The Vikings were some of the fiercest warriors of all time, and a select few carried the ultimate weapon, a sword nearly 1,000 years ahead of its time, built by a mysterious craftsman, from a material unknown to rivals for centuries. The sword was known as the “Ulfberht.”

The swords were far better than any other swords made, before or since, in Europe.

The secrets behind its design, creation and use have been lost, but now, the world’s largest steel company and a modern day blacksmith divine its mysteries and bring the Ulfberht back to life.

To do it right…it is the most complicated thing I know how to make, and it’s that challenge that drives me.

A millennium after its time of glory, discover the Secrets of the Viking Sword, right now on this NOVA/National Geographic special.

Master swordsman John Clements has cut with some of the most famous swords ever made, from Damascus steel blades to the legendary samurai sword, the Katana. Forged by master craftsmen, from the 14th century onward, the samurai sword is renowned for its elegantly curved blade and impressive cutting ability.

I think the Katana is a beautiful weapon. It’s a fine weapon. It slices, it cuts, it thrusts, it dices, it makes julienne fries. It’s wonderful, but it has been exaggerated.

You see demonstrations of a sharp sword like this cutting material, all the time, and you think it’s impressive because, “Oooh, look what it does!” But that’s really not that impressive, and here’s why.

This is a wide medieval bastard sword, and this one’s blunt. It’s got no real edge to it, no edge sharpness, but watch what I’m going to do with it.

A really good sword is not just about cutting with a really sharp edge.

Strength, flexibility, weight and shape all determine how well a blade meets the combat challenges of its time and whether it’s a superior sword.
Many great swords are famous, but there’s one few have ever heard of that was perfectly designed for its day.

FREDRIK CHARPENTIER LJUNGKVIST (University of Stockholm): They were a luxury, rare and expensive. It was the Rolls Royce of the swords.

NARRATOR: Produced only from about 800 to 1,000 A.D., this Viking sword was made from a pure steel, not seen again in Europe for nearly 1,000 years.

This high-tech weapon of its time was inscribed with the mysterious word “Ulfberht.” Carried by only a few elite warriors, the Ulfberht represented the perfect marriage of form and function in the chaos that was a Viking battle.

NIELS LYNNERUP (University of Copenhagen): It’s not, “People, divide you up and have a nice duel one to one.” The fight was very violent, chaos, people moving around, striking out whenever possible. Some people were struck multiple times and from all kinds of angles.

NARRATOR: The Vikings spread out from Scandinavia, colonizing vast expanses of Europe, from the 8th through 11th centuries. They are so admired as fighters that people, to this day, reenact their battles.

In Viking times, most men fought with axes and spears, but those who could afford it used swords for close combat. The Ulfberht’s combination of strength, lightness and flexibility was an advantage.

ALAN WILLIAMS: The swords were far better than any other swords made, before or since, in Europe. And these must have been extraordinarily valuable to their contemporaries, because of their properties.

NARRATOR: Thousands of Viking swords have been found, most discovered in rivers or excavated from Viking burials across Scandinavia and northern Europe, but only 171 have been identified as Ulfberhts.

JON ANDERS RISVAAG (Norwegian University of Science and Technology): The swords, as they are today…it’s very hard to see that this was actually a state-of-the-art weapon.

NARRATOR: Buried for centuries, only corroded skeletons of the once glorious blades remain.

JON ANDERS RISVAAG: They don’t look very much today, but in their time, the Ulfberht was the weapon of the upper strata. You would certainly notice a person carrying a weapon like this. This would be a very precious, very beautiful object, and a deadly one, obviously.
NARRATOR: The secret of the Ulfberht’s construction has been lost for nearly 1,000 years, but can a modern day blacksmith recapture that technology and bring this remarkable sword back to life?

RICHARD FURRER: To do it right…it is the most complicated thing I know how to make, and it’s that challenge that drives me. I don’t need a sword, but I, I have to make them, not because I can’t do anything else, but because I can’t do anything else.

