Manufacturing Processes – Casting and Joining
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Lecture – 02

Hello and welcome back to the course on Manufacturing Processes - Casting and Joining. Let me remind you - we were discussing the casting process and we started discussing about the advantages and disadvantages.

We said that, the greatest advantage that we get from the casting is that there is no wastage of material like in case of machining where we waste a lot of material in terms of the small chips, which cannot be reused.

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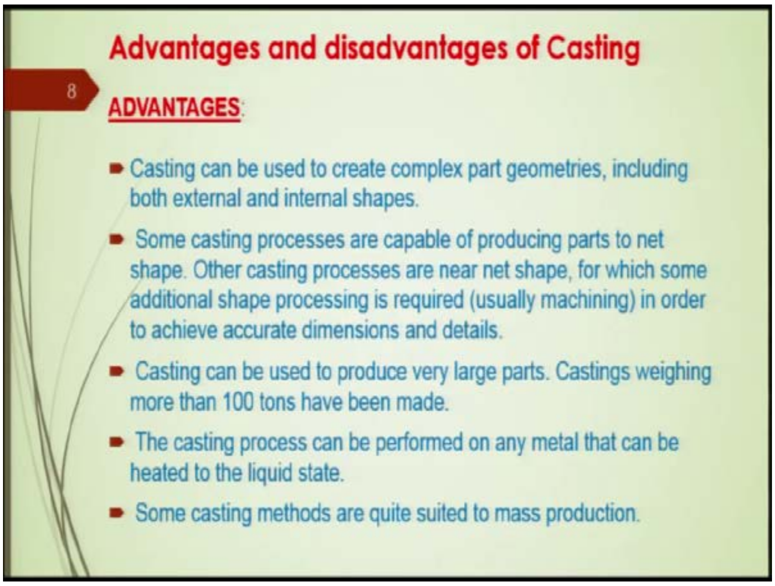

In case of casting, some casting processes are capable of producing parts to net shape. Other casting processes are near net shape type for which some additional shape processing will be required. Usually, they are machining in order to achieve accurate dimensions and details, this we said last time.

Casting can be used to produce very large parts. Casting weighing more than 100 tons have been made. More than 100 tons means, as I gave you an example of the Buddha statue in the Spring Temple in China - this is 1000 tons of weight and there we have about 1100 different parts, each of them is made by casting process.

So, as you understand that each of them is about few tons. Casting processes can be performed on any metal that can be heated to the liquid state. So, this I said earlier, that any metal that can be melted can be casted also.

Some casting methods are quite suited to mass production. This means that those casting processes are easy to automate and they can be actually used in the mass production at a very large scale; because of the automation the production rate goes very high.

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Now, there are few disadvantages as well. The biggest disadvantage, I already told you indirectly, is the limitation on mechanical properties. Mechanical properties are not always very good.

Porosity: when I was introducing the casting process, I told you that the gas which evolves from the cavity after the molten metal is poured into the cavity has to be escaped.

The mold material has to be selected in such a way that the gas can be actually taken out, it can escape. If it goes through the molten metal and cannot escape, it remains inside the molten metal in terms of small air bubbles and those create the porous surface in the casting. Poor dimensional accuracy and surface finish for some casting processes for which we need to have the subsequent machining or other processes. Safety hazards to humans when processing hot molten metals and environmental problems.

Because, always there will be some fume coming out. Apart from that, it will be tremendously hot, because as you understand that the process deals with the molten metal. So, temperature becomes very high in the foundry shop where the metal is melted, or the casting process is being performed.

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Now, there is a historical background, which is interesting to know The casting is one of the oldest shaping processes, dating back 6000 years. That means, 6000 years ago, people knew about casting. Discovery of casting copper occurred accidentally in Mesopotamia.

Initially various kinds of ornaments used to be made by copper. And, the ornament which used to be made by copper, used to be made by hammering. So, the proper shape was given by hammering only.

