

Two knife makers visited in Turkey, Sivas. Sivas is the city in Turkey which famous for handmade knives. Steel of knife is producing local steel factory. One knife maker is very famous in town and knows as best knife maker in that area another knife maker which we visited is regular knife maker. During purchasing a knife from regular knife maker, we figure out their knives are not sharp as desired sharpness. We asked knife maker this situation and he offer to sharpen the knife. The interesting part is coming after that requesting some angle for the edge. Knife makers said he didn't know anything about the angle and he couldn't make a sharpening angle. Sharpening without angle is against all information giving in theses so we want to observe sharpening process and agreed to sharpen. He used two different things to sharpen these are first oil stone

which named grit stone minded in turkey and second leather strop lightly abrasive. First mistake he made during sharpening on stone, the just randomly stroke blade on the stone without gliding stable angle. The second mistake is he was using a leather belt which is too loose and slightly covered with abrasive these wrong method mentioned research part. After he finished sharpening, the edge becomes duller than before. Before going that famous knife makers, we talked butchers and learned that he makes special knives if we ask and order him. With the help of that information we told him that we don't want to buy regular cheap knife which he selling regular custom, we requested special knife. Because of its takes the time he offers to finish it in 3 weeks because of that we couldn't observe sharpening process but results were really good. It was really sharp and even and the edge was without burr and finished well. As a result, the proper way of sharpening create the huge difference in knife and bring fame to knife maker. The Proper way of sharpening also add some value to the knife which cause increasing price 5 times more than a regular knife.

### 3.3) Interview:

Interview method used for understanding users needs more deeply. Chefs and students at that field know the importance of sharpening. They also describe sharpening process and sharpening materials very well however only 3 people said that they are sharpening their knives with stone or special equipment. Average sharpening duration is described as once a month in that group. However, they also said that it depends of cutting action they made in that period. All professionals steel their knives with steel rods around 4-5 times everyday. Half of them use special services to sharpen their knives because they are so busy to make them own. One chef said that he just sharpen own chef knife; he doesn't have time for others because there is so much knife in common kitchen area because of them he using services. These Services costs around 5-10 dollar for a knives which depend on company. Rather than one chef most of the professionals don't have enough knowledge about sharpening process and sharpening angles. Only one guy who also have the higher career than others serious about sharpening. He using special stones and special waters produce for that stones. Most of the chef said that they don't want any industrial sharpeners in their kitchen even the chef who most serious about sharpening said that he doesn't want any device spark flames in him work area. One chef told her experience about very noisy and industrial type of sharpener. She said that : "I couldn't resist it and finally I throw it to garbage". All chefs are pointed out a practicality. Chefs said that they are so busy in the kitchen so a product which is easy and fast to operate will be fit their work rthym.

The amateur participant was another case for research. She doesn't know anything about sharpening and she just using other knife's spine for sharpening which is actually steeling. However, she claims that she wants to buy a special knife in the future and she will be get a sharpener for it. She also said that she can be buy sharpener if it looks like professional enough.

All chefs give positive reactions after we told our design ideas. They said that they will definitely use If it will be practical and easy to use. The guy who experienced in sharpening said that he definitely wants one of them if we produce in the future. All of them think that there is a gap in the market in that field; that kind of device will fill that need. They think that target price(30-50dollar) is affordable and relatively cheap for that kind of product and will motivate them to buy without the doubt.

## 4)Brief:

The design concept is handheld knife sharpener for professional chefs. However due to amateur chefs are following professional chefs advice it will be used by amateur chefs also. Sharpener has same working principle as fixed v angle sharpeners. Rather than rods, we will use another abrasive material to sharpen it. That sharpening material will be the 3m material containing aluminum oxide. With the help of that new material, grit size range is going to be wide enough to create the perfect edge.

Angles should be adjustable for different purpose of use and go up to 45 degrees for each side. Types of knives, the thickness of the blade , a material of blade and handle type will not affect sharpening. Due to our interview outcomes showed that steeling more used in daily, our product will also have the steeling ability. That way product can use every day and become handy.