NARRATOR: In northern Wisconsin, Ric Furrer is starting out on the task of a lifetime. He’s one of the few people on the planet who has the skills to unravel the mystery of how the Ulfberht was made.

RICHARD FURRER: I’m drawing a full-scale paper model of the sword blade that I’m going to try to recreate.

This Ulfberht inlaid sword was popular about 1,000 years ago, and nobody has made a recreation metallurgically accurate since then. I hope to figure out if I can recreate accurately how these blades would have been made back then.

NARRATOR: There are mysteries about everything related to the making of the Ulfberht.

RICHARD FURRER: These were, to a large extent, secrets. You didn’t want to give away your manufacturing technology for your weaponry to anybody else. So, we have to look at the artifact and then reverse engineer. Sometimes it’s a matter of removing a 32rd of an inch here or adding it there or…subtleties that you don’t think matter that can, in fact, make a huge difference in how the blade performs.

The trick is to piece together from enough archaeological evidence to figure out what the proportions of these blades should be and then the chemistry. What is the material that these were made out of? And that is new information, why they’re metallurgically different.

NARRATOR: In London, one of the world’s leading experts on historic steel weaponry, Alan Williams recently made a discovery about the Ulfberht that shocked scientists and sword makers alike.

ALAN WILLIAMS: I’ve been fascinated by armor and swords for a very long time and have always wanted to find out what they were made of and how they were made. Smelted iron was the source for swords, weapons, armor, for thousands of years.
NARRATOR: From about 800 B.C., 'til today, humans have made weapons from steel. The process starts with iron, which is found in the ground as ore. The crushed ore is heated to separate the iron from the rock. But, on its own, iron is too soft to yield a strong weapon. The trick is to add carbon, most commonly from coal or charcoal. This hardens the metal and turns it into steel. But not all steels are created equal.

First, Williams examines a sample, encased in acrylic, from a typical Viking-age sword. Not only does it have low carbon, it has impurities, known as “slag,” that weaken it further.

ALAN WILLIAMS: Medieval iron is both soft and brittle. This is a sample of a sword of modest quality. These long inclusions—perhaps looking a bit like sausages—these are inclusions of slag, the non-metallic part of the ore which has never been separated from the iron. The slag makes the iron brittle, which doesn’t, actually, give you a terribly good sword.

NARRATOR: Medieval blacksmiths in Europe didn’t make slag-free steel, because their fires weren’t hot enough to fully liquefy the iron. In modern times, metals are melted at temperatures over 3,000 degrees. This separates out the slag and allows more carbon to be mixed in evenly. But in the Viking era, carbon could only be introduced incidentally, mainly through the coal in the fire, and the only way to remove the slag from the metal was to try to hammer out the impurities with each strike.

Of the thousands of European swords from the Middle Ages that have been found, all were thought to have been made from this inferior steel, until Williams analyzed the Ulfberht.

ALAN WILLIAMS: One or two swords I looked at seemed to be different. They were made of steel, which I’d never seen, before or since, in a medieval object. This seems to be a completely different material.

The first thing that strikes you is that there are none of these long, grey slag inclusions, which make the metal brittle. The uniformity is more like a modern steel than it is a medieval one. And it has got a carbon content of about three times as much as the medieval steel we looked at a moment ago. I thought it was very odd. I couldn’t think of a reason for it.

NARRATOR: The only swords Williams found that were made of this clean, high-carbon steel were those marked as Ulfberht. The metal, known as “crucible steel,” gave the swords capabilities far ahead of their time. But it could only be made by melting iron at high temperatures. And no one in Europe would know how to do this for centuries.
ALAN WILLIAMS: The material used was a novel material, not found anywhere else in Europe in the middle ages.

RICHARD FURRER: The biggest mystery is where did they get this raw material? We have no archaeological evidence of any crucible steel production in Europe until 800 years later.

NARRATOR: So how did these Norsemen, widely viewed, to this day, as barbarians, get this cutting-edge technology?

