2.2 Let's make a Sword

2.2.1 Bang it!

- **You're the smith** in ancient times (from 500 BC to, let's say, 1800 AD) and you have a lump of iron or steel. Maybe it fell down from the sky like in ancient Egypt, where iron was known as "ba-en-pet" or "metal of heaven". It is generally believed that before about 1300 BC, extremely rare **meteor iron** was the only iron the ancient Egyptians knew. Vagn Fabricius **Buchwald** doubts that and I tend to believe him as you will see later. If your iron did not fall down from the sky, maybe you or some specialist of your town, made it from iron ore, charcoal, secret magic ingredients, plus prayers or spells. Maybe you imported steel from what is now India, because the ancient Indians could make some particularly good stuff called "**"wootz" steel**, or maybe you still have the pieces of your father's magical sword that broke when he fought someone or something while having unclean thoughts; whatever.
  Now make a sword from your iron or steel.
  - How do you do it? Most contemporary people have never pondered that question. If pressed, they tend to weasel and guess that's it's done by casting, rolling, or by pressing it into a form. You might have seen that in a car factory, where the car body is made from sheet metal that way.
    All of that is wrong. *Completely, utterly wrong*.
  - Let's start with something easier. You have your piece of iron and you want to make a pitchfork or the pieces of a chastity belt because your spouse needs one. What you do is: heat up your piece of iron until it has a certain red color. Then, while it is still hot, you bang it into the wanted shape with your trusty hammer. Repeat heating and banging until you have the final shape. Then you are done.
    Now you want to make a decent sword. You're going to heat and bang your material too but that is only a small part of the total process now.
    You, the smith, will spend far more time on making a sword than on making pitchforks, pots and pans.
    Nevertheless, no matter how involved your forging technology might be, one essential fact remains:

> **Everything, I repeat: EVERYTHING that was made from iron or steel up to and beyond about 1800 AD, some smith had banged into its final shape with a hammer.**

- All the iron or steel swords, knifes, axes, suits of armor, chastity belts, chain links, locks and keys, needles and so on were made this way. *No exceptions* .
  - Next time you see a complete suit of armor in some museum, you will look at it with a new kind of perception. Imagine making it with nothing but a hammer, an anvil, a fireplace (a smith's **hearth**, actually, coming with bellows and charcoal) and some simple tools like tongs and files.
    Could you do it? Neither could I!
    Nowadays you need to go through "a long and grueling training phase of almost 3 months" if you want to become a top model—I'm quoting from a TV show. The producers of that show left no doubt that this kind of ordeal entitles you to a sizeable income. If you want to make real money, however, you might need a year or even two of involved training, including squandering other people's money by the billions, as **investment banker**.
    In contrast, a humble smith, able to produce one of the swords we discuss here, had to learn and practice for many years. Thousand and some years ago *and* today!
    At a **Viking** show in Schleswig, Germany (home of major Viking artifacts, including swords, in its large museum), I watched a young smith forging a simple sword. "Could you make a replicate of one of those fancy pattern-welded damascene swords I see in the museum?" I asked him. He laughed and replied: "I've been at this for three years. Come again in about 5 to 6 years; then I might be up to a fancy kind of damascene sword". As an afterthought he added: "And don't forget to bring along several thousand Euros in cash if you want to buy one".
- You might tell me: "this is vaguely interesting—but is it true? After all, I have seen superior steel swords made by casting molten steel into a mould when I watched "**Conan the Barbarian**" in the movie theatre, not to mention good old "**Siegfried**" of Wagner fame in the opera. And what about those old Chinese guys who were famous for their huge cast iron cauldrons 2.000 years ago? In the Bronze Age, everything was cast; I have seen the moulds for swords in the museums. I also know that during the last war that you Germans won (1870, against the French), huge cast steel cannon from **Krupp** , a company name almost synonymous with "Gussstahl" **(cast steel)**, was used. So how about that?"

- What you tell me is absolutely correct. But you still got it *wrong*. Let me tell you:

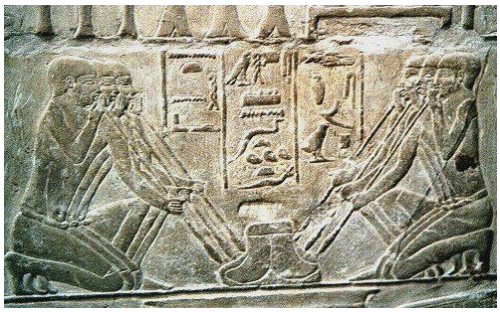
Conan, as well as Richard Wagner's Siegfried, and plenty of others, simply got it wrong.