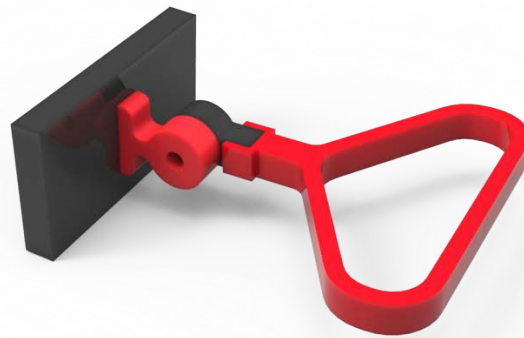
Sharpener will be practical, fast and efficient. At the same time, design will be portable and in harmony with other kitchen equipment. The operation is going to under the control of the users hand. Hand controlled operation should provide

As desired from users device isn't include any electrical parts in it. The product will have 30-50 dollar range of market price to compete for other sharpeners. Sharpener definitely will be safe to work with all kind of knives.

## 5)Design:

The beginning of the design our first consideration was the angle. As mentioned in the research part angle is one of the important facts that effecting knife sharpness but at the same time product lifetime. Due to a fact, that angle should be chosen for application and knife types. If we consider that sharpener is designing for kitchens which can have different knife types; fixed sharpening angle shouldn't be used in our design. Because of that, we skip fixed angle and decided to use adjustable angle. Research outcome shows that Sharpening angle should be under 25 degree for double side edge and it must be 45 degrees for chisel edge. Kitchens can be have two different types of knives so angle should able set up to 45 in product design. Due product targeted amateurs also, customers can be damage their knife if they don't have enough knowledge. Also, interviews showed that amateur chefs don't have enough knowledge about sharpening angle by types and limitations of angles. Even professional chefs have limited knowledge about edge angles by types. In that case, the product includes some warnings to stop 25 degrees for double sided knives. These will help to remind customers to limitations. Coding angle with color and writing application types crucial to help amateurs or professionals. According to these requirements, we come up with 2 different types of concept for

grinding head First one shown in the figure 25



**Figure 22 canceled design**

Because of the first type is not portable and easy to use second grinding head became the main concept for development. One of the main reasons for choosing the second type is a sharpening movement similar to steeling rods which all chefs are using every day. And familiar to that technic. Transferring user knowledge to the new design is creating easy to use for professionals.

For improved stability head part fixed base with leg without frustrate turning ability. These change also improve usability by transferring angle adjustments to the top. These way user can see adjust angle more easily.

Other requirements coming from research is a wide range of grit size. Grit size should be coarser and go up to finer. Stones or diamond coated metals are expensive choices for device targeting amateurs and chefs. Because of our middle price range limitation stones are replaced by 3m lapping films. This replacement required some design elements also which are flat base and attachment for the flat base. Attachment problem solved by using double tape which will also help more flat contact with the base. Interviews showed that chefs are sharpening their knives a month and If consider that lapping films can use at least 5 times, this information showed that replacement time should be minimum 5 months. Replacement in 5 months does not require any fast loading design so double sided tape solution feasible in that case.

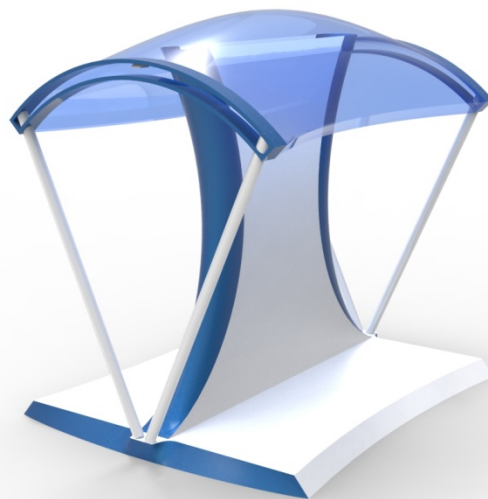
The dimension of the base chosen by considering minimum size 3m lapping film available in the market. Rather than single fixed base; a multiple number of the base designed for taping different grits. They designed to attach rods by using magnets. These way people can change grits easily during sharpening. Also, these magnets will be magnetized steel rods which will collect the entire metal chip produced during sharpening. It provides a more clean solution for sharpening. Magnet clips will help the company to expand accessories in the future also.

Interviews show that chefs are using steeling more than sharpening. Average usage of steeling 2-4 times in a day depends on the application. However, research part revealed that steeling is not operating proper way

even by professionals. In that case steeling becomes more important for the daily use of our product. Due to the fact that we came up with new design solution which converting angle rods to steeling rods. These idea is fitting all steeling requirements even provide the better solution with steeling fixed angle and keeping blade edge more straight with 2 rods. These way users will keep our products on their table for using every day rather than using every month and throw away. For product ranging these rods is going to produce by two options which are ceramics or fine steel. Users can choose each type depends on the personal favor and chooses.

