

Intervention Script

Welcome to the experiment! Today you are going to learn about additive manufacturing. You will be instructed on different concepts and will be asked to perform a series of tasks. This experiment will be 15 minutes long. Today you will be learning about an additive manufacturing process called <insert AM Process>. The machine that you see in front of you uses <insert AM Process> additive manufacturing to create <plastic/metal> parts. You will be instructed on different topics on additive manufacturing and be allowed to interact with the parts and assemblies on the machine to learn how they work and gain a better understanding about the additive manufacturing process.

Powder Bed Fusion	Material Extrusion
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Storing of Material

We will first be learning about the raw material used in this additive manufacturing process and how this raw material is stored in the machine.

Task 1.1	Try to move to a position and adjust your view accordingly so that you can easily grab the lid handle in front of the machine. Then go ahead and use that to lift the lid to look at what's inside.	Try to move into a position where you can easily see and access the machine, and everything on the desk.
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Conduct sub-task: Allow <time> for task completion.

Task 1.2	You should now see several parts inside the machine. Focus your attention to the bin on the left side of the machine and try to get a good look at what's inside it.	Focus your attention on the right side of the desk to get a good view of the donut shaped object on the right side of the desk.
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Conduct sub-task: Allow <time> for task completion.

Instruction	What you see in this bin is powder. The raw material for this additive manufacturing process is fine powder. This powder can be metal or plastic powder. The powder is stored in this powder bin. This bin has a platform as the base of the bin and this platform is called a feed plate. The feed plate is used to move the powder up or down within the bin.	The donut shaped object that you see is a spool of filament. The raw material for this additive manufacturing process is plastic filament. This filament is stored in the form of a continuous spool of plastic wire. Most machines have a fixture or location where you can place this spool of material for convenience, and this place is usually called a spool holder.
Task 1	Try to get into a comfortable line of sight and position to get access to the feed plate, and then drag the feed plate up and down to understand how it controls the quantity of powder stored in the feed bin.	Try to get into a comfortable line of sight and position to get access to the spool of filament and the spool holder, and then go ahead grab the spool of filament on the desk next to you and try to place it onto the spool holder.

Conduct main task: Allow <time> for task completion.

Instruction	There is currently not enough powder in the feed bin to make a new part. We need to add more powder into this bin so that we can be ready to print.	Move back into a position where you can easily see and access the machine. Now try to look around to find two horizontal rails on the machine. On these rails is an assembly that can move left to right on the rails. This assembly is
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Task 2.1	Try to move and look around to find a green bottle on the desk next to you.	called the extruder head. This is where the filament from the spool goes into the machine. Try to look closely at the top of the extruder head to see where the inlet of the extruder head might be.
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Conduct sub-task: Allow <time> for task completion.

Instruction	This bottle contains powder. We need to add this powder into the bin.	We need to load filament from the spool into the inlet of the extruder head on the machine.
Task 2.2	Grab the bottle and then focus your attention back to the powder bin on the left side of the machine.	Focus your attention back to the right side of the desk and find the loose end of the filament lying on the desk.

Conduct sub-task: Allow <time> for task completion.

Task 2	Try to pour powder from the bottle into this bin.	Grab the tip of filament and pick it up. Then try to connect it to the inlet on the extruder head. You should notice it “snapping” once you move it close to the inlet.
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Conduct main task: Allow <time> for task completion.

Instruction	Go ahead and put the bottle away back onto the side.	Now the machine is setup to print parts.
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Provide New Material

Task 3.1	Move back into a position where you can easily see and access the machine, and then focus your attention to the bin on the right side of the machine.	Focus your attention to look closely at the extruder head and the parts around the inlet.
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Conduct sub-task - Allow <time> for task completion.

Instruction	This bin already has powder in it. It is called the build bin, and this is where powder is brought into from the powder bin. To move the powder from the powder bin into the build bin, we need a part that can move powder from the left side, to the right side.	There are gears and motors around the inlet of the extruder head. These allow the filament that goes into the inlet of the extruder head to be pushed further down the head. This is the filament feeding system of the machine and helps consistently provide new material for use.
Task 3	Try to look around to find two horizontal rails on the machine. On these rails is an assembly that can move left to right on the rails. This assembly is called the recoater.	N/A

Conduct main task: Allow <time> for task completion.

Task 3.2	Move to a position to grab the recoater. Then try to move the recoater to see how it works.	N/A
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Conduct sub-task: Allow <time> for task completion.

Task 3.3	Where do you think the excess powder pushed by the recoater goes? There is a cabinet door below you. Try opening that to see where the powder might be being collected.	
<i>Conduct sub-task: Allow <time> for task completion.</i>		

Creating Primitives

Once we load material into the machine and have a system in place to distribute and consistently provide new material for use, we need a system to transform this raw material into its final state.

Task 4	Move back into a position where you can easily see and access the machine. Then focus your attention to the right side of the lid, right above the build bin. You should see a transparent glass window, behind which is an assembly on a single rail.	Move back into a position where you can easily see and access the machine and focus your attention to the bottom of the extruder head. You should see a conical part at the very bottom and a square block directly connected above it.
<i>Conduct main task: Allow <time> for task completion.</i>		

Instruction	This assembly is called the laser head system. The powder bed fusion additive manufacturing process uses a high-power laser to sinter the powdered material into a solid state. Sintering is the process of partial melting, where the heat applied to the powder is lower than the heat needed to achieve melting point. The machine therefore uses the laser head system to focus the emissions from the laser onto the build bin.	The conical part is the nozzle of the extruder, and right above it is the thermal heating block. The material extrusion additive manufacturing process uses a thermal heating system to partially melt the plastic filament into a semi-solid state. The thermal block on the extruder head therefore melts the filament after which the semi-solid material is pushed out through the conical nozzle outlet.
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Patterning Material/Energy

Now that the system has a continuous supply of material and a system to transform it, we need a system to have selective control on the distribution of the material to build the part as per a 3D geometry. To make a 3D part, we need access to every point in the build volume. The build volume is the 3D space in which a part can be manufactured. This space is defined by projecting the 2D area of the build plate into a third dimensional axis. The build plate is a platform on which a part is manufactured.

Task 5.1	Move back into a position where you can easily see and access the machine and focus your attention back to the build bin on the right side of the machine.	Move back into a position where you can easily see and access the machine and focus your attention to the bottom of the machine.
Instruction	The build plate on this machine is in the build bin on the right. It has a manufactured part on it and is covered by a half-filled bed of powder. The build plate can move up and down on this machine. In combination with the laser head system, the machine can selectively control how the powder is transformed in the entire build volume above the build plate.	The build plate on this machine is below the extruder head. It has a manufactured part stuck on it. The build plate can move back and forth. In combination with the extruder head, the machine can selectively control how the filament material is transformed and extruded within the entire build volume above the build plate.
Task 5	Try to move the build plate up and down by dragging the part attached to it.	Try to move the extruder head and build plate one at a time, to see how they can be used to

	selectively deposit material at any point in the build volume above the build plate.
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Conduct main task: Allow <time> for task completion.

Support New or Previously Deposited Material

Additive manufacturing is the process of adding layers on top of each other to generate a 3D volume. Therefore, each layer needs to have something below it to support itself. For the first layer, it is the build platform itself that supports the layer that is generated. For the following subsequent layers, it is the previously generated layer that supports the new layer. In some cases, there is a need to generate sacrificial structures to support new layers. These sacrificial structures are called support structures and are used in addition to the part itself, to support new layers formed above them.

Instruction	Powder bed fusion can use weak support structures as well as the powder itself to support the formation of new layers.	Material extrusion can use weak support structures to support the formation of new layers.
Task 6	Move back into a position where you can easily see and access everything on the desk, and focus your attention to two already manufactured Nittany Lions on the desk. One part has supports on it and the other does not. Pick up these parts one at a time and take a closer look at them to compare the two.	

Conduct main task: Allow <time> for task completion.

Task 6.1	Move back into a position where you can easily see and access everything on the machine, and then go back to the build plate on the machine to notice the Nittany Lion partially encased in powder. This is what the part looks like at the end of the manufacturing process and when the top half of the powder is removed.	Move back into a position where you can easily see and access everything on the machine, and then go back to the build area on the machine to notice the Nittany Lion stuck on the build plate. This is what the part looks like at the end of the manufacturing process.
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Conduct sub-task: Allow <time> for task completion.

Congratulations you are done! The program window will now close. You now move on to the next step.