Contrary to their image, the Vikings were advanced in many ways. They were highly skilled navigators and traders who are believed to have extended their reach as far as North America and Central Asia.

FREDRIK CHARPENTIER LJUNGFQVIST: During the Viking age in Scandinavia, all free men were, by law, forced to possess weapons and go to war. But much Viking warfare was raiding and plunder.

NARRATOR: Many Vikings were pagans who worshipped their weapons and even believed a sword could help a warrior enter heaven.

FREDRIK CHARPENTIER LJUNGFQVIST: The warriors would come to a special place, called “Valhalla,” where they would have feasts and fighting. In a warrior paradise, the only way to get to Valhalla was to be a warrior and die in battle, with your sword in your hand.

GUNNAR ANDERSSON (National Historical Museum, Sweden): The sagas tell stories about the swords, how powerful they were. Many of the swords had personal names, sometimes, that are connected to, for instance, a bear or a wolf. By giving it a name, you could also incorporate the power of your ancestor or somebody very strong into the sword.

JOHN CLEMENTS: See how your whole weapon’s blocked, and there’s that sweet opening right there? So, you throw that blow, my point’s right between both your weapon and your shield.

NARRATOR: According to John Clements, in the arms race of the day, blades rarely touched each other directly. Instead, they pounded against armor and shields as fighters tried to go for the kill.

JOHN CLEMENTS: The reality of Viking combat is there’s not the constant edge-on-edge, blade-on-blade contact.

Very good.
They’re using the shields far more dynamically. They’re getting in close, they’re overwhelming their opponent with vicious blows. I come in, I hit your shield. If I, if I don’t do it right, you’re going to get me. But if you do, there is that opening, because you can’t raise your shield.

You’ve got to think of the sword as a tool that’s being used to do things such as warding off blows. It has to be robust and resilient, because fighting is not just about clash, clash, clash. It’s a lot more dynamic.

_NARRATOR:_ The lack of brittle impurities in the steel made the Ulfberht unusually flexible, and this was a huge advantage. A Viking fighter was doomed if his sword got stuck in a shield and broke. It took a special steel to withstand such stress, and a sword that could do this might even have been seen to possess magical powers.

_RICHARD FURRER:_ These blades and these blacksmiths were held in certain esteem and also feared a little, because of this elemental property of what they’re working with and what they’re producing. To be able to make a weapon from dirt is a pretty powerful thing.

_NARRATOR:_ Magic and science have been intertwined throughout human history, And the Ulfberht merged the mysticism of the past with the precision of the modern world to come.

_RICHARD FURRER:_ So, this is our steel-to-be.

_NARRATOR:_ Starting with raw iron, Ric begins the process of making crucible steel. It’s the first of many steps on the way to a finished sword. A mistake at any point could lead to failure.

_RICHARD FURRER:_ This charcoal will be the carbon source for the steel, so the charcoal here will get absorbed into the steel. And we don’t need much.

_NARRATOR:_ If all goes well, carbon from the charcoal will harden the raw iron into steel.

_RICHARD FURRER:_ This is sand, and this is our bottle glass. They will melt and chemically bond with the waste material, the other slags, and will help float them away and leave clean metal so the carbon can be absorbed.

_NARRATOR:_ As part of their mystical practices, some medieval smiths might have used a different carbon source to strengthen their swords.

_GUNNAR ANDERSSON:_ You can also use bone—burnt bone—together with coal in hardening the steel right. And assume, now, that you’re using burnt bones
even from your ancestor or from a bear or something like that. And you hammer in the power of the animal or your ancestor into the weapon, in itself, together with charcoal, and you make a perfect steel blade, a very powerful steel blade, probably, as well.

**RICHARD FURRER:** We are putting the top onto the crucible. This clay will completely seal this crucible from the furnace environment. Mostly it’s to keep more charcoal from getting in. So, we want a set amount of carbon, and if the charcoal were to enter, we would have too much. And there it is.

