

[Innovative design]

*REUSE AND RECYCLE OF DEBRIS
FOR PRINTED BUILDINGS*



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REUSE AND RECYCLE OF DEBRIS FOR PRINTED BUILDINGS

INTRODUCTION

You are now in Madrid, and the only historic place in this city that is emblazoned with the Malta's Order is situated between Corredera Baja de San Pablo, 20 and Calle Barco, 49.



It is not just an ordinary building, but one that for many years accompanied the changes of the country and has helped in many scenarios.

First, it was emblazoned with the Order of Malta because of Madrid's dependency from the Real Monasterio de las Comendadoras de San Juan de Acre in the town from Salinas de Añana.

But what is the Order of Malta? Well, it is a religious order of the Catholic Church that has existed for many centuries now, with the sole purpose of caring for people in need through its medical, social and humanitarian works.

With this information, we can affirm that this title with all its purpose relation gives more significance to the building.

After a long time, its utility changed, becoming a residential building, being the home of many famous characters like Carlos Gondorff, an architect, and Ana Ruiz, the mother of Antonio Machado.

But after the Civil War its structure problems started to increase, until 1991 when the City Hall of Madrid bought it and decided it would be better to renew it, starting by kicking out the remaining residents in 2008. This decision was made because of its state that was already dangerous for the people and too degraded for a monument.

Therefore, the City Hall decided it was time to part ways with those walls and demolish it, but for this valuable masterpiece to not leave the city just like that, they wanted to be able to recreate this building with its own **debris**, using a **3D printer**.

This way, when the project is finished, Madrid will have a replica of this monument with its own material, making it even more like the original. This originality is especially important since this Administration cares deeply about the preservation of historical heritage.

Madrid doesn't want to lose its essence, just come back to life, without leaving behind the promotion of a green city, where **recycling** is vital.

KEYWORDS & DEFINITIONS

- Debris: scattered pieces of waste, rubble, or remains of a structure, especially a building, that has been damaged, demolished, or destroyed.
- 3D printer: a device that creates three-dimensional objects from digital designs by layering materials, such as plastic, concrete or metal, on top of one another.
- Concrete: a building material made from a mixture of cement, sand, gravel, and water. When the mixture dries and hardens, it forms a strong and durable substance that is commonly used in construction.
- Recycling: the process of converting waste materials into new products or materials, in order to reduce waste and conserve resources. Recycling can involve the collection, sorting, processing, and remanufacturing of materials like paper, plastic, glass, and metal.

TASK

The City Hall of Madrid decided to hire your team of engineers and scientists to create a mechanism that would turn the debris of the old building into material that can be used in a 3D printer of buildings.

This new mechanism/technique is extremely important not only to be able to completely renovate this monumental building, but to innovate the green production of materials in the construction area.

OBJECTIVES

Design a system in which debris from old buildings can be recycled into a material that a 3D printer of buildings could use.

SUB-OBJECTIVES

- Systems, machines and/or procedures necessary to process all the upcoming debris before turning them into anything else.
- Systems, machines and/or procedures necessary to transform the processed debris into concrete
- Define the materials the system will need to be functional: State the materials needed to build the system you are proposing.
- State the impact of the solution for the society: Make an impact study towards the society and the benefits this method provides.

- List the properties of this new concrete: State the feasible scenarios where this