Robotics
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Lecture - 01
Introduction to Robot and Robotics

Let us start with the course on Robotics. The first topic it is on Introduction to Robots and Robotics.

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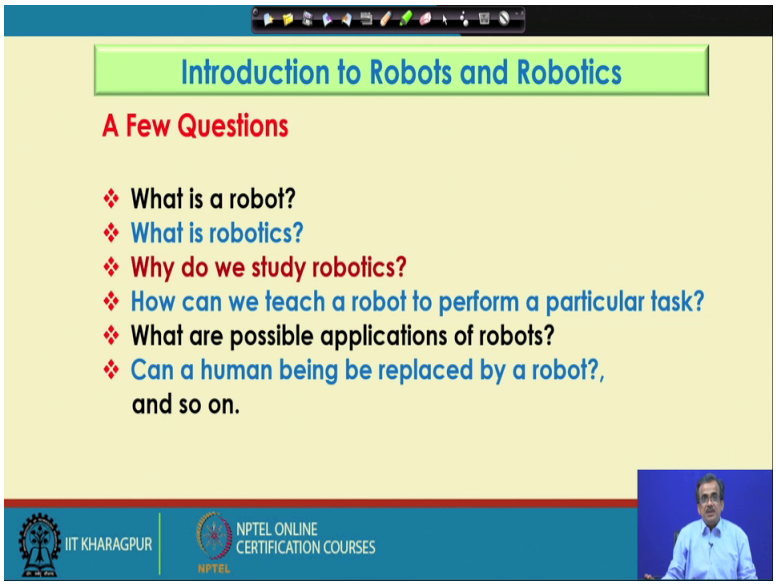

Now, before we start learning robotics, a few questions may come to our mind, these are as follows. What is a robot? What is robotics? Why should we study robotics? What is motivation behind robotics? How can we give instruction to a robot that you perform this particular task? What are the different types of robots we generally use? What are the possible applications of robots? Can a human being be replaced by a robot? And so on.

So, similarly there are many other questions. Now, here actually what I am going to do, I am just going to give answer to the first few questions. But, the last one, that is can a human being be replaced by a robot, that I will try to answer towards the end of this particular the course. Now, let me start with the first one that is what is a robot.

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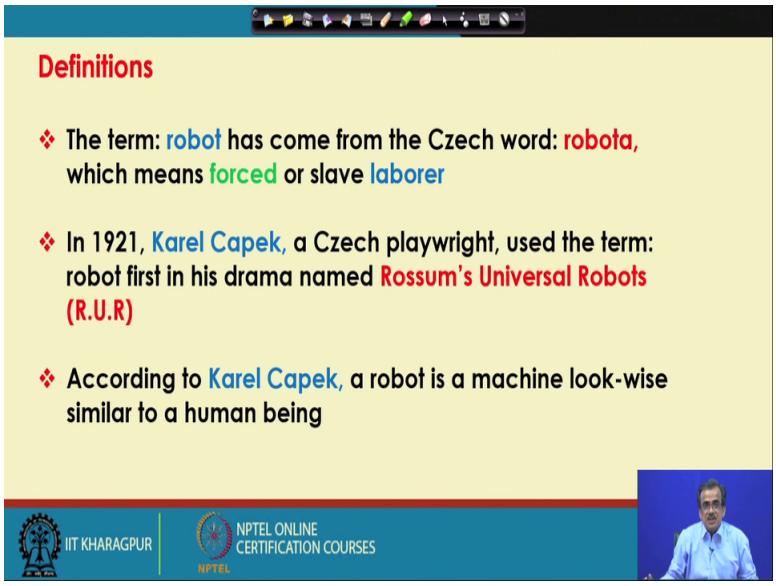

So, I am just going to define, that particular the term robot. The term robot has come from the Czech word robota, which means the forced or the slave laborer. That this is just like a servant, and we are going to give some task to the robot, and it is going to perform that particular the task just like a servant.

Now, the term robot was introduced in the year 1921 by Karel Capek. Now, Karel Capek a Czech playwright, he wrote one drama and the name of the drama was Rossum's Universal Robot R.U.R. And in that particular drama, he introduced a thumb the robota that is the robot. But, the way he described robot, the robot was look-wise similar to a human being. But, nowadays we use a few robots, which do not look like the human being. So, this is the way actually, the term robot was introduced in the year 1921. But, during that time, there was not even a single robot in the world.