**NARRATOR:** *Ric will try to melt the metal in an oven he’s building. It’s based on an ancient furnace made of clay and brick that was recently uncovered 2,500 miles from Scandinavia, in Central Asia.*

**RICHARD FURRER:** We fill this all the way to the top, to the tippy top, because we need all the heat. So, we need all the fuel we can get into the furnace. The theory is that this is how they did it 1,000 years ago.

Charcoal will burn hot enough to melt steel. The trick is to get it contained into such a way that you can deliver that heat long enough for the material to melt inside the crucible.

Almost finished; we just have two more bricks, and then we’ve got it sealed up and ready for the burn run.

If we run this right, it should get almost to 3,000 degrees Fahrenheit, and we should get a nice full liquid on our crucible charge. And then we have our starting material for the Ulfberht.

Last brick.

**NARRATOR:** *Closed at the top and vented from the side, this oven traps more heat than other European furnaces of the time.*

*Ric and his assistant, Kevin Cashen, will man the bellows for hours. In medieval times, an entire village would help.*

*The ingredients need to reach nearly 3,000 degrees for the slag to separate from the liquefied steel. Even the smallest fracture in the crucible, the container holding the steel, could derail the entire process.*

**RICHARD FURRER:** We’re hoping that if we run it right, we’re going to end up with a crucible steel ingot, but the idea of actually doing all of these steps and putting it into one piece of metal is daunting, because, at absolutely every stage, you can have a fatal error.
NARRATOR: The Vikings didn’t invent crucible steel. In fact, there’s no evidence that anyone in Europe knew how to make it until the industrial revolution in the 18th century. But for more than 500 years before the Ulfberht, warriors elsewhere had been fighting with crucible steel weapons.

Swordsmiths across Central Asia produced some of the greatest swords of all time, known as Damascus steel blades. Curiously, they were made from material similar to the Ulfberht.

ALAN WILLIAMS: Damascus steel is a separate class of crucible steel, which is similar in chemical composition, but the crucible steel was cooled very slowly, so the iron formed large crystals. And with careful forging these large crystals form a surface pattern on the blade.

NARRATOR: These unusual swords exhibited many of the same superior qualities as the Ulfberht, but if the Vikings didn’t know how to make crucible steel, then where did they get it?

Clues can be found in artifacts excavated from Viking graves, in Scandinavia, as early as the eighth century.

GUNNAR ANDERSSON: The Buddha was found on an island west of modern-day Stockholm. It originates from India, northeast India. And it tells us, of course, that trades with the Far East existed. The ring is the same thing, there. It’s this written inscription that says “Allah.”

NARRATOR: Thousands of artifacts from the east have been uncovered from Viking graves. Islamic coins were even commonly traded in Scandinavia.

FREDRIK CHARPENTIER LJUNGQVIST: You could go, mostly by river and lakes, all the way from Lake Mälaren, here in Sweden, to northern Iran. The route was known as the Volga trade route.

The interesting thing is that the most Ulfbehrt swords are dated from exactly the same time when the Volga trade route was open, that is from the early 800s to the mid-1,000s.

I think it’s very likely that the steel that you find in the Ulfberht swords originated from Iran. I would guess that you bought it from friendly trading connections in Iran, paid with furs and other Nordic commodities, and took it back on your small ships that you used on the rivers.

ALAN WILLIAMS: After the 11th century, the Volga trade route is closed, and the manufacture of these Ulfberht swords stops, which, to me, is strong evidence they were made out of an imported raw material.
NARRATOR: The oven that Ric has used as a model was found in Central Asia, near the end of the Volga trade route.

After five hours, it’s time to see if he has successfully made a crucible steel ingot.

RICHARD FURRER: I think this burned pretty good, so we should have an ingot in there.

NARRATOR: Most of the impurities have separated from the steel and been absorbed by the sand and glass that fall off with the crucible.

RICHARD FURRER: It seems like we have a good ingot, let’s see if we can turn it into a good Ulfberht blade.

NARRATOR: This single piece of steel will make the entire blade. The absence of lava-like sparks suggests he’s created slag-free, pure steel. But the artistry comes in working the hard, carbon-rich metal.