Fixing or holding knife sharpening on table or surface requirements are solved by using suction cups. However due to suction cups need the flat surface, stabilizing with hand also included as an option to use that knife sharpener any surface. Stabilizer Handle located on the top of the product. A form of the handle is made for fit user's hand at the same time for protecting hand any kind of slipping accident caused by during sharpening. Angle and shape of the form are going to lead knife away to users hand in an uncontrolled situation to avoid accidents. This kind of protection also suggested by users.

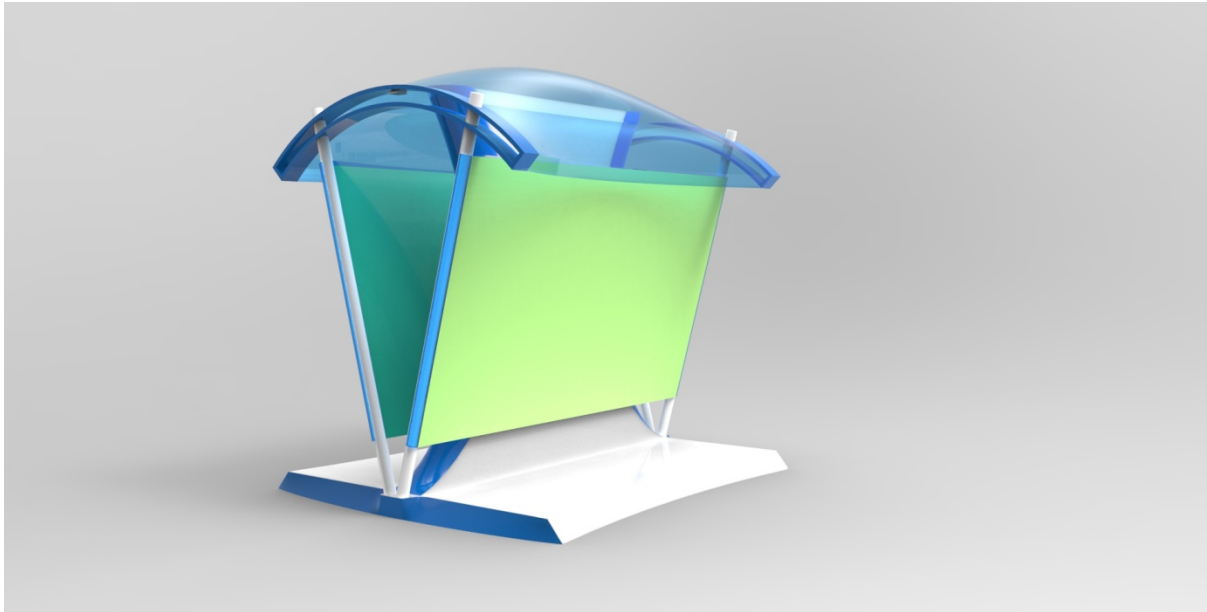
Clamps or any kind of fixing equipment is not used for holding the blade. Fixing equipment limited the sharpeners ability and making product unpractical. Also, they limited knife types that can be used in that product. As we see in our research; products that have clamps complained about some limitation and not practical devices. Chefs that joined interview insisted practicality issue. Because of that stability of the knife under the control of users hand in design; these will also improve product experience with step by step improving techniques which same as a sharpening stone.



**Figure 23 steeling rods structure**

Another improvement made by turning one-sided sharpening in two-sided. This will prevent multiple adjustments during changing blade sides which cause really painful and impractical sharpening at finer stages. New double sided design doesn't require any angle adjustments after first adjustments finished. These will shorten operation time. Another advantage coming with the new design is It free user to count a

number of strokes to sharpen each side equally. Also, these way chefs are steel or sharpen their knife quickly even in working times which some chefs complain about time issues. Rods are redesigned for fitting for two-sided design. In the new design, we influenced the mechanic design of compass (drawing tool). End of the rods contains gears as a compass. That gears are meshing each other, different direction of the rods move at the same time with the help of that. Same direction of the rods is connecting with the fixed tube. With these improvements, 4 rods can be move same time and angle.



**Figure 24 final Design**

After the two-sided design is finished we improve interface also by adding color coding in specific angles. There will be 4 different colors for indicating angles for the application. One face Contains color with numbers that showing angles. Another side contains same colors with application name written on it. A design decision made these ways because even most of the professional chef that we talked don't have an idea about sharpening angles for the application. Two faces indicators will help them to sharpen correctly.