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Now, if you see the literature, the term robot has been defined in a number of ways. For example say, according to the Oxford English Dictionary, now robot is a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer, so this is nothing but an automatic machine. Then according to a according to a ISO, that is International Organization for Standardization, the robot has been defined as follows, the robot is an automatically controlled, reprogrammable, multifunctional manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.

Now, as I mentioned, that robot is nothing but an automatically controlled machine. And it is reprogrammable that means you are the same robot can perform a variety of task, and to perform the variety of task we will have to change its program. And it is multifunctional, that means, the same robot, the same manipulator can perform the different types of machining operation. It can do some sort of peak and place type of operation and so on.

Now, here actually we are using the term manipulator. So, by manipulator we mean that that is a robot with fixed base. Now, this manipulator could be either serial manipulator or parallel manipulator. So, those things I will be discussing in details after sometime.

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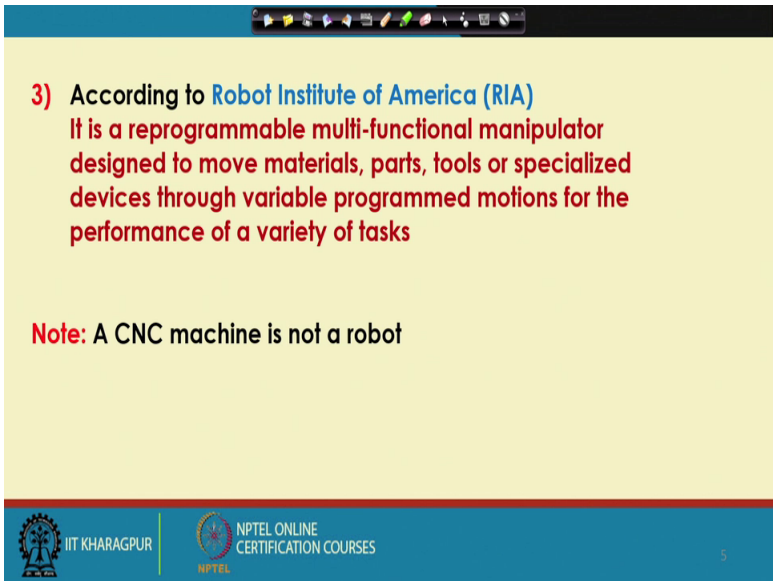

Now, another very popular definition is given by RIA that is Robot Institute of America. Now, they defined robot as follows, it is a reprogrammable multi-functional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of a variety of task.

Now, these terms I have already defined. For example, by manipulator we mean robot with fixed base, and that is nothing but a mechanical hand; that means, the human hand we are going to model design and develop in the form of an artificial hand, and that is nothing but the manipulator, and it is reprogrammable and multifunctional. Now, in terms of re programmability, if we compare a robot with one NCCNC machine; now in CNC machine like computerized numerical control machine, we can perform a variety of task by changing the program.

Similarly, in robots the same robot I can use to serve a variety of purposes, simply by changing the program. But, here there is a basic difference between the level of re programmability, which can be achieved by a robot, and that can be achieved by a CNC machine. Now, it is important to note, that the level of re programmability, which can be achieved by a robot is more compared to that of the CNC machine. And that is why, a CNC machine is not a robot, and that is why, I have put one note here, that CNC machine is actually a is not a robot.

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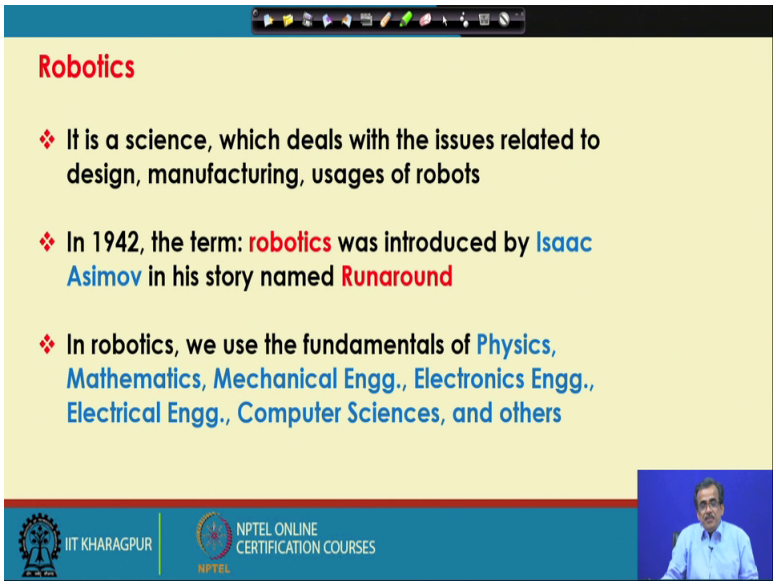

