SSM INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi / Affiliated to Anna University / Accredited by NAAC)

Dindigul – Palani Highway, Dindigul – 624 002

INSTITUTION'S INNOVATION COUNCIL

WORKSHOP
ON
PROTOTYPE DESIGN & DEVELOPMENT

(3D PRINTING)

REPORT CONTENTS:

About the Event:

SSM Institute of Engineering and Technology is keen on giving the latest technologies to students in association with Institution’s Innovation Council. The aim of this workshop is to make students design their own prototype model with the latest 3D printing Technology.

A total of 40 students from the department of Mechanical, Automobile, Computer Science Engineering have actively participated in the workshop. Mr. P. Dheenathayalan (AP/Mechanical), Mr. M. Selwin (AP/Mechanical), Mrs. N. J. Divya (AP/ CSE) have coordinated the event.

The event was conducted in Mechanical CAD Lab from 28.03.2023 to 03.04.2023. Students have learnt to design their own model from Tinker CAD and fabricated their model using Fused Deposition Modelling machine.

Event Brochure:

Workshop on Prototype Design & Development Brochure

Introduction to 3D Printing:

3D printing is an additive technology used to manufacture parts. It is ‘additive’ in that it doesn’t require a block of material or a mould to manufacture physical objects, it simply stacks and fuses layers of material. It’s typically fast, with low fixed setup costs, and can create more complex geometries than ‘traditional’ technologies, with an ever-expanding list of materials. It is used extensively in the engineering industry, particularly for prototyping and creating lightweight geometries.

3D printing and Rapid Prototyping

‘Rapid prototyping’ is another phrase that’s sometimes used to refer to 3D printing technologies. This dates back to the early history of 3D printing when the technology first emerged. In the 1980s, when 3D printing techniques were first invented, they were referred to as rapid prototyping technologies because back then the technology was only suitable for prototypes, not production parts.

In recent years, 3D printing has matured into an excellent solution for many kinds of production parts, and other manufacturing technologies (like CNC machining) have become cheaper and more accessible for prototyping. So while some people still use ‘rapid prototyping’ to refer to 3D printing, the phrase is evolving to refer to all forms of very fast prototyping.

When was 3D printing invented?

3D printing began as an idea for accelerating industrial product development through faster prototyping. Even though there were a few patents beforehand, Chuck Hull is typically credited with the invention of the 3D printer via his Stereolithography Apparatus (SLA), patented in 1984.

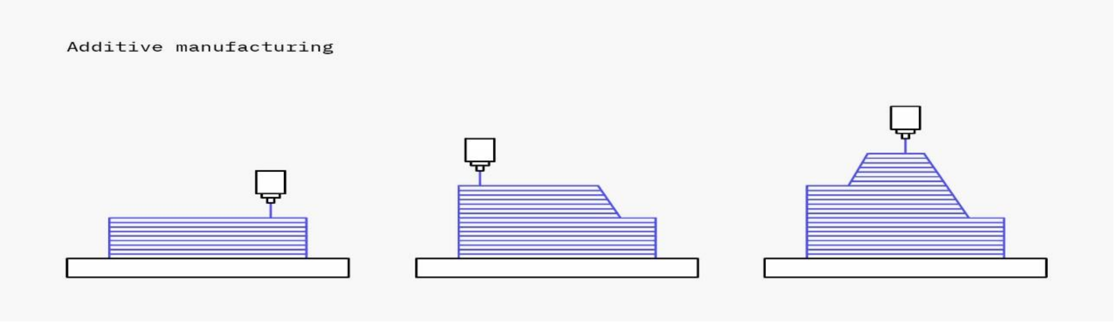
How does 3D printing work?

Additive vs traditional manufacturing

Additive manufacturing has only been around since the 1980s, so the manufacturing methods developed before it are often referred to as traditional manufacturing. To understand the major differences between additive and traditional manufacturing, let's categorize all methods into 3 groups: additive, subtractive and formative manufacturing.

Additive manufacturing

Additive manufacturing builds up 3D objects by depositing and fusing 2D layers of material.

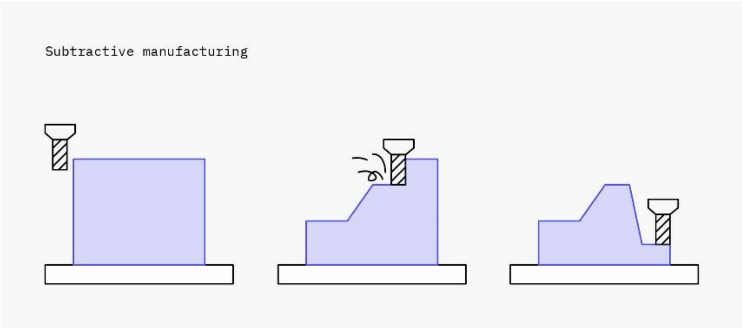


This method has almost no startup time or costs, making it ideal for prototyping. Parts can be made rapidly and discarded after use. Parts can also be produced in almost any geometry, which is one of the core strengths of 3D printing.

One of the biggest limitations of 3D printing is that most parts are inherently anisotropic or not fully dense, meaning they usually lack the material and mechanical properties of parts made via subtractive or formative techniques. Due to fluctuations in cooling or curing conditions, different prints of the same part are also prone to slight variations, which puts limitations on consistency and repeatability.

Subtractive manufacturing

Subtractive manufacturing, such as milling and turning, creates objects by removing (machining) material from a block of solid material that's also often referred to as a 'blank'.

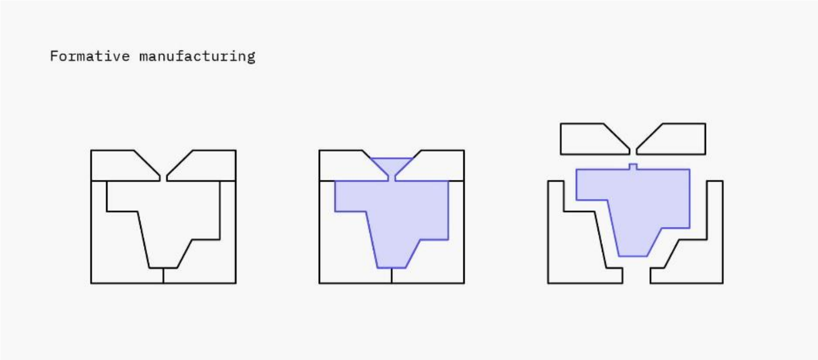


Almost any material can be machined in some way, making it a widely used technique. Because of the amount of control over every aspect of the process this method can produce incredibly accurate parts with high repeatability. Most designs require Computer Aided Manufacturing (CAM) to plot customized tool paths and efficient material removal, which adds setup time and costs, but for most designs, it’s the most cost-effective method of production.

The major limitation of subtractive manufacturing is that the cutting tool must be able to reach all surfaces to remove material, which limits design complexity quite a lot. While machines like 5-axis machines eliminate some of these restrictions, complex parts still need to be re-orientated during the machining process, adding time and cost. Subtractive manufacturing is also a wasteful process due to the large amounts of material removed to produce the final part geometry.

Formative manufacturing

Formative manufacturing, such as injection molding and stamping, creates objects by forming or molding materials into shape with heat and/or pressure.



Formative techniques are designed to reduce the marginal cost of producing individual parts, but the creation of unique molds or machines used in the production process means setup costs are very, very high. Regardless, these techniques can produce parts in a large range of materials (both metals and plastics) with close to flawless repeatability, so for high volume production, they're almost always the most cost-efficient.