Therefore, as you understand the quality and the accuracy was not very good. Now, the casting of copper started being introduced, shapes much more intricate could be formed by casting than by hammering, which was used earlier to get the shape. More sophisticated tools and weapons could be fabricated. Because casting processes were introduced, more sophisticated tools were introduced.

More detailed implements and ornaments could be fashioned. Fine gold jewellery could be made more beautiful and valuable than by previous methods, that is the hammering. So, that was the advantage almost 6000 years back.

Egypt ruled the western civilized world during the Bronze Age, which is about 2000 years, largely due to it is ability to perform the casting processes. They already knew, they are aware of different kind of casting processes and therefore, they could fabricate very intricate shape of tools, very fine jewelry and that is how they actually ruled the western civilized world for a very long time.

Construction of cathedrals, churches required the casting of bells, the huge bells which are there on the cupola of the churches or the cathedrals.

These bells actually are made by casting. Particularly the sand casting because there is no other way you can make such huge and such heavy bells. Now, many of the casting techniques developed for bell founding were applied to cannon making.

So, when the bell founding or the foundry of the bell- that means, making the bell by casting, was developed then they started using it for making the cannons for the defense. Now, it was very popularly used because the cannons could be made at a faster rate and at a larger number, that was important at that time.

The first cannon, which was cast, made of bronze, that was made in the Ghent, which is in Belgium. And, surprisingly this is in the year 1313 just imagine how long ago. And, another surprising thing is that this was made by a religious monk. The first cannon, which was a casting made by a religious monk was made by using the same technique that was used for making the bells.

The list of parts includes dental crowns made by casting, jewellery, statues, wood-burning stoves, engine blocks, heads for automotive vehicles, machine frames, railway wheels, frying pans, pipes, pump housings. So, these are the different types of parts which are made by casting. All varieties of metals can be cast, ferrous and nonferrous. These are the greatest advantages of the casting process.

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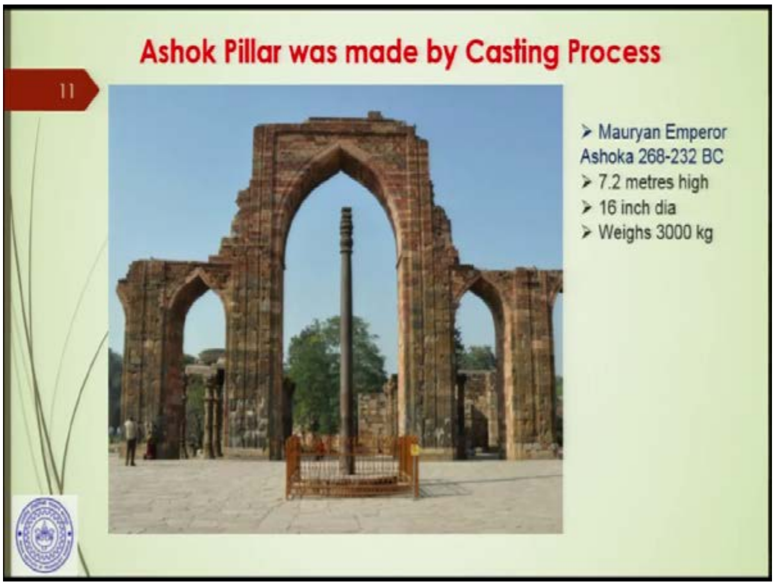

It is interesting to look at the historical background. This is an example of the casting that all of you must be knowing. It is the Ashok Pillar and this Pillar is located in Delhi o, this is in 268-232 before Christ, made by the Mauryan Emperor Ashoka. So, just imagine how long ago.

Now, it is 2020 and then add another 232 . And, this is 7.2 meters high, 16 inch diameter and weighs 3000 kilogram. Now, just imagine that such a huge pillar, how this could be actually made by casting.