Conan (alias **Arnold Schwarzenegger**), not knowing how swords were *really* made, had to become a politician. Being clueless is acceptable if not actually required for that job. Siegfried is dead (spear in the back; forged point, not cast).

- **"Cast-iron"**, the *name* for a material quite different from iron or steel, can be cast, indeed. But cast-iron is neither iron nor steel but some brittle stuff. Cast-iron sword bearers, if there were any, did not enjoy a long life.
  Bronze, an **alloy** of about 90 parts Copper (Cu) and 10 parts tin (Sn) was cast with ease indeed, but iron and steel were *never* cast before the middle of the 19th century.

The reason for that is simple: the old smiths' couldn't get it up.

- They could not get up the **temperature** of their fires to the 1536 ^{o}C (2732 ^{o}F) required to melt iron. For comparison, copper (Cu) and gold (Au) melts at 1084 ^{o}C (1983 ^{o}F) and 1064 ^{o}C (1947 ^{o}F), respectively; and bronze comes in at a low 800 °C -1000 °C (1472 ^{o}F - 1832 ^{o}F), depending on composition.
- Make a nice fire and blow into it a bit (through hollow reeds like the old Egyptians), and you might get up to 1100 ^{o}C (2012 ^{o}F). But blow as hard as you can and you will not even get *close* to 1536 ^{o}C (2732 ^{o}F).



Melting gold in ancient Egypt

Source: Photographed in-situ

- The picture shows a relief in the Mastaba of Mereruka in Sakkara, Egypt. It goes back to the 6th dynasty and is about 4.400 years old. It shows probably gold smiths (or more likely their apprentices / employees / slaves) blowing into a kind of hearth intending to melt (a little bit) of gold. It take six guys for that particular blow job just to get a little bit of gold up to 1064 ^{o}C (1947 ^{o}F)! There is no way whatsoever to melt a lump of iron or steel large enough for making a sword in this way.

By the way, I will debase myself to the point where I give **temperatures** in degrees **Celsius** *and* in degrees **Fahrenheit** instead of **Kelvin** to help you non-scientific and possibly non-metric folks out there. All you need to know about temperature and how to measure it is found in this module.

- I will also spell out the full names of elements and compounds *and* give their **chemical symbols** to help the chemically challenged out there.
  Out of the goodness of my heart I even give you a complete **periodic table**, from which many secondary links will give you plenty of data about all chemical elements.
- I will, however, *not* give **inches**, pounds and other nonsense next to **centimeters** and **kilograms** . I will also not insult your intelligence by referring to **nanometers** (nm) and so on as "one hundredth of a millionth of a centimeter", "a fiftieth of a thousands part of the diameter of a hair" or other crap like that.
  I will give you this basic module for the essentials of the metric system and for figuring out yourself how to convert length scales if you must.

Now back to the ancients not getting the temperature up. Think about it: What would *you* do to get **very high temperatures**?

- You won't be successful with an open **fire**. You need involved constructions around your fire *and* you need to blow plenty of air (or even better: oxygen) into it. In other words: you need a **blast furnace**.

- I bet you couldn't build a blast furnace. Neither can I. But all of us can make *very* high temperatures with the switch of a finger: by turning on a light bulb, for example. We use **electricity**, in other words.
  The temperature of the tungsten (W) wire in your light bulb is around 3000 °C (5400 °F) and you get that by just throwing a switch.
  Unfortunately you, the ancient smith or iron smelter, did not have electricity at your disposal. At best you had a bunch of slaves (or wives) for working the bellows. A good water wheel working your bellows is much better, and a steam engine is better still.
  Electricity beats all that. But steam engines and electricity haven't been around all that long; the other options are not all that effective. It is no accident that there was no mass production of steel before the advent of powerful steam engines in the middle of the 19th century.
- In the words of **Franz_Sales_Meyer**, who around 1888 wrote the "Handbuch der Schmiedekunst" (handbook of the smiths' art) that my grandfather (a smith) used:

"Wrought iron can't be melted".