Now, next I am just going to define, what do we mean by the robotics. Now, the robotics is a science, which deals with the issues related to design, development, applications of robots to perform a variety of task. The term robotics actually, it was coined by Isaac Asimov in the year 1942. Now, Isaac Asimov, he wrote one story, the name of this story was Runaround. And in that particular story, he used the term robotics first, but once again let me mention that during that time during 1942, there was not even a single robot in this world.

Now, here in robotics, we use the fundamentals of different subjects. For example, physics, mathematics, mechanical engineering, electrical and electronics engineering, computer science. And that is why, it is bit difficult to become a true roboticist, because if we want to become an expert, a true expert of robotics, we will have to know the fundamentals of all these basic subjects, and a robotics is actually a multi disciplinary subjects.

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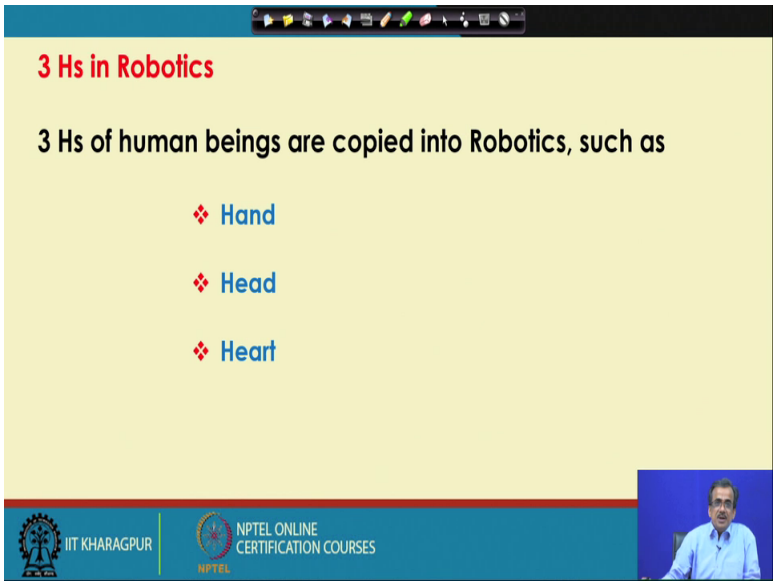

Now, I am just going to define one concept, which I have already mentioned little bit like in robotics, we try to copy a 3 H. Now, these 3 Hs are nothing but, the Hand, Head, and a Heart that means we try to copy the hand of a human being in the artificial way, in the form of one manipulator that is the mechanical hand. We try to copy the head of a human being that is nothing but the intelligence.

And we also try to copy the heart of a human being, but not the mechanical heart, but the emotion of a human being. And that is why, in future the robot will be intelligent and at the same time emotional too. Now, if we consider the human being, we are intelligent, we are emotional, and in robotics, we try to copy everything from the human being. So, in future, we are trying to design and develop intelligent and emotional the robots.

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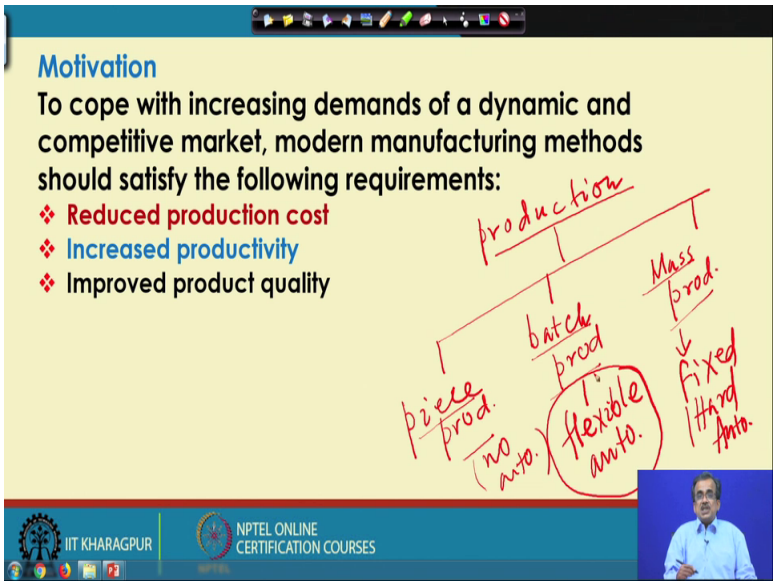