RICHARD FURRER: This part, this initial breakdown, is terrible. You have to be very gentle with it or you can crack it.

NARRATOR: Crucible steel is difficult to work, because, as it cools, the iron atoms form interlocking crystalline structures, called “dendrites,” that look like frost patterns on a window. The carbon in crucible steel makes the areas around the dendrites rigid and hard to forge.

RICHARD FURRER: It’s solidified into this dendritic tree, and it doesn’t want to be anything else. So you’re hitting it, and it’s kind of all nestled together. What you have to do is just nudge it, and, slowly, it breaks down. And after that you really start to enjoy it.

NARRATOR: It will take eight hours of pounding just to form the ingot into a bar.

RICHARD FURRER: Two more.

It’s breaking down quite nicely. So now, we’ll start forming it out into a longer bar and draw the sword from there, but it’s looking real good.

NARRATOR: To test how good it really is, Ric will send a small piece of the crucible steel he’s made with his ancient recipe to the largest steel company in the world.

ArcelorMittal produces nearly 100 million tons of steel a year. One out of five cars in the world contains its metal.
RICHARD SUSSMAN (ArcelorMittal): In the modern steel world, we try to customize the recipe for steel for the particular application, and so there are now hundreds of variety of steel, which are suitable for some applications but not for others.

The Vikings, in their day, I’m sure, wanted hardness on the surface of the sword, so it could cut through easily. They would want the sword, however, not to shatter or break in combat. If it got stuck in a shield, they’d want to be able to extract it without it breaking or twisting or bending. And they’d want it to be able to keep its edge.

NARRATOR: To choose the best metal for a particular application, Sussman’s team tests the capacity of different types of steel to withstand stress. Today, they’ll pit Ric’s crucible steel against the typical European metal of the time. As the Vikings raided their way across Europe, this inferior iron is what an Ulfberht would most likely have met in battle.

The metal is brittle and breaks like a dry twig.

RICHARD SUSSMAN: It would have been a very inferior sword, because it could have shattered in action.

NARRATOR: Now, the machine will measure whether Ric’s crucible steel will be able to withstand more stress.

RICHARD SUSSMAN: The crucible steel that we were given had, actually, very nice characteristics for a sword, which you want to have good strength but also not shatter in action, I think—good characteristics overall.

NARRATOR: An examination of the microstructure, with a scanning electron microscope, will reveal whether Ric has succeeded in making a slag-free, pure steel.

RICHARD SUSSMAN: As we’re moving along here, across the surface, it’s quite interesting how clean it is.

NARRATOR: The image is nearly free of slag and other inclusions that appear as dark circles.

RICHARD SUSSMAN: The inclusions are very small and very minute and very widely distributed.

NARRATOR: Two thousand years after it was invented, Sussman, who has spent decades developing modern steels, gives Ric’s crucible steel what, for him, is high praise.
RICHARD SUSSMAN: This would be a fairly decent steel today. Considering the lack of metallurgical knowledge in its day and the tools that were available, compared to steel making today, it’s not bad.

NARRATOR: After 11 hours of pounding, Ric has transformed his piece of crucible steel into a blade.

RICHARD FURRER: …two more, one more. There we go.

We have the blade profiled, and now we’re going to start refining the tip to its final shape. So, now it’s going to start looking like a sword. It’s no longer a bar of steel. It’s going to start to take on its final shape.

NARRATOR: Ric’s sword will eventually be more pointed, like all Ulfberhts.

RICHARD FURRER: …one more. Flat.

JOHN CLEMENTS: The swords of the Norse tended to be swords that are designed to get through the mail armor that they’re wearing, the chain-linked armor. And that requires a different point and a different cross-sectional geometry. They changed the way their swords were shaped to facilitate thrusting through that mail.

NARRATOR: To show the advantages of the pointed swords that emerged in the Viking era, first Clements tests an earlier replica sword from Roman times against Viking-era chainmail. Designed to slash at opponents from horseback, it has a more rounded tip.