Aluminum and Acrylic glass used in the design. The acrylic used for primary element because some part has a complex form. Using Plastic that produced by injection molding is one of the easiest way to produce complex shapes. Using acrylic as a primary element will be helping reduce the cost of the products also. Transparency of product helps users to see knife during the operation which will make easier to sharpen. In advance, semitransparent acrylics are creating harmony with kitchen. Users can choose different colors for their favor which will increase product range in the feature. Metal frames used for giving strength to the products. Metal also create harmony with rods. The expensive and professional sharpeners (that we search) are containing metals. Metal can be one of the tags that showing products are for professional. Using acrylic and Aluminum together will create perception that these product is for professionals and amateurs as well. Users suggesting that product shouldn't look too industrial, at the same time shouldn't look so cheap or



stylish. That kind of design will be fit these requirements. Other flat part made by the translucent abs material to make the product cheaper and rigid.

All parts are coming with assembled. Due to product relatively small size, it doesn't design to be foldable. Research on different products showed that foldability makes products hard to assemble and not user-friendly. Due to the fact, that product doesn't have that option.

## 6) Further Development:

Design that presented the previous section is the first concept design for that subject. Design part didn't include engineering solutions or production consideration. All these considerations will be improved after the first prototype tested out. Diminutions, material selection can be changed if there is an improvement need. The design will be tested with all different knives. Knife sharpening test will be made with them to test edge quality that produces in that product. After all, the product will be tested in real life to observe user behaviors and thoughts.

## 7) Conclusion:

The study intended to design new efficient sharpening solution by using 3M lapping films. To understand sharpening; sharpening angles, edge qualities, differences of sharp and dull knife searched deeply. Outcomes pointed out the importance of sharpening angle and surface quality of the edge. Also, differences between steeling, lapping and sharpening figured out. The importance of each step is noticed to use in development part. Abrasive materials and sharpening, steeling and lapping equipment are researched to choose correct components for development. 3M lapping films advantages are become more important. After researching components and other components are helping us to understand important points and tricks of applications. In the last part, general types of sharpeners are investigated. Customer reviews product manuals and websites are used for research materials. All good and bad side of the products are written in the text. The good sides used as a guide in development part and bad sides are used as a consideration. Two sharpener system are stand out than others' system sharpener are stand out because of practicality, easy of use and compact design. Sharpening stones are stand out because the efficiency of sharpening and ritualistic user experience and traditional connection. In the other hand, all knife sharpeners are putting in the market positioning chart and a market gap is examined. Product positioned in the market after that. Market target audience chooses as professional chefs and because of amateur chefs are following professional chefs advices they will be included also. Price range is targeted between 30 dollars to 50 dollars.

Interview and field research are made to support our literature research and for understand user needs. For field research, One of the knife maker towns visited in Turkey. Town called Sivas produced own local steel and that steel is using to make a knife in local knife makers. Visiting two different knife makers that using some material reveal the importance of sharpening. It also gives chance to testing angle, surface quality differences

and how these affecting knife sharpness. In that, the part author also finds out better-sharpened knife costs 5 times more than a regular knife.

Interviews are made with chefs, chef school students and one amateur. Participants are described how they are sharpening their knife. It appears that most of the chefs don't have enough knowledge about sharpening also and part of them are taking sharpening services from companies because of they don't have a time. Practicality became more and more important for design after that answers. Most of the chef said that they don't want any product look like industrial. They also don't want a product that operate by electricity. We consider this advice in the designing part. The other outcomes came from the interview that importance of sharpening. Chefs are sharpening their knives average 4-5 times every day. At the same time, they are sharpening their knives every month so steeling more important for them for daily usage. It also gave another design advice that adding steeling function in design.

When we told participants our design ideas they give positive reaction about it and they said they definitely need that kind of design in their kitchen even some of them try to order.

Last part of the study was designing our product with gathering all information. We design first concept containing adjustable angle rods which also can be used in steeling and changeable grit size grinders. For further development, it will be tested and developed for manufacturing and marketing.

In my opinion, this kind of design will create the fast and effective solution for chefs and amateurs. It will help motivate people to sharpen their knife. In these way, people can use their knife longer and sharp as much as possible and also help the environment if people don't buy a new knife when their knife is dull.

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