Now, the next is what is the motivation behind robotics, why should we study robotics, what is the reason. Now, if you see today's market, today's market is dynamic and competitive. And if you want to be in competition, and if you want to be in business, so what you will have to do is. So, you will have to fulfill at least three requirements. Now, the requirements are as follows, like you will have to produce good at low cost; and at the same time the productivity has to be high; and the quality of the product has to be good. Now, you see the three objectives, like reduced production cost, increased productivity, and improved product quality. Now, it is bit difficult to achieve all these three things at a time, and some of them are actually conflicting.

Now, if you want to achieve all three, there is only one solution, and that is nothing but automation. So, you will have to go for automation, if you want to achieve all three requirements. Now, if I proceed further, let me tell you something regarding, the different types of products and methods, which we generally use. Now, if you see the production methods, the production the purpose of production is actually to convert the raw materials to the finished product. Now, this production could be of three types. For example, we can have the piece production, we can have the piece production, then there could be batch production, batch production, then there could be mass production.

Now, for piece production, so we have got several designs and each design, we manufacture small in number. Now for batch production, we have got a few designs; and

each design, we produce a few in numbers. Now, in mass production, we have got only one design, and that particular product is produced a large in number. Now, if I just want to automate this particular batch production, mass production and of course for piece production, automation is not possible; so there is no automation for this particular your the piece production no automation.

But for batch production, we can go for automation. And for mass production, we go for automation. For mass production, we generally go for the fixed automation or the hard automation. So, fixed or the hard automation. And for this particular, the batch production, we generally go for the flexible automation flexible automation.

Now, robotics is an example of your; this flexible automation. And that is why, for batch production, particularly in the manufacturing unit, we will have to go for the robots, if you want to survive in this particular the competitive market and that is why the robotics and the robots have become so much popular in manufacturing units. But, nowadays not only in manufacturing units, the robots are used in different areas. For example, robots are nowadays used in space science, used in medical science, robots are also used for seabed mining in agriculture, firefighting and so on. So, there are various applications of robots nowadays.

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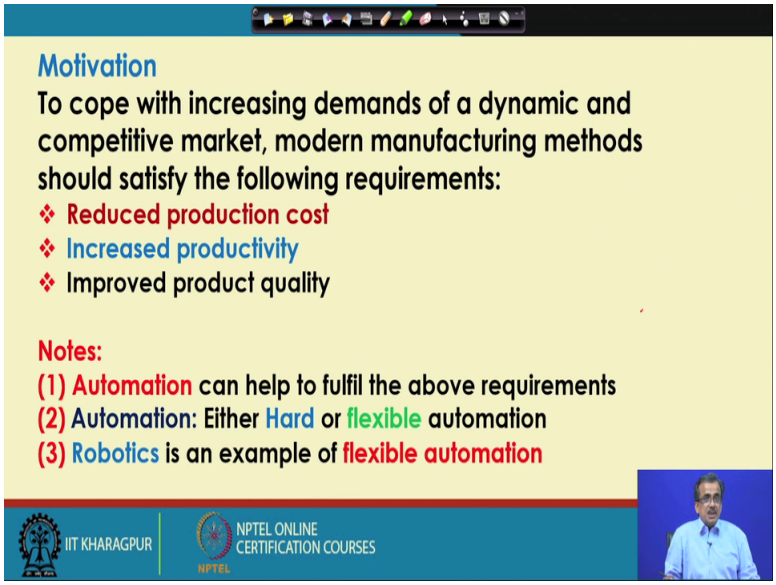

Now, here all such things I have noted. Automation can help to fulfill the requirements of the above a requirements. And robotics is an example of the flexible automation, and that is why we should study robotics.