JOHN CLEMENTS: I don’t think a single ring was deformed, split, popped or in any way damaged. So, obviously, a point that’s more rounded, hitting the mail is not going to do as much on puncturing or on even catching it, as will a narrow, tapered, harder point that will get through.

So this Viking-era blade has a slight taper to the point.

Sure enough, it popped about two or three rivets. There is the puncture, there is the cut. And I could feel the blade getting through the cloth and getting into that rubber and that foam underneath.

A blade like this, definitely progress in the arms race between swords and armor.

NARRATOR: The Ulfberht’s shape was perfectly suited to meet the martial challenges of its time, but its true excellence stemmed from its unusual metal and from the intangible value of its name.
RICHARD FURRER: We’re at the point now where we do the inlay, or the cutting of the inlay, for the name Ulfberht.

We’ve got the cross. “U-l-f-b-e” is more or less centered, “r-h, cross t.”

NARRATOR: Like his mysterious predecessor, 1,000 years ago, Ric’s taking a chance by branding the sword.

RICHARD FURRER: There is some argument that the cuts actually weaken the blade, so if I do this wrong, I’ll have to start over from the beginning.

JON ANDERS RISVAAG: As one might see here, that is the b in Ulfberht. And, as you can see there, it stands out from the rest of the sword. If you look closely, you can see some parts of the lettering are actually starting to come off, because it’s been through a hard time in both…in the earth and through the burial. So, this is a very highly skilled craftsman doing this. It’s not very easy to do that.

RICHARD FURRER: This is one of the many make-or-break points in this sword manufacture, because we have to cut the name just right and inlay the contrasting iron letter into the crucible steel blade. So, I’ll carve it with a few chisels, and then we’ll inset the twisted iron inlay.

The fact that they went through the labor to give it that amount of extra effort, that amount of power, by inlaying this name, made them more valuable.

JON ANDERS RISVAAG: Why they put this on, it’s…we don’t know. We are quite puzzled. But it might be because it was, they were making a statement: “This is the real deal. This is something of quality.” But Ulfbehrt is actually an enigma. We don’t know who Ulfbehrt was.

FREDRIK CHARPENTIER LJUNGQVIST: We have no examples, from the written sources from the time, of the name. It does not appear anywhere.

NARRATOR: So what can this name tell us about who made these swords?

The fact that Ulfberhts appear over a 200-year period means they couldn’t have been produced by a single craftsman. But the name seems to be Frankish, from a medieval empire that included France and Germany. And the signature holds an important clue.

JON ANDERS RISVAAG: There’s actually a small cross in front of the name, and ordinary people would not put a cross in front of their name.
NARRATOR: During the Middle Ages, the Roman Catholic Church dominated the Frankish empire and more. A frequent enemy of the pagan Vikings, the church was a major arms producer and arms dealer.

FREDRIK CHARPENTIER LJUNGQVIST: A Greek cross before a signature was only used by bishops and abbots, and so the signature tells us that it was either a bishop’s name or an abbot’s name, or maybe even the name of a monastery.

NARRATOR: It’s possible that the swords were manufactured by the Vikings’ rivals in the Roman Catholic Church and then, somehow, smuggled north.

FREDRIK CHARPENTIER LJUNGQVIST: But we have no way of really knowing how the Vikings got possession of the Ulfbehrt swords, since it was forbidden to trade with the Scandinavians.

NARRATOR: If people in the Church did make the swords, it begs the question how they got the crucible steel. Many experts agree that it was brought by the Vikings from Central Asia or the Middle East, so perhaps the Vikings themselves were the craftsmen despite the foreign inscription.

ALAN WILLIAMS: There are lots of reasons why a Scandinavian might have used a foreign word and have used the cross. It might have been magic; it might have been copying symbols from the disappeared Roman Empire; it might have been simply because somebody thought they liked the name, like putting the name “apple” on a computer. There are dozens of possible reasons why the makers of these swords could’ve used the Frankish name Ulfberht.