Another surprising thing that all of you must be knowing that the material, which material, it is made of that is not very clear so far. Because, it is still not rusted although it is lying under the open sky, and it has gone through the rain and the air but it is not rusted yet. So, just imagine that it is about 2252 years ago that this pillar was actually made.

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Application of aluminum die casting in the automobiles is shown here and you can see the different parts are labeled here in this diagram. You can see that many of these parts are made by the casting.

Those parts are made of aluminum material, because in automobiles we try to get the weight as less as possible, for the less fuel consumption. These aluminum parts are made by the die casting and the die casting method will be discussed in great details later on.

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Foundry practice: foundry practice is the casting process that is called the foundry. Following areas need attention for the successful casting operation so that you could get a casting. By the way, the final product, which you are getting out of casting process is also called the casting.

So, I will be using frequently the casting as a process as well as the casting as the final product. So, to get the final product to get the casting, which is of good quality, which is defect free, you need to have these four points very scrupulously kept in mind. First of all, this is preparation of molds and patterns. Second point is the melting and pouring of the liquefied metal. Solidification and further cooling to room temperature and the casting defects and the inspection.

I told you about these points a little bit, that what kind of molds you will be using, what kind of sand you will be using, how much is the strength of the mold, how much is the porosity of the mold, what kind of patterns you will be using, whether it is the single use, once use or it is the multiple use patterns and so on. Melting and pouring of the liquefied metal, what is the pouring temperature.

Because depending on that you will have different kind of castings, that is you may have a casting with a defect, where the molten metal does not reach the intricate parts of it because the initial pouring temperature was less, was not adequate. During solidification and further cooling to room temperature, different kind of shrinkages occur.

When it solidifies, it actually reduces in size, either it is in the dimensional or it can be in the taper form, for example, that we will see at a later stage. Casting defects and inspection should be looked into very carefully. So, all those things you can see. I will show you right now a video on the foundry practice and you can see these processes clearly.

So, let us go through a small video clip, where you will see all those things in details and I think it will be very clear to you how the entire process, entire foundry practice is performed.

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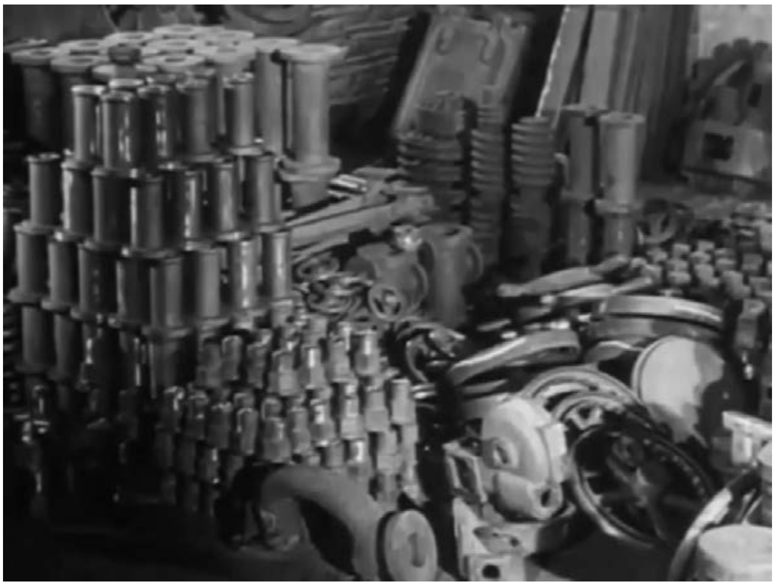

Castings a vital necessity in all engineering industries, some simple others more complex, many of them are hollow like this typical pipe T piece.