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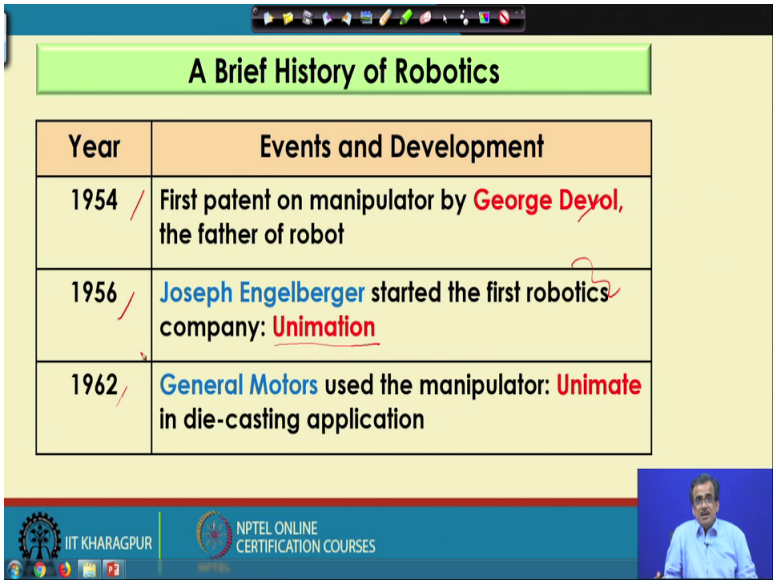

Now, I am just going to concentrate on a brief history of robotics. Now, if you see the NC machine, that is the numerical controlled machine; that was developed first in the year 1950, but robot came after that. So, the first robot, which was developed, that was developed in the year 1954. And 1954, the first patent on the manipulator, that was filed by George Devol, and he is known as the father of robot. In 1956, Joseph Engelberger started the first robotics company, and the name of the company is Unimation. So, Unimation is the first robotics company, which was started in the year 1956. Then in the year 1962, General Motors used the manipulator, the name of the manipulator is Unimate, and this particular robot was used in die-casting application.

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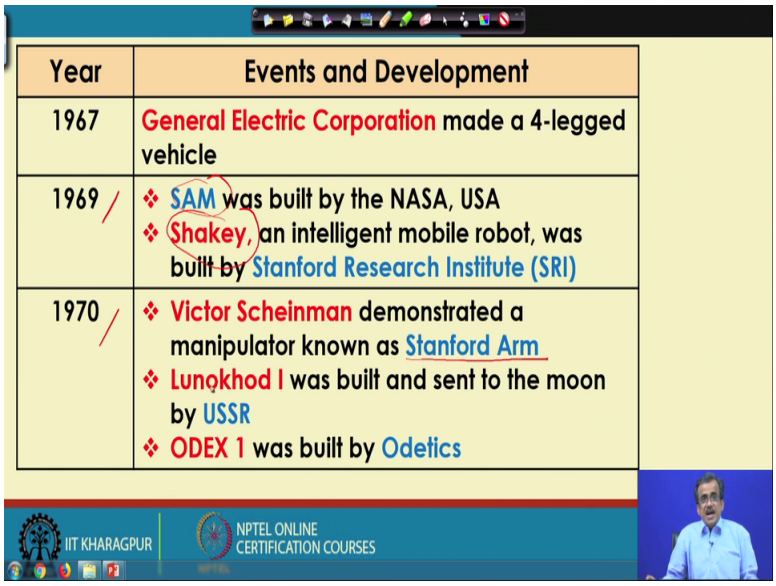

Now, next in the year in the year 1967, General Electric Operation made one 4-legged robot, and this is a 4-legged vehicle, and they demonstrated and it worked well. Then in the year 1969, SAM was built by the NASA, USA. SAM was the name of that particular robot, which was built by the NASA, then Shakey, an intelligent robot that was actually manufactured by Stanford Research Institute SRI. In fact, Shakey is the first intelligent mobile robot that was developed in the year 1969. In 70, Victor Scheinman, demonstrated a manipulator known as Stanford Armm, then Lunokhod 1 that was another robot, that was send to the moon by USSR, then ODEX 1 another robot that was built by Odetics, in the year 1970.