JON ANDERS RISVAAG: So, if you look at this mystery, this enigma, of this person Ulfberht, who he was and what kind of position he had, it might not ever be solved.

RICHARD FURRER: I wonder who he was or, rather, who they were, or what this inscription meant to the people that owned the swords. Because we don’t know if Ulfberht is a “kenning,” a word of power…could be an area, could have been a workshop, because these spanned 150 years. So I wonder about a lot of things, but if you think too much about other things, you make mistakes.

NARRATOR: Whoever or whatever Ulfberht may have been, the inlaid lettering helped reassure customers they were buying from a master craftsman.

RICHARD FURRER: That looks all right. Let’s set it. Give me one good hit.

NARRATOR: Once the letters are pounded into place, they are heat-treated. But Ric won’t know if they have set properly until the end of the process, when the
sword is polished and the thick layer of iron oxide that’s accumulated is removed from the surface.

**RICHARD FURRER:** I’m putting in all of this work to make this blade. And if it does work, you still have hours and hours of polishing, to verify that all the work you did up to that point actually made a good sword and that the letters exist. And if it doesn’t work, it really sucks. You just end up with a piece of recyclable material.

**NARRATOR:** With the letters welded in place, Ric must now make something called the “fuller.” The fuller is an indentation down the center of the blade. It reveals the ingenuity of Viking-age craftsmen.

**RICHARD FURRER:** You’ve got the start of the fuller, and that will get progressively deeper as we go. We’re just going to bring that all the way up the blade.

The fuller allows longer blades, wider blades, yet the same weight as thicker, un-fullered pieces of steel, because it acts like an I-beam. An I-beam has structural members here and a horizontal. So, here, we have the fuller acting as the horizontal, and a little bit thicker material, and then going down to a cutting edge. So you have the minimal amount of material to give you the maximum amount of strength.

So, in this time period, the blades are getting longer and longer and longer, but the weight remains about the same. A completed sword weighs about two pounds, a little bit less, about like a baseball bat. Swords weigh about what a baseball bat weighs.

**NARRATOR:** The fuller made longer blades lighter.

**NIELS LYNNERUP:** You’re fighting for your life. You need to use every opportunity you can to strike. Some of these Viking swords are heavy. You just don’t move like the Three Musketeers easily. It takes some force to wield the sword, and, having done a full stroke, you need to swing it back up.

**NARRATOR:** If a fighter didn’t get his sword up fast enough to strike an opponent, he might not get another chance. These victims of a Viking attack, found in a mass grave in southern Greenland, all show clear evidence of blows to the head.

**NIELS LYNNERUP:** In a forensics context, what we’re looking at is the velocity and the weight of the swords. If we take this skull here, we can see a very clear marked cut edge. This is where the weapon struck and actually managed to cut through quite a lot of the skull, before, finally, some of the bone here was crushed, and then the sword was taken out. And this blow would certainly have been deadly.
NARRATOR: When a warrior was killed in violent combat, the living often took precautions to avoid his wrath in the afterlife.

GUNNAR ANDERSSON: If you bent the sword, you also destroy the power of the sword, right? And you bury it together with the person that owned it, and, in that way, you made sure that the powers of the weapon were buried, as well, and killed, as well.

NARRATOR: Hundreds of swords, which were heated and then bent, have been unearthed from Viking graves.

JON ANDERS RISVAAG: If you took a sword off an enemy, you would make damn sure that he didn’t come back in the afterlife and bothered you with the sword. So it’s sort of a ritual killing of the sword too.

NARRATOR: Ric is heating his sword for another purpose. He has reached the riskiest part of the entire process. It’s called the “quench.”

RICHARD FURRER: The quench is where it’s really born. It’s just a piece of metal until it comes out of the quench.

NARRATOR: The goal of the quench is to harden the sword by heating then rapidly cooling it. We know now that this affects the atomic structure of the metal. According to legend, ancient blacksmiths cooled their swords with anything from water to dragon’s blood, but Ric will use oil. He’ll quench the sword when the blade glows a consistent, dull orange.