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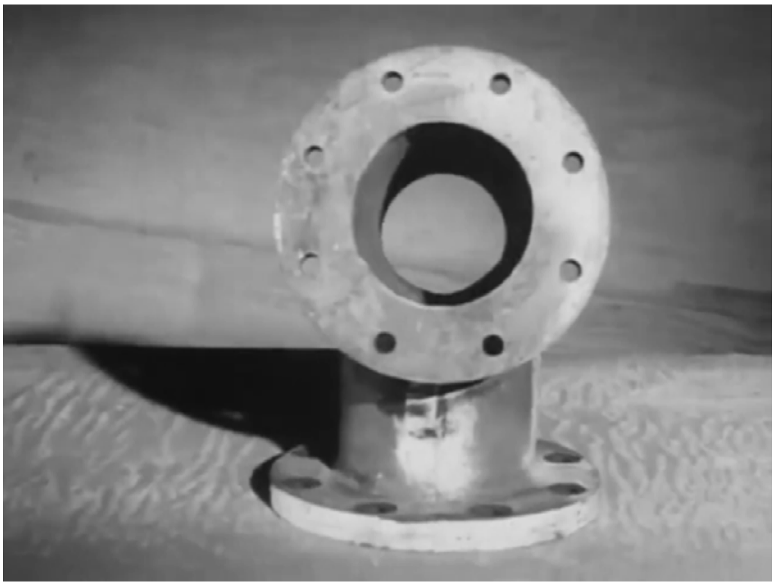

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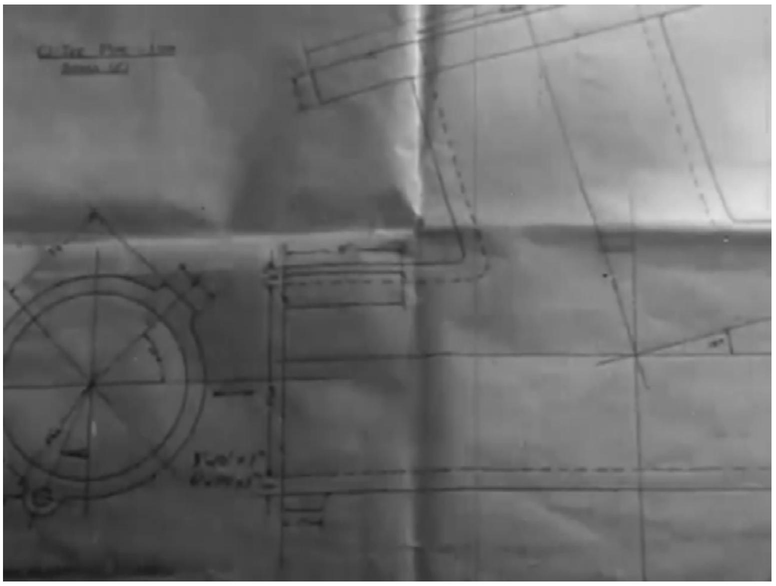

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How are such castings made? From the original machine drawing of the required part a wooden pattern is developed.

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Frequently it is designed in two pieces to assist the molding processes.

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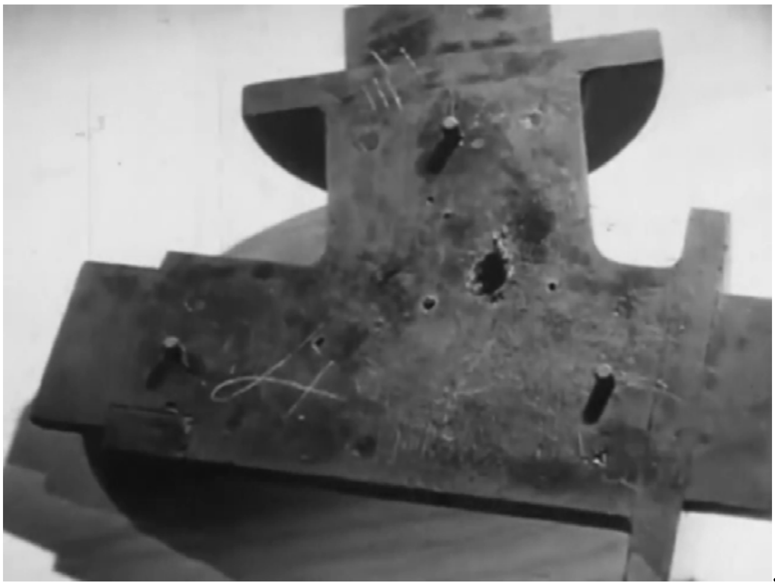
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Dowels in one part and sockets in the other, ensure perfect registration when the two pieces are put together.