How these methods compare

Manufacturing is complex, and there are too many dimensions for comprehensively comparing each method against all others. It is near impossible to optimize all at once for cost, speed, geometric complexity, materials, mechanical properties, surface finish, tolerances, and repeatability.

In such complex situations heuristics and rules of thumb are more valuable:

- **Additive manufacturing** is best for low volumes, complex designs, and when speed is essential.
- **Subtractive manufacturing** is best for medium volumes, simple geometries, tight tolerances, and hard materials.
- **Formative manufacturing** is best for the high-volume production of identical parts.

The different types of 3D printing

3D printers can be categorized into one of several types of processes:

1. **Vat Polymerization:** liquid photopolymer is cured by light
2. **Material Extrusion:** molten thermoplastic is deposited through a heated nozzle
3. **Powder Bed Fusion:** powder particles are fused by a high-energy source
4. **Material Jetting:** droplets of liquid photosensitive fusing agent are deposited on a powder bed and cured by light.
5. **Binder Jetting:** droplets of liquid binding agent are deposited on a bed of granulated materials, which are later sintered together.
6. **Direct Energy Deposition:** molten metal simultaneously deposited and fused.
7. **Sheet Lamination:** individual sheets of material are cut to shape and laminated together.

Event Schedule:

S.NO	DATE	SESSION	MODE OF TRAINING	CONTENT TO BE DELIVERED
1	28.03.2023	FN	Lecture	**Introduction:** Subtractive vs Additive Manufacturing- History of Additive Manufacturing- Evolution of Additive Manufacturing- Advantages- Applications
2			Video Demonstration	**Additive Manufacturing Techniques:** Vat photopolymerization, Material Extrusion, Material Jetting, Binder Jetting, Powder bed fusion, Direct energy deposition and Sheet lamination, Selective Laser Sintering, Direct Metal Selective Laser Sintering.
3		AN	Hands on Training	**AUTODESK TINKER CAD:** Object Modeling using Basic Shapes Library
4	29.03.2023	FN	Lecture	**Types of FDM printer:** Cartesian, Polar, delta, Robotic (SCARA) Main Parts and Construction of FDM printer: Frame, Linear rods, Linear motion bearings, Slider/Carriage, V slot extrusion, Pulley, belt, Lead screw Arduino processor, Controller board, Limit Switch, Hot end, Extrusion system: Direct Drive, Bowden type, Power Supply, Heat Beds etc
5			Lecture	Principle of FDM/FFF printing, Basic steps to perform FDM printing, Significant process parameters of FDM printing, layer height, raster angle, raster width, build temperature, Nozzle temperature, orientation, printing speed etc.
6		AN	Hands on Training	**Ultimaker CURA:** Add Printer, Manage Printer, Machine Settings, Modifying G Codes, Customizing Material & Nozzle Size, Importing STL file, Aligning object to Printing Position, Quality Settings, Infill Settings, Printing Temperature, Support Settings, Build Plate Adhesion, Fan Cooling Settings, Slicing: Generating G Code Files. **FDM Machine Operations:** Filament Loading and Unloading, Menu Control System.
7	31.03.2023	FN	Lecture	**FDM Materials:** PLA, ABS, PETG, Nylon, PVA, PC, TPU, Carbon reinforced nylon, ceramics, metals, Dual and multi material etc. **Introduction to 3D Scanning**
8			Lecture	Applications of FDM printer in AM, Applications of AM: Aerospace, Biomedical, Automotive, Bio-printing, Tissue & Organ Engineering, Architectural Engineering, Surgical simulation, Art, Health care
		AN	Hands on Training	Make a cube of any dimension using FDM 3D Printer.
9	03.04.2023	FN	Hands on Training	Download a .stl file of simple object from internet, convert into Gcode and print with FDM 3D Printer at 30% infill density.
				Download a .stl file of simple object which require support material from internet, convert into G-code and print with FDM 3D Printer.
				Design and print objects containing moving parts without assembly.
10		AN	Hands on Training	Design the Coupling in 3D modeling software and print it using PLA material.
				Design the Key ring of your own name in 3D modeling software and print it using PLA material.
				Emboss / Engrave your name on a 3D object and print it with PLA material.
				Print your photo with the help of LITHOPLANE.
11	03.04.2023	AN	**ASSESSMENT**	

Session Event:

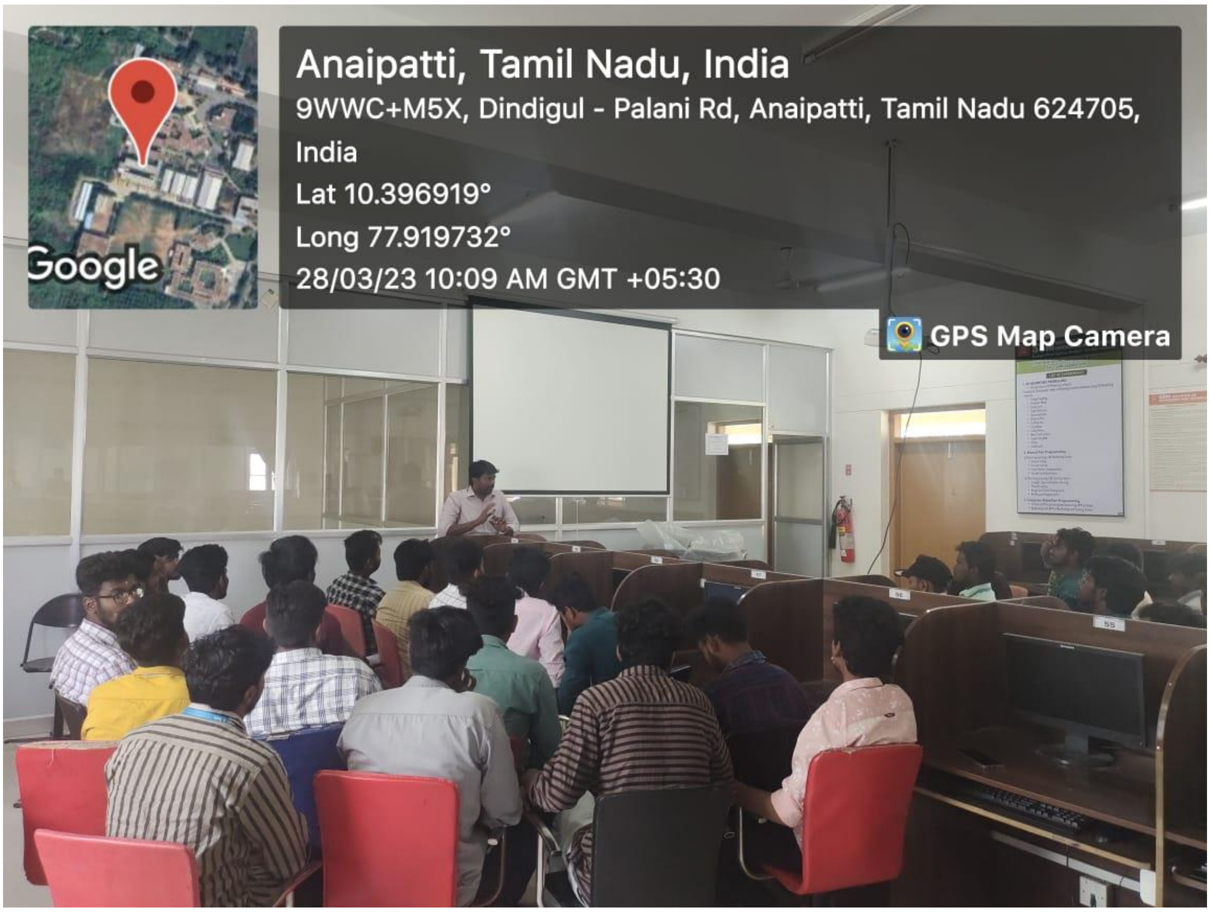


Fig 1. Introduction to Additive manufacturing by Mr. P. Dheenathayalan (AP/Mech)