RICHARD FURRER: Up until the last few minutes, all the prior work can be destroyed. This one has so much technology going into it, so much time. If it breaks in the quench, I’m going to be absolutely gutted.

NARRATOR: It’s uncertain whether the makers of the original Ulfberhts quenched their swords, but Ric believes they did and thinks it offers final proof of a blacksmith’s mastery over the metal.

RICHARD FURRER: I’m in love with the steel, this very primal interaction with this raw material that’s largely unforgiving, and, even if you treat it right, absolutely everything can go wrong.

We’re coming up nice.

NARRATOR: The quench will make the blade hard, but it can also crack the sword.
RICHARD FURRER: The “ping” is the audible sound of the steel cracking. So we hear it as a “tink” or a “ping,” and that means that somewhere along that blade, it has cracked, and we need to start over.

I think we’re about there.

We’ll know within about 10 seconds of the quench if we got a good sword or not.

I think we’re going to go for a quench, like, maybe…right now.

No ping! Did not crack.

A little bit of straightening, it’s a little bent, but we can handle that.

I don’t think a crucible steel with bloomery letter Ulfberht has been made since the originals. So it’s been 900 to a 1,000 years.

We have an Ulfberht!

I think we’ve got a good blade. I want to see the name. I’ve waited quite a while to see the name.

NARRATOR: The name will remain hidden until the sword cools and Ric can polish it.

But after 1,000 years, the mysterious Ulfberht inscription has one more secret to reveal. As of today, Alan Williams has examined 44 Ulfberhts, across five countries, and has made one final discovery.

ALAN WILLIAMS: Some swords have the name Ulfberht spelled “cross, u-l-f-b-e-r-h, cross, t.” And some have them spelled “h-t, cross.” Those that were spelled “h, cross, t” had the very-high-carbon steel, whereas the swords which had the Ulfberht name spelled differently, were made of much lower carbon steel, much inferior steel. These must have been copies.

NARRATOR: Of the 44 Ulfberhts that Williams has examined, 33 are not made of crucible steel.

JON ANDERS RISVAAG: You can see here the r, the h, the t and the last cross.

ALAN WILLIAMS: They are contemporary fakes, of course. They were made at the same time, by people trying to cash in on the reputation of Ulfberht. They were probably made by illiterate craftsmen for illiterate customers.

JON ANDERS RISVAAG: It’s the Armani or Gucci or whatever, or the Porsche or…so you want to copy the brand.
ALAN WILLIAMS: To the unsuspecting buyer, it appears to be the genuine Ulfberht, but there’s a much greater chance of it snapping, which is, of course, extremely embarrassing in battle.

NARRATOR: Ric’s sword is made from crucible steel and bears the inscription of a genuine Ulfberht, “cross, t.”

But before his sword can truly be called an Ulfberht, he must see if the inlaid name has survived the process. After tempering, or reheating, the sword a final time, to keep it from becoming too brittle, he begins to polish.

RICHARD FURRER: It can take a few days of rubbing by all hand work to, to get these cleaned up and looking like people assume swords look. It was the luster of the metal that, that made people lust after it. In a world of mud and trees and rock you have the polished metal, and that was different.

NARRATOR: He uses increasingly fine-grained stones to polish the sword, and only then will he sharpen it. But he still can’t be sure if the inlay has survived.

RICHARD FURRER: If the inlay survives all of the grinding, what will happen is, if we add an etchant to it, an acid, then that should create enough of a contrast between the two materials to where the name should be easily readable. We’ll see how well I did.

The cross, u-l-f-b-e-r-h, cross, t.

It looks really good. It was a good inlay. It’s going to be a fine sword. I think it’s worthy of the name, worthy of the name “Ulfberht.”

Here we are talking about a sword that was made last a thousand years ago. I see myself as a caretaker of this knowledge. I can’t make a blade better than this. It represents my entire skill set as it sits now, sitting there in a two-pound chunk of steel.