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Once, it has been designed and made a pattern may be used many times.

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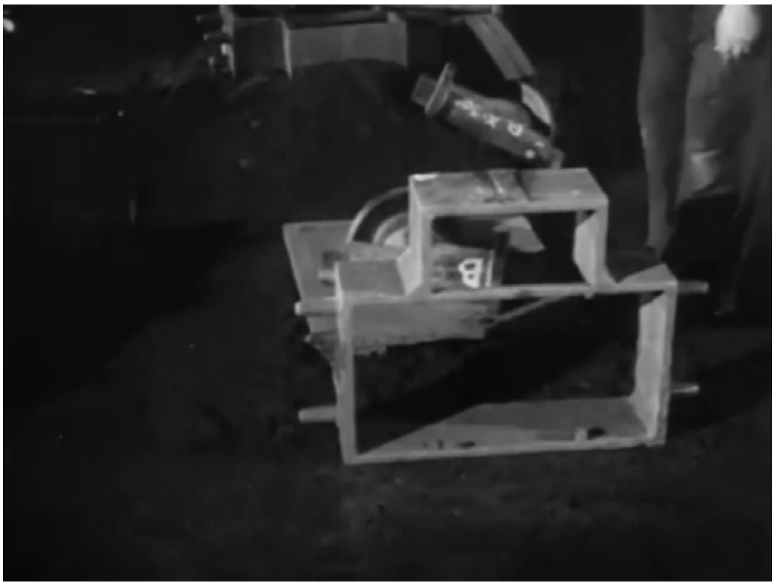

Here, we see a hand molder putting down the bottom half of the pattern onto the wooden board that will form a temporary support.

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When the mold box is filled with special molding sand, that is carefully rammed home around the pattern.

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The success of hand molding is entirely dependent upon the skill of the molder whose knowledge and judgment determine how tightly the sand should be rammed up.

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After removal of surplus sand and squaring off the face of the lower part of the mold, the second part of the pattern is fitted on.

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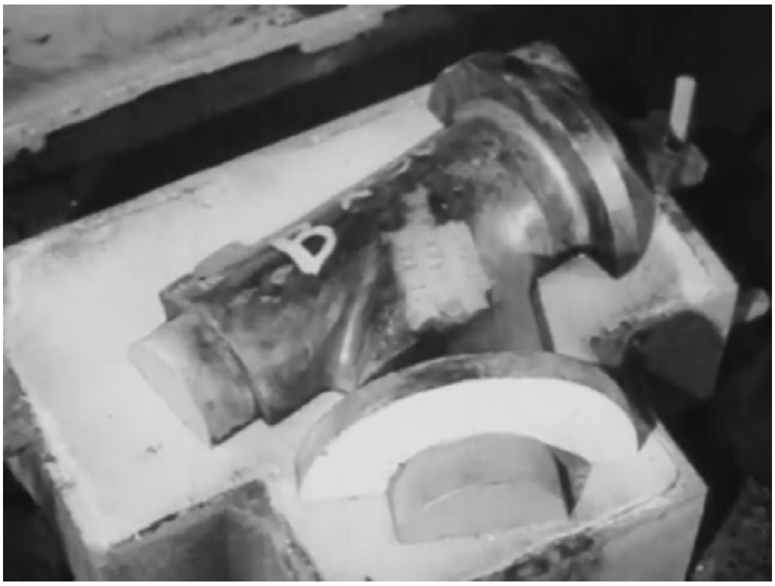

Dry parting sand on the mold face ensures clean separation of the two halves of the mold later.