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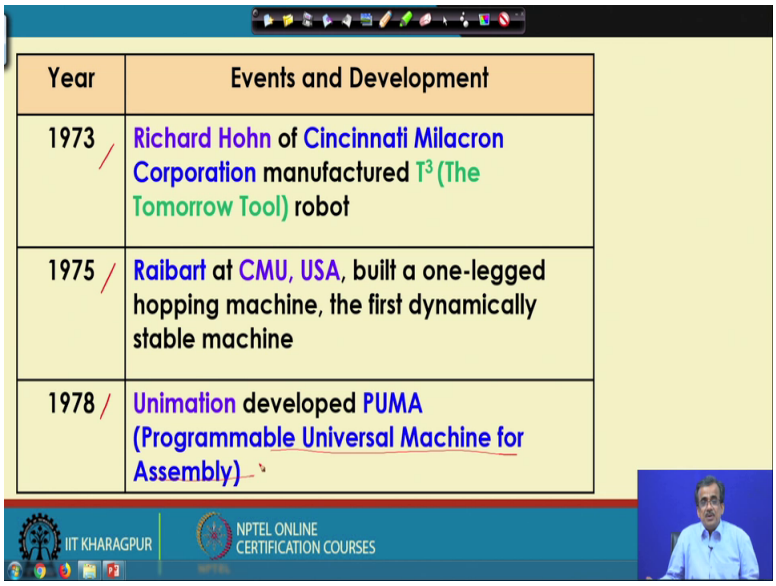

Then in the year 1973, Richard Hohn of Cincinnati Milacron Corporation manufactured one robot, the name of the robot was T 3, The Tomorrow Tool. Then in the year 1975, Raibart at Carnegie Mellon University, USA, built one one-legged hopping machine, and that is the first dynamically stable machine. And Raibart, in fact, is known as the father of the multi legged robots.

In the year 1978, Unimation the first robotics company, they could develop the PUMA, that is Programmable Universal Machine for Assembly. And this is actually a manipulator, which is having that the current version of this particular PUMA is having 6 degrees of freedom, and it is very frequently used in a various industries.

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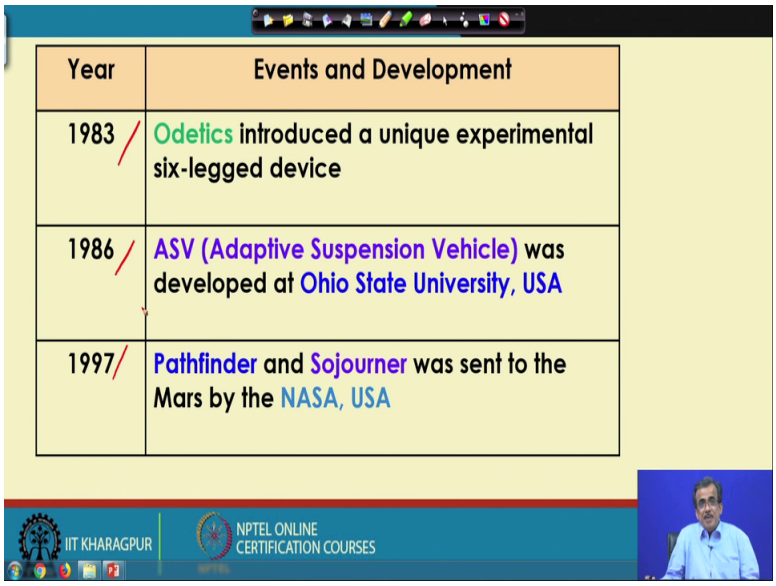

Then in the year 1983, Odetics, that a robotics company, they introduced a unique experimental six-legged device. In the year 1986, Adaptive Suspension Vehicle, in short that is ASV that was developed by Ohio State University, USA. In 97, a NASA, USA, they developed the intelligent robots like Pathfinder, and Sojourner, and they sent it to the mars, but that particular mission was a failure. And that particular failure was due to some sort of mismatch of the specifications.

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Next in the year 2000, Honda could develop one Humanoid robot, Asimo robot. So, Asimo Humanoid robot was developed by Honda, in 2000. Then comes your in 2004, the surface of the mar Mars was explored by Spirit, and Opportunity, and this particular mission was successful. And you might be knowing, what happened in 2012, the Curiosity one intelligent autonomous robot was sent to the Mars by the NASA, USA, and this particular mission was successful.