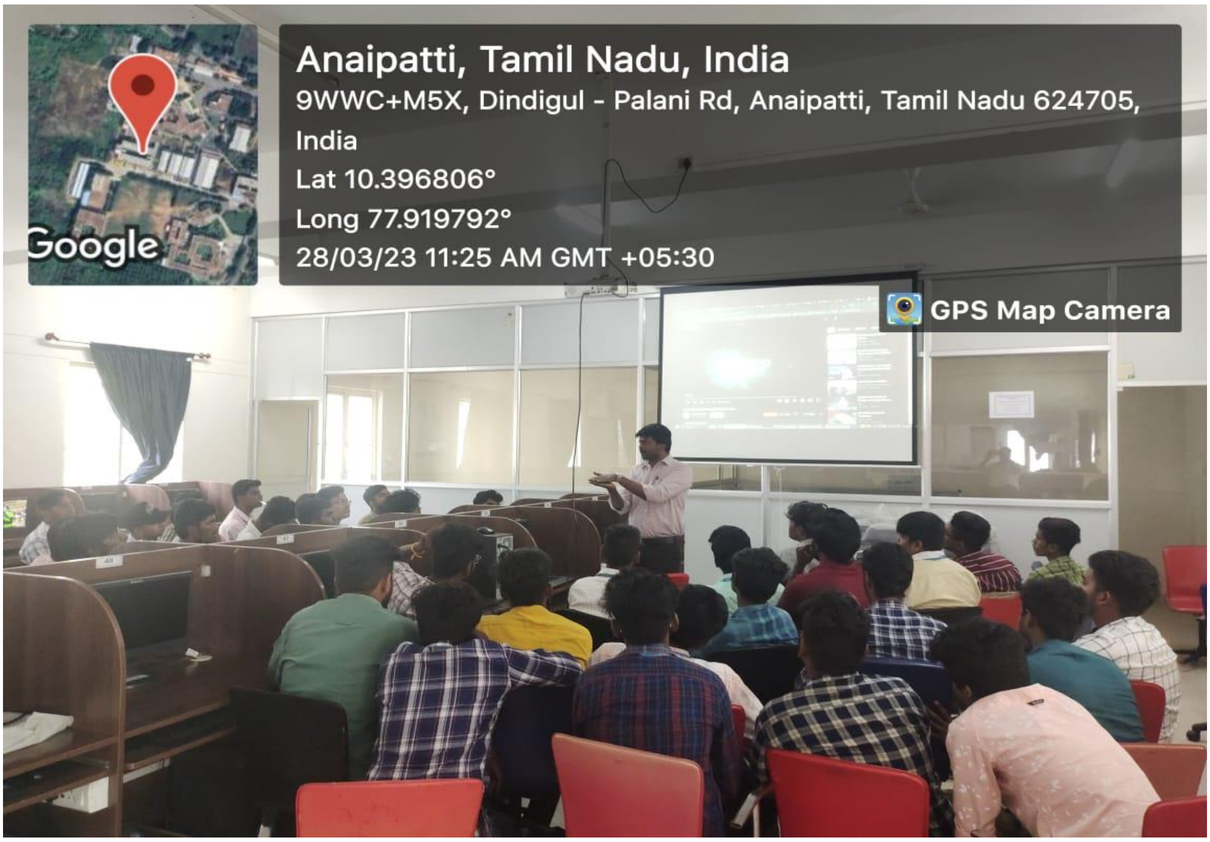


Fig 2. Video Demonstration on Additive Manufacturing Techniques

Hands on Training on TINKER CAD by Mr. M. Selwin (AP/Mech)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