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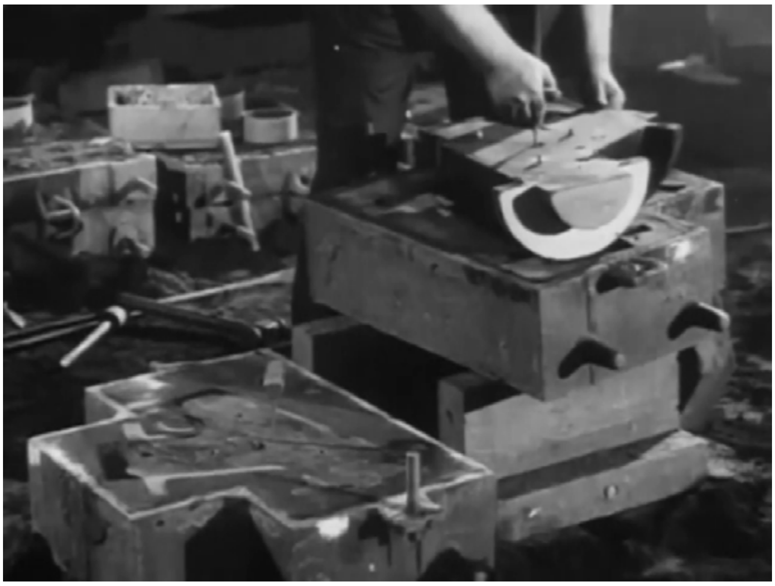

The two mold boxes are kept in correct alignment by register pins. After separation, the patterns are withdrawn from the two half molds, the bottom half of the mold is called the drag, the top half the cope.

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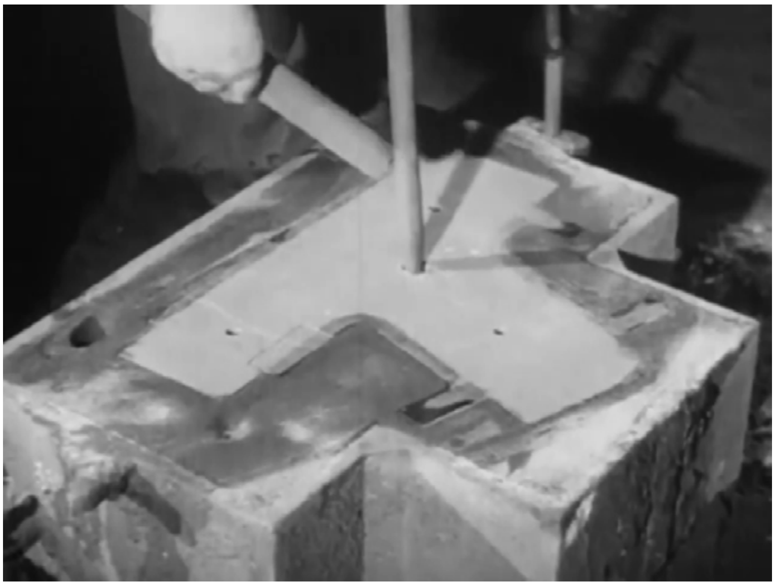

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The pattern is first wrapped to clear it and give an easy withdrawal.

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For a hollow casting a core of baked sand is used to prevent the molten metal from filling the whole space left by the pattern in the mold.

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Here you can clearly see where the metal will flow to form the walls of the casting. The register pins make it possible to replace the top part of the mold in its correct alignment.

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The molder also controls the pouring of the metal. Later he breaks down the mold, the core sand is broken out from inside the hollow casting, which is then fettled and machined.

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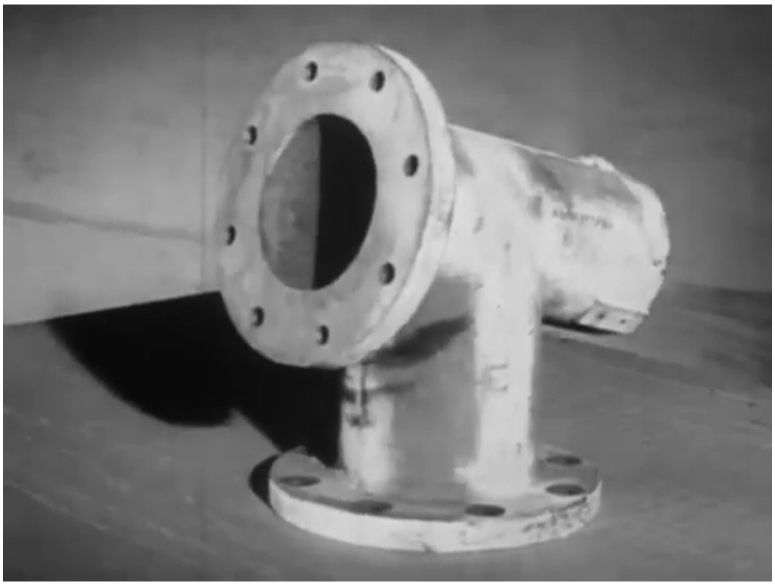

And, we have the finished job.

So, you have seen the foundry practice video. I hope this process is very clear to you. What was shown is the pattern, how the pattern can be inserted, how the cavity can be made and how the internal cavity can be made by the use of different kind of cores. And, this was the sand casting. So, a cavity was obtained within the sand mold. And, hence when the final product or the final casting was obtained, that mold had to be broken.

Therefore, it cannot be used more than once. All these 4 points, namely preparation of molds and patterns, melting and pouring, solidification, casting defects are important. Casting defects of course, have not been shown, but I will discuss casting defects at a later stage.

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Now, I would like to show you another very interesting video, which is the video on the making of the iron wheel. This is little similar to the earlier one. Nevertheless, it will actually give you a very good idea about the casting process.

This is a very small clip and here is that, which is the making of the iron wheel and these iron wheels are made for the BMW Cars. So, you can see the high quality that they obtain out of the casting process. Here is this.

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In another video, I have made a casting model or pattern on my lathe. Now, it is time for showing the casting process. This is done by the company near Unsauro the foundry from Copenia. It is a really beautiful and industrious place and I am glad that I got the permission to film here.

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First part of the process is of the preparation of the mold. The bottom half of the molding box or flask is set onto the floor, where one part of the pattern is laying.

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The oddly shaped block in the corner will form a cavity to hold a special filter to keep the slag out. The other blocks are sprue patterns, they form the channels, which will lead the molten iron to the mold cavity.

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And, here comes the big sand dispenser. The sand is poured into the flask and pushed by hand into the corners.

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The flask is filled to the rim and after some compacting the top is trimmed flush with the rim. After 10 to 15 minutes the resin that is mixed with the sand has hardened. So, the mold can be turned upside down.

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It is now in the same position as it will be later for pouring. After cleaning away the dust the top molding box the cope is set upon of the bottom one the drag.

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Then, the other half of the pattern is put in place, also the other parts of the sprue pattern and an internal feeder.

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The graphite powder is used to make it easier to separate the patterns from the mold later; on the left an iron pipe is visible, that is the pattern for the vertical parts of the sprue.

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The internal feeder is covered with sand completely. It is just the cavity with an opening towards the pattern.

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The iron will fill this space and provide additional liquid iron when the molten iron in the wheel is cooling down and shrinking.

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Now, the halves of the mold are parted to remove a pattern.

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The two protruding knobs that are visible on the top part are there to interlock the two parts in the right position.

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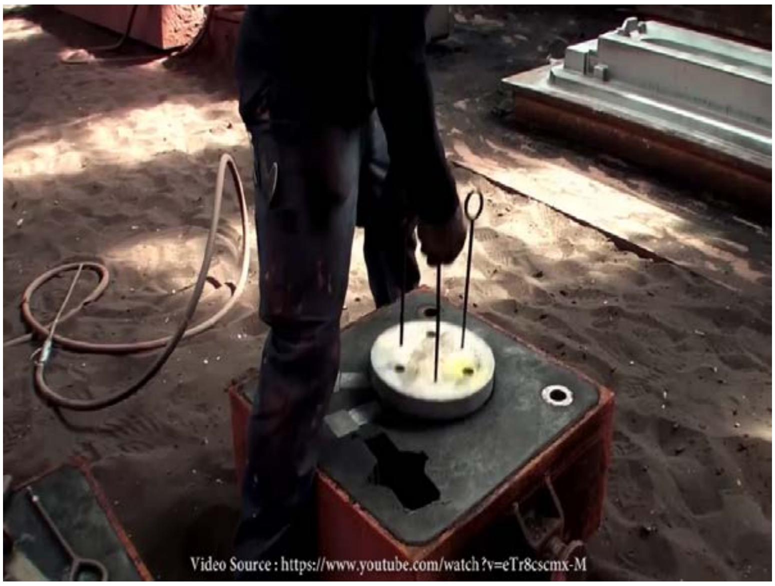

So, that is the moment when my threaded inserts in the model become important. Three hooks are screwed into them and with carefully knocking upwards, the pattern will eventually come loose. Of course, the pattern has to have no undercuts and the vertical surfaces need to be slightly tapered.

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When we finally put the model of the wheel aside after 6 times of molding; it looked quite ok at first.

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But a closer look revealed some damage; if I had wanted more wheels I should have used better wood.

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Next step is the preparation of the mold for the casting. This reddish liquid is a suspension of shamud, it will form a thin layer on the mold as a protection against the heat of the liquid metal.

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Because it is alcohol based it can be set on fire. So, it dries and hardens at the same time.

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Now, the filter is inserted, and some fireproof putty is laid around the cavities in the mold.

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Now the top is set upon the bottom and the two parts are pressed together with clamps.

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The second part is of the casting process itself. Here is the liquid iron in an induction furnace, slag is removed from time to time.

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But the furnace is not full yet. So, another container of scrap metal goes into it; maximum load is 3.5 tons.

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When the temperature is above 1350 degrees Celsius, the iron is filled into a casting ladle and brought to the molds.

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The final measurement of the temperature, when about 80 kilograms of cast iron are poured into the mold.

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While cooling down, the iron and the other components, mostly carbon, will form microscopic crystals. And, their shape influences the material properties; this will be ordinary cast iron with lamellar graphite also known as grey iron.

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Some days later, I came back and looked for the wheels in this part of the factory where the paddling and finishing is done.

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Oh, here they are, 45 kilogram each and already sandblasted. Next, we will have to drill the holes into them, then they will be ready for use in our cannon project.

So, now, I think you have a clear idea about the casting process, particularly the sand casting. In these two videos we have watched different aspects. You have to see this carefully, because lot of things which I already told you earlier have been shown to you in these video clips.

Particularly in the second part of second video, you must have observed that there are some waste materials, which are the materials from the gating system which is cut off from the final casting; they are actually remelted.

You have seen that those parts are again put back to the oven and they are remelted. So, I am coming back to my earlier advantage point of casting that here the wastage of material almost is none. So, that is one of the greatest advantages.

And, of course, you have seen the use of the core. So, the core is used to get the internal intricacies, internal cavities, that also have been shown in the first video; you must have seen that. Overall, this gives you a complete picture of the sand mold casting. And, about the other castings, I will show you few more videos, small clips. About the other casting processes, we will be discussing in our subsequent discussions.

Thank you for your attention.