Then all of you might be knowing, what happened in the year 2015, Sophia, that is one intelligent little bit emotional humanoid robot, that was built by Hanson Robotics, Hong Kong, and this is actually as on today the most sophisticated intelligent humanoid robot. And a few weeks ago this particular robot was brought to IIT, Bombay, and there she could talk, she could communicate with other people, and some of you might have seen in paper or a television. So, that particular the very sophisticated intelligent humanoid robot that is Sophia.

So, these are in sort the brief history of the robotics. Now, the purpose behind giving this brief history of this particular robotics is just to tell that we started in India. The study on robotics little bit late, we started around 1979, 80. So, we started a little bit late, although the first manipulator, the first patent was filed in the year 1954.

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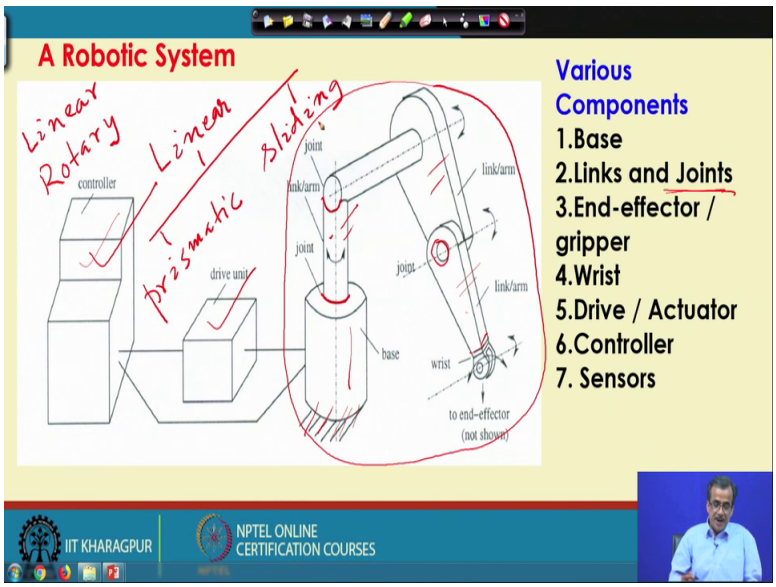

Now, I am just going to concentrate on a particular the robotic system. So, what are the different components of a typical robotic system? Now, here in this particular schematic

view, you can see that that this particular thing is nothing but a robot. So, this is actually the robot, and this is the manipulator, this is a serial manipulator. And this is the drive unit for this serial manipulator. And this is the controller or the director for this particular the manipulator.

Now, as I told that this is a serial manipulator, and by manipulator we mean a robot with fixed base. So, here the base of this particular robot is fixed. So, it is a fixed base we have got one link here, another link here, another link here, and these links are used just to transmit the mechanical power. And in between the two links, we have got the joints, so we have got a few joint. For example, say if I consider that this is the base of this particular the manipulator, and this is the next link, so in between, so these two you have got a joint here.

Similarly, in between this link, and that particular link, we have got a joint here. Similarly, here in between this link and that link, we have got a joint here, between these and these we have got another joint here. So, in between the two links, so we have got a particular the joint. Now, if you see the robotic joint, the robotic joint could be basically of two types, it could be either the linear joint, or there could be the rotary joints the rotary joints. Now, these linear joints could be either. So, the linear joint it could be either prismatic joint, prismatic joint or there could be your the sliding joint prismatic joint or sliding joint. Now, here I am just going to draw a rough sketch for this prismatic, and the sliding joint.

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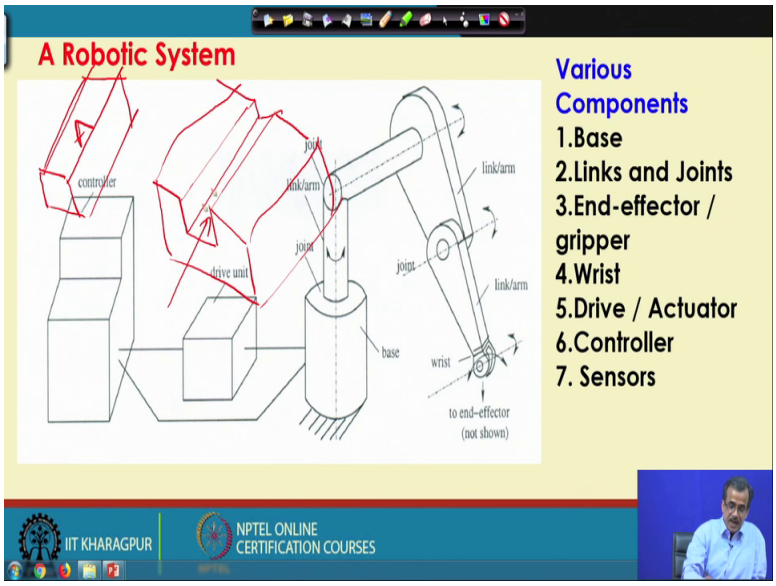