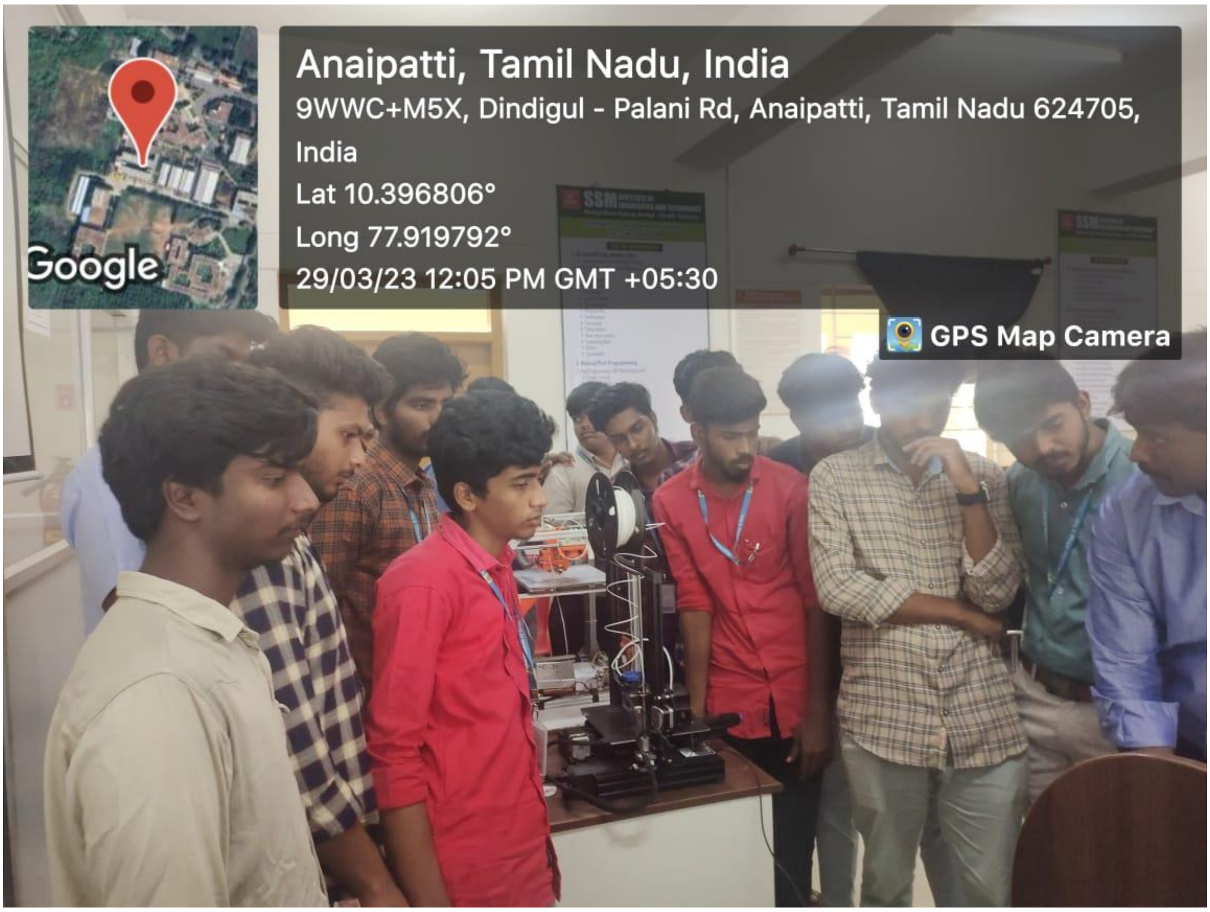
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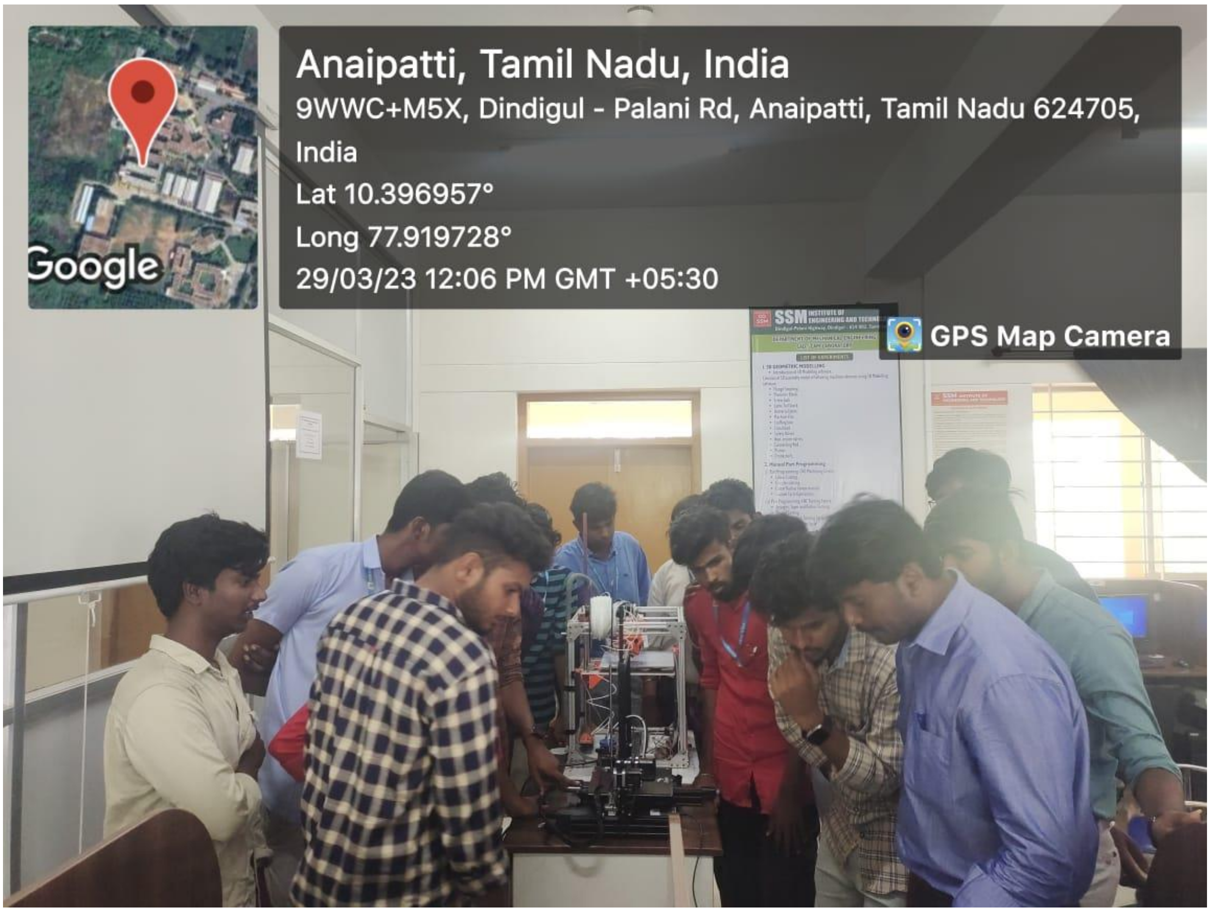
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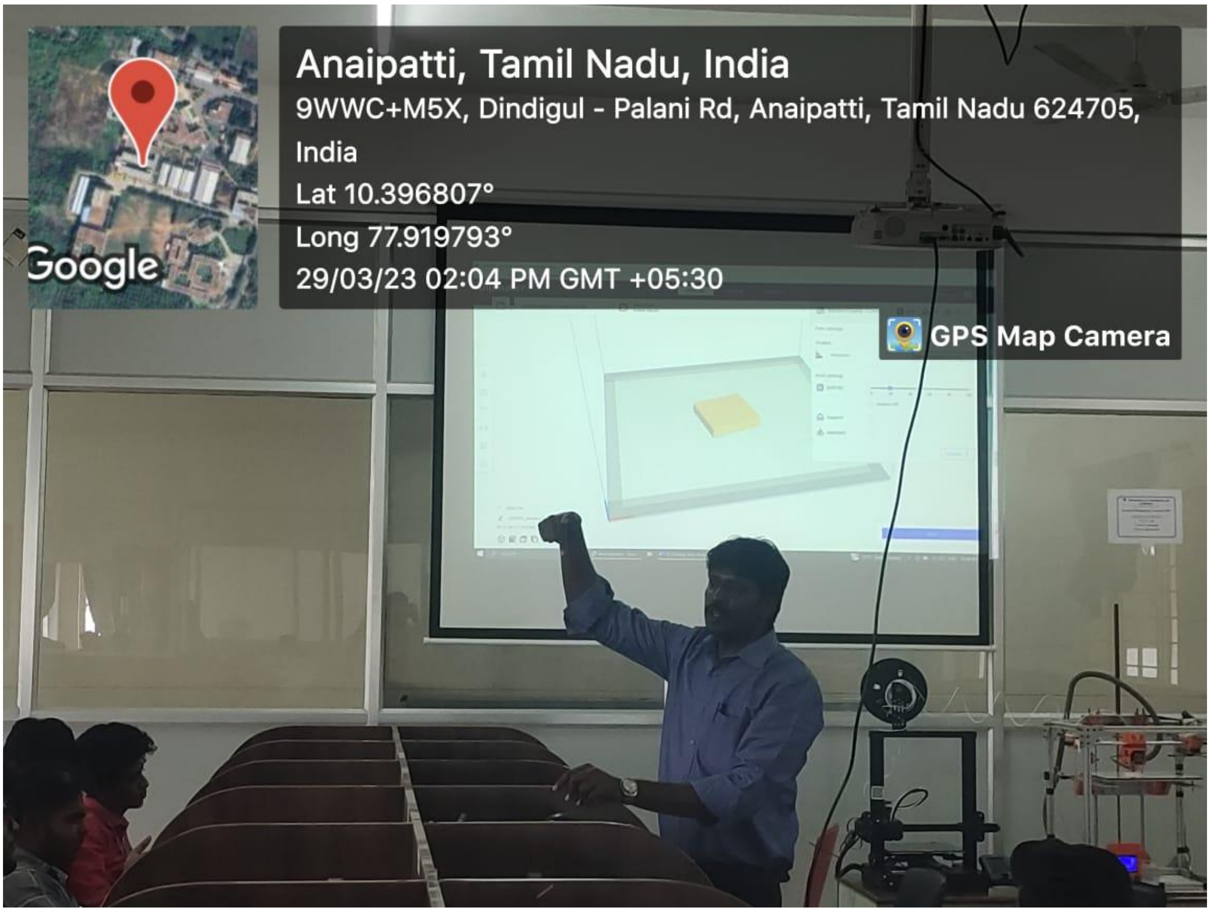
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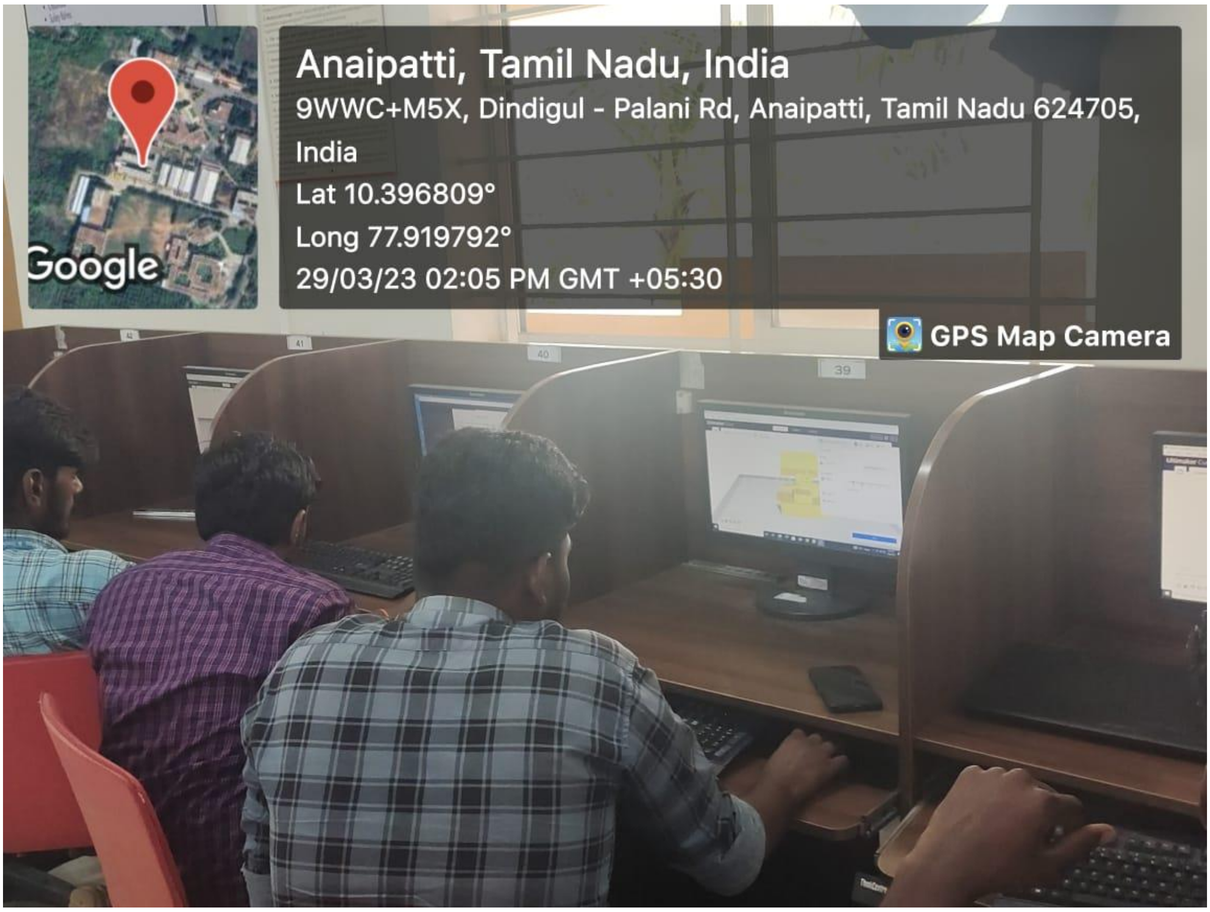
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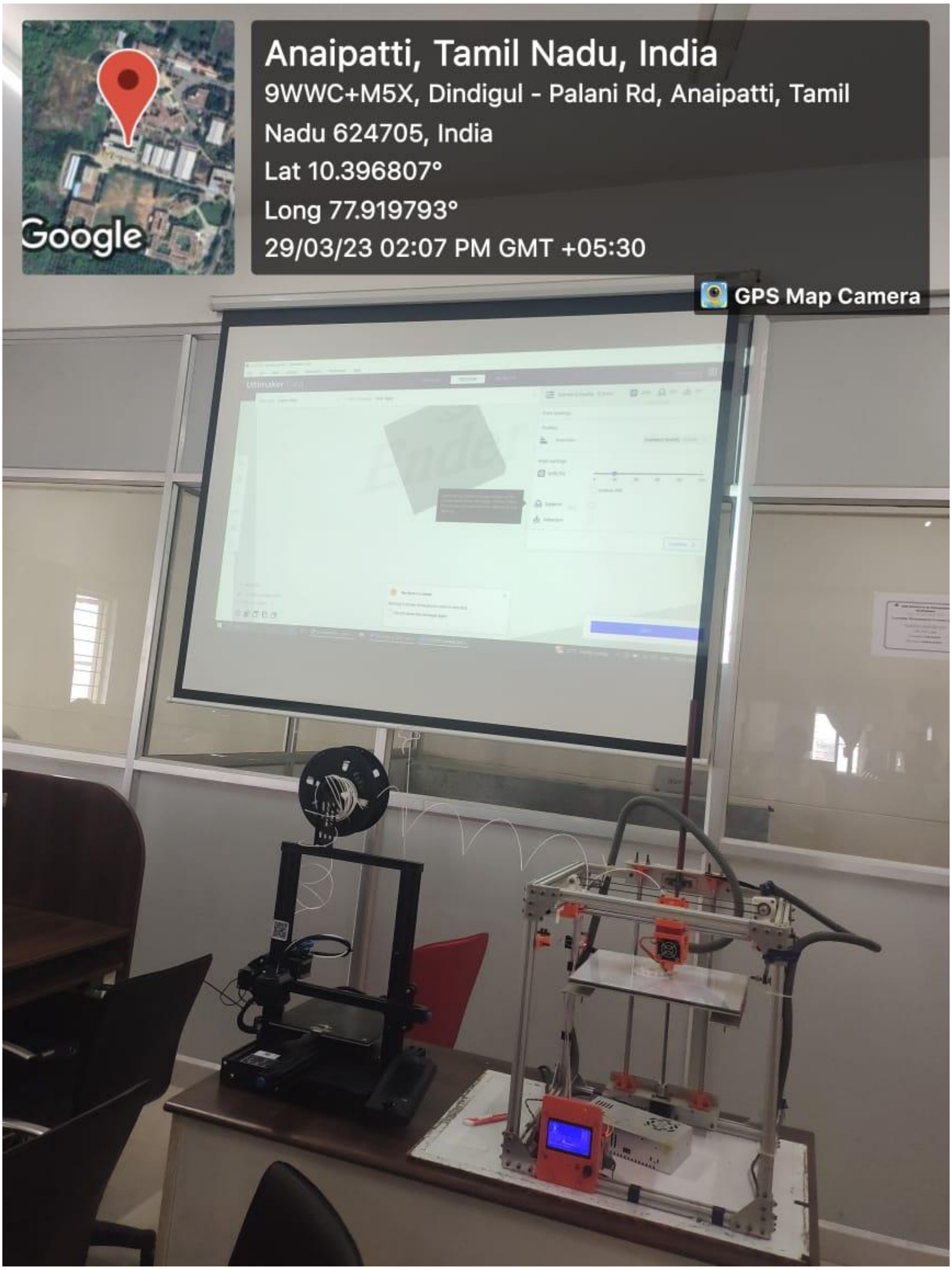
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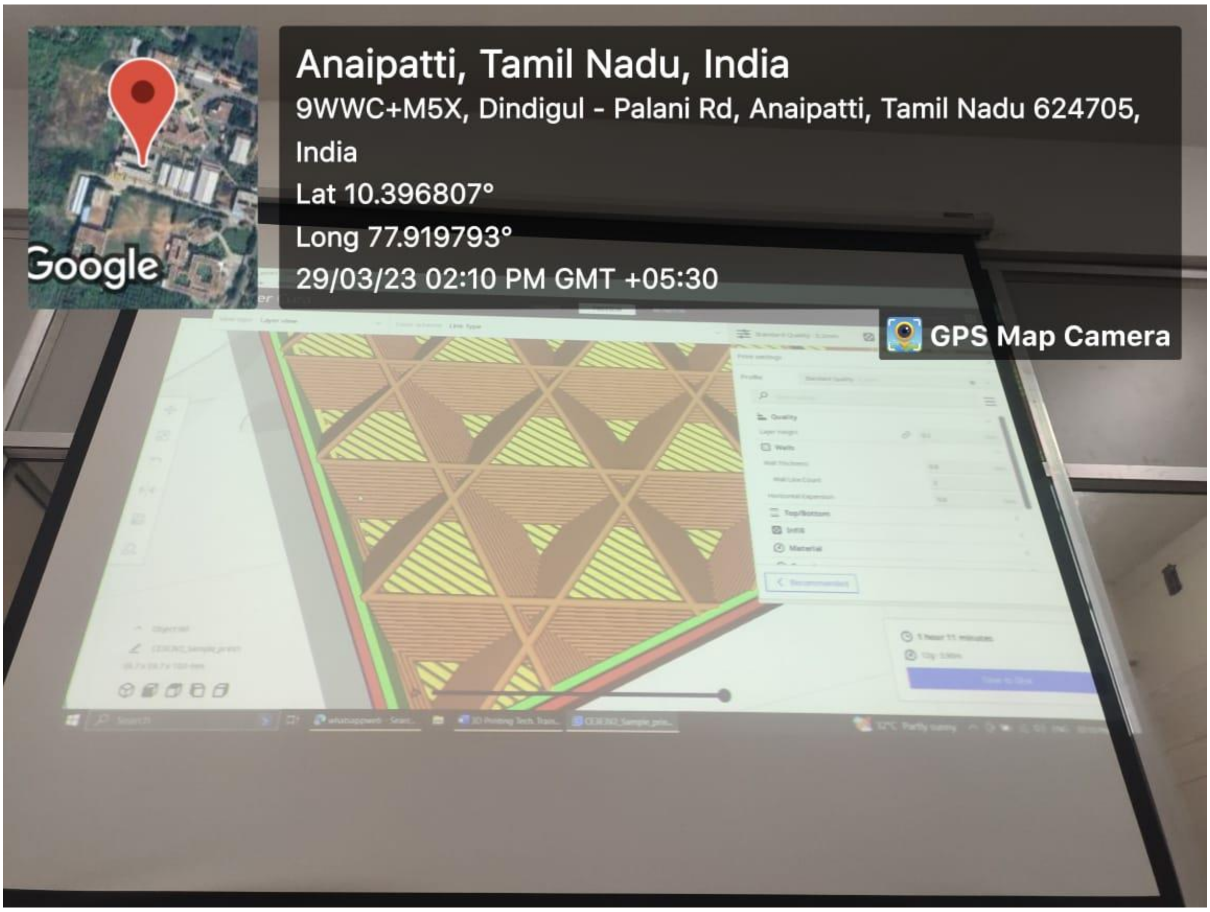
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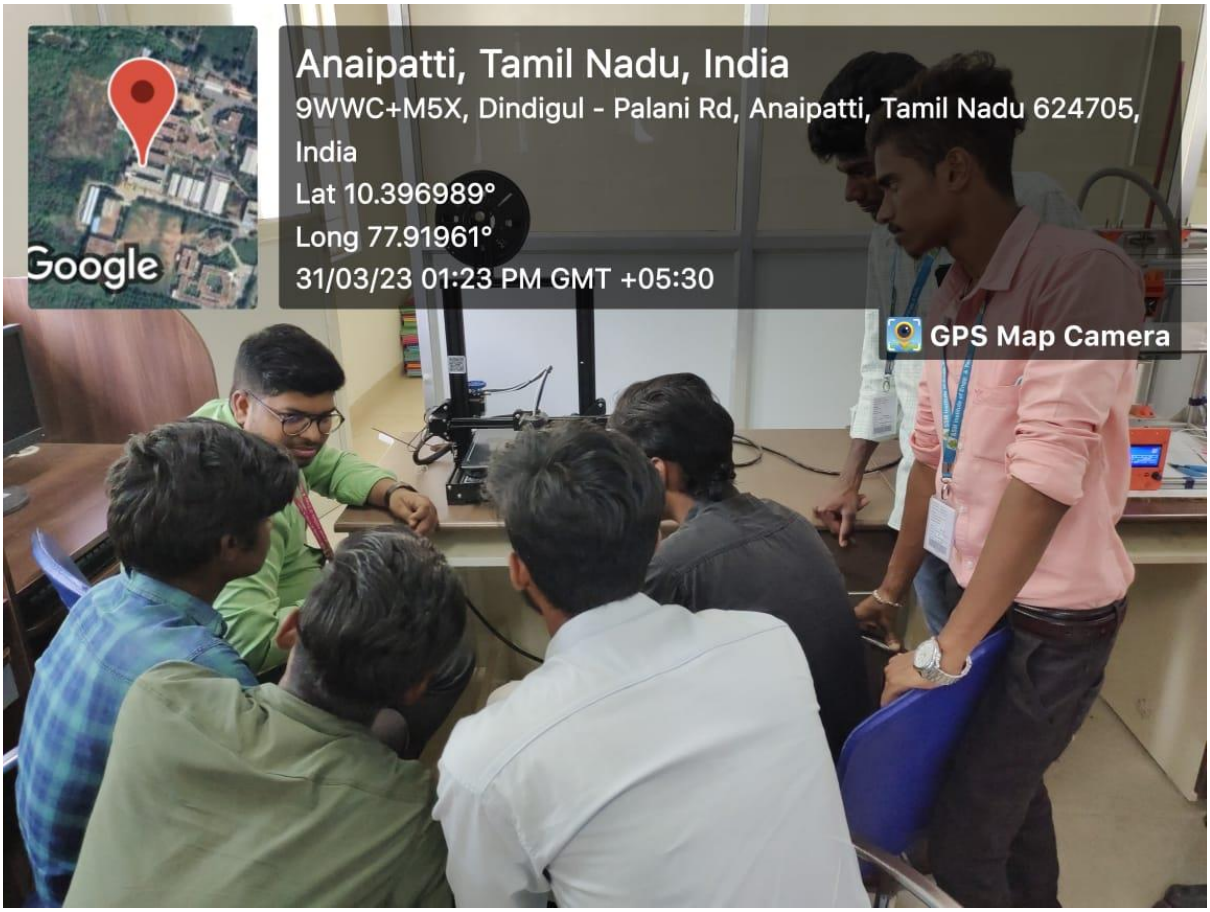
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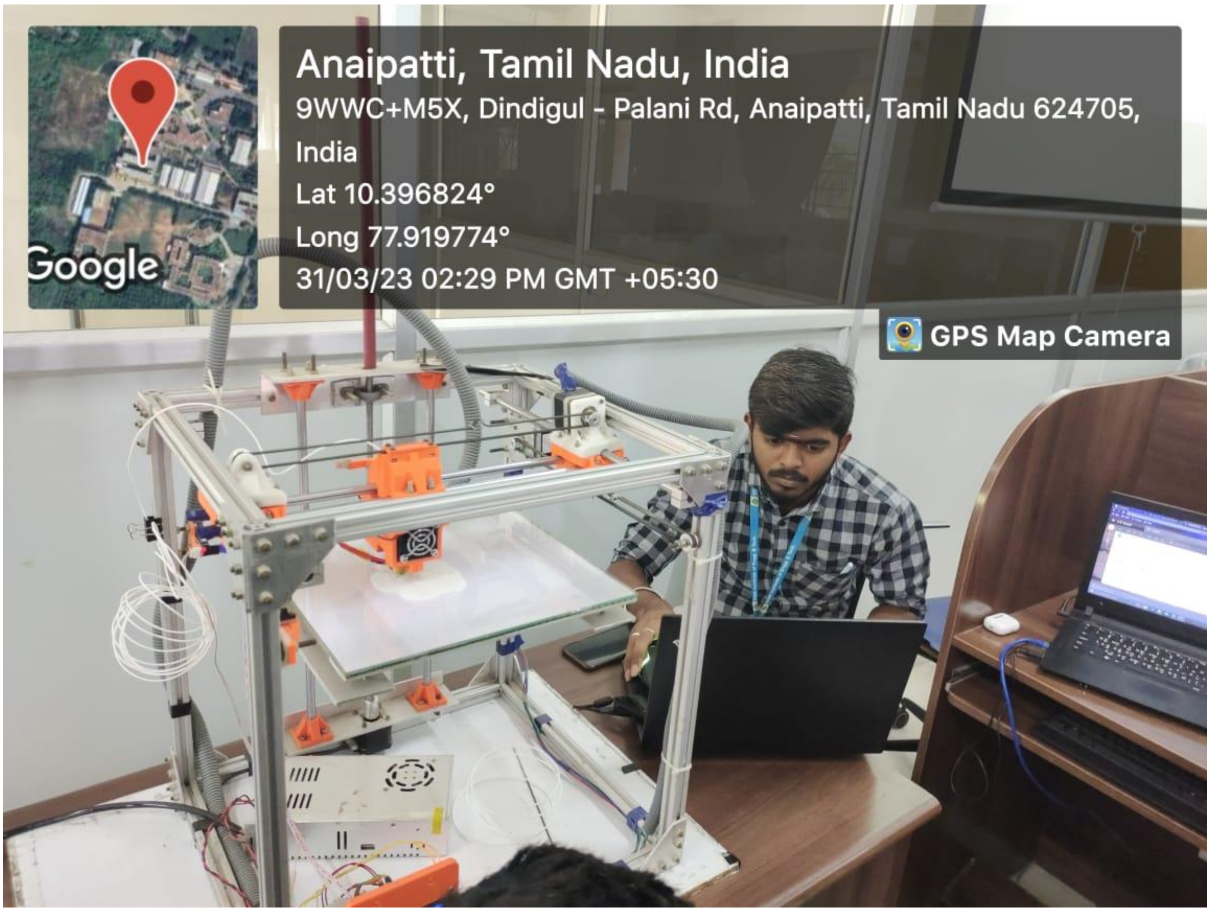
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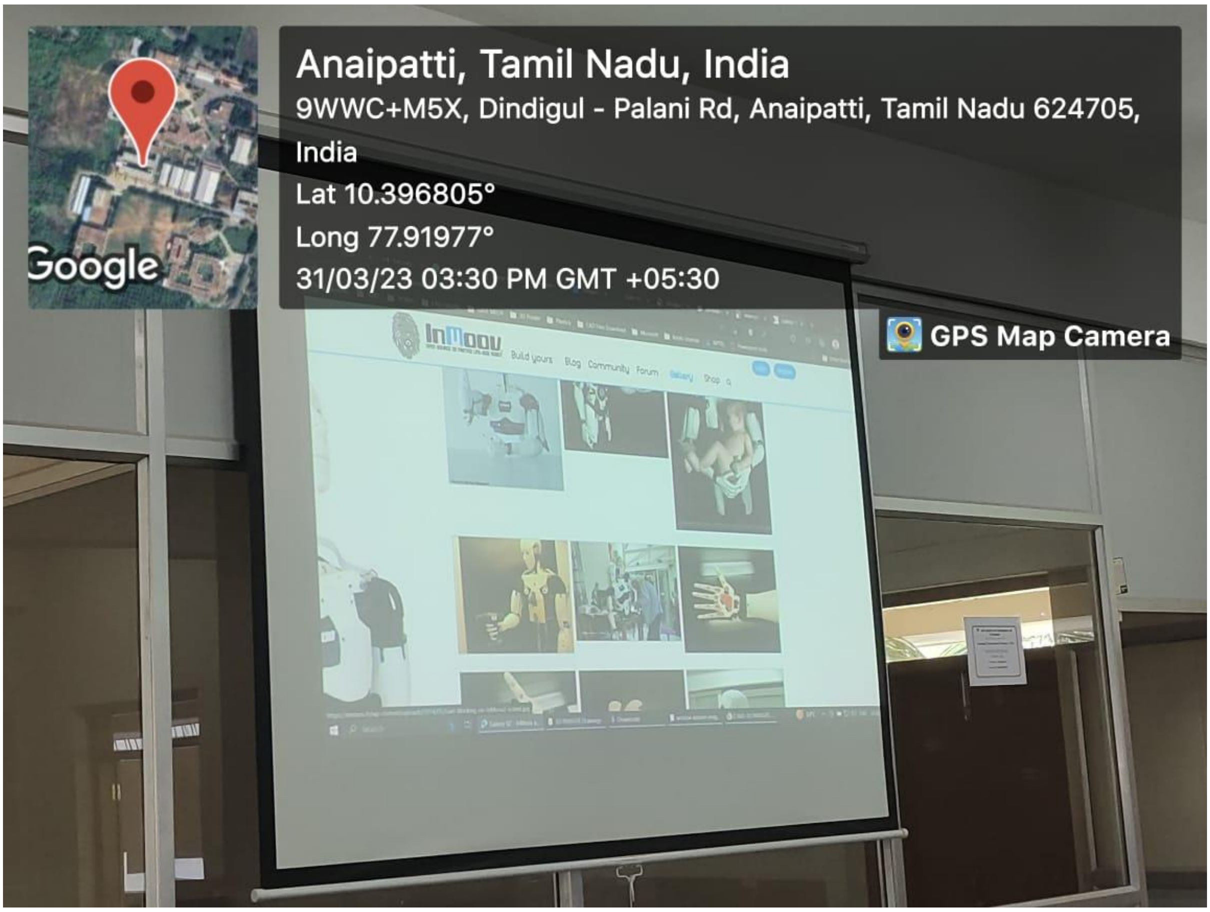
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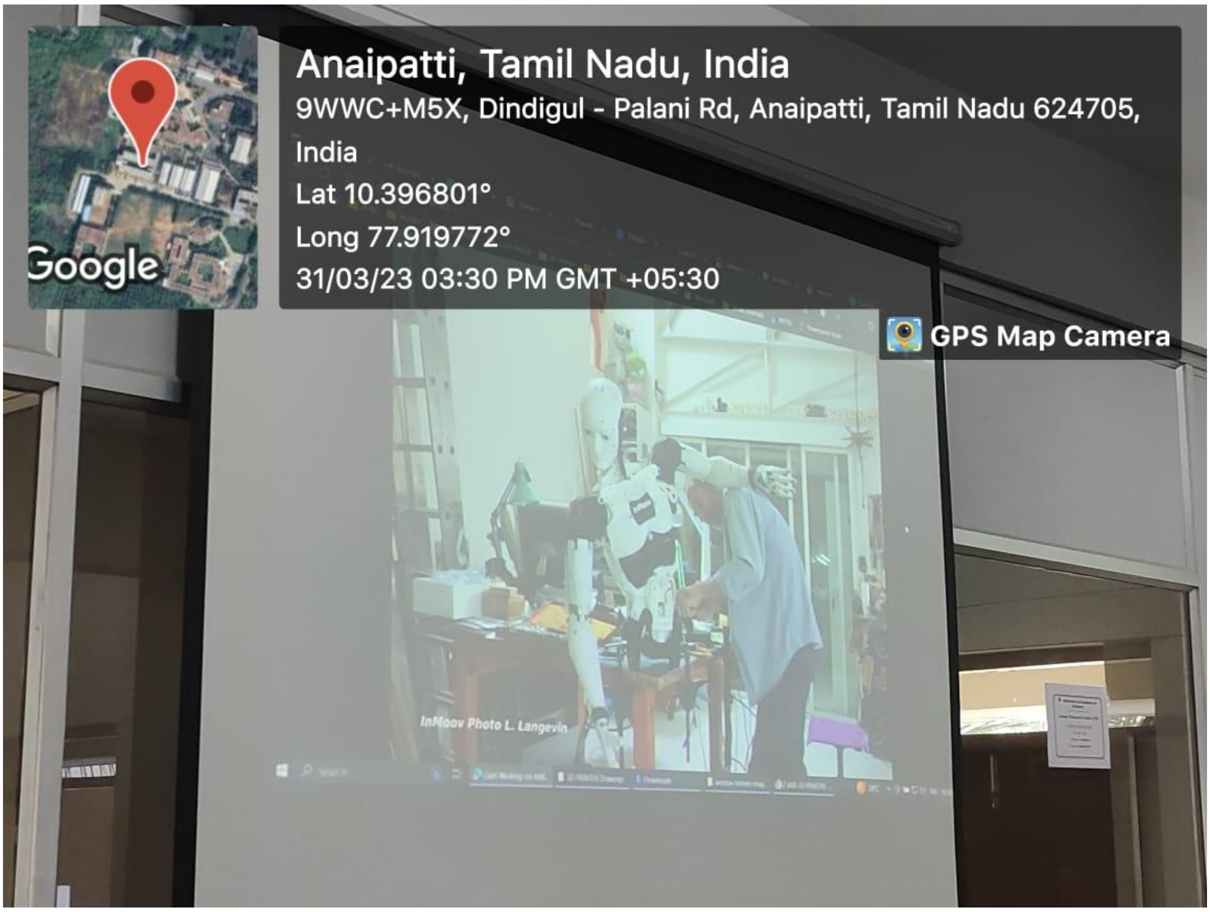
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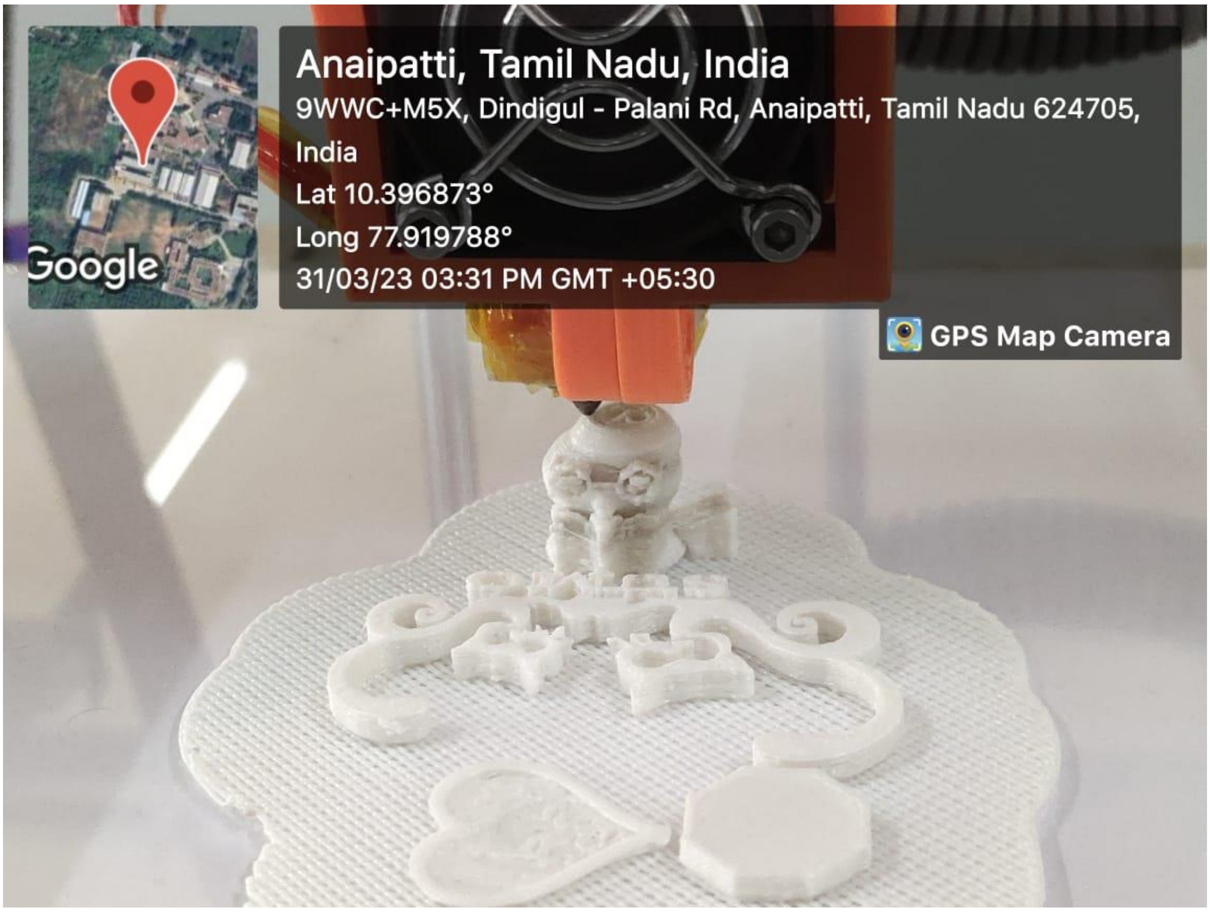
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