Now, if I just draw this particular the prismatic joint, supposing that I have got a block like this. So, if I consider a block like this. Now, here I can insert one this type of key. Now, if I insert this particular key here. So, this particular joint will be nothing but a prismatic joint, and this is a linear joint. So, this particular part, say part A can be can be just move in the linear direction here, and this is an example of the prismatic joint.

Now, similarly I am just going to take the example of one sliding joint, now supposing that I have got a block like this. Say I have got a block like this. And here, I will have to insert one pin, that pin could be something like this. Say I will have to insert a pin something like this here, and this particular pin can be inserted here and there will be only the linear movement, and this is the example of one sliding joint. So, these are all linear joint.

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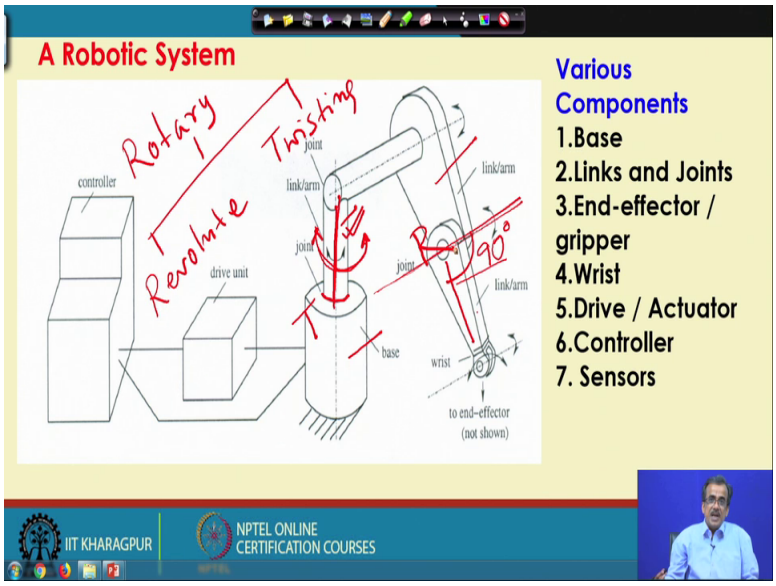

Now, next come your the rotary joint. Now, here so if you see the rotary joint, the rotary joint could be of two types basically, we could have the revolute joint revolute joint, and there could be the twisting joint. Now, both the rotary joint, but basically it has got there is a difference between this revolute joint, and the twisting joint. Now, to define the difference to find out the difference between the revolute joint, and this particular the twisting joint; so I am just going to take one example here.

Now, let me take the example. So, this is the fixed base, and this is the link, and in between I have got a joint here. Now, with the help of this particular joint, so this particular link can be rotated something like this. So, it can be rotated something like this. Now, if this is the output link and this side is input. The axis of the output link is nothing but this about which I am taking the rotation. And this particular axis is coinciding with the axis of the output link. This is the output link. This is the axis of the output link, and I am taking this rotation about this particular axis.

So, this particular rotary joint is nothing but, the twisting joint denoted by T. Now, let me take another example, say this is one link, this is another link, now with respect to this. So, here I am just going to take the rotation, the rotation about this particular axis. Now, here if this is the input side and that is the output side. So, the axis of the output link is something like this, and the axis about which I am taking the rotation is this, and they are at 90 degree.

So, if this output, axis of the output link, and the axis about which I am taking the rotation, if they are at 90 degree. So, that type of rotary joint is known as the revolute joint, so this is nothing but a revolute joint denoted by R. So, basically once again let me repeat we use two types of joints; linear joint, and the rotary joint. And once again two types of linear joint, the prismatic joint and the sliding joint, and two types of rotary joint we use, one is the revolute joint, another is the twisting joint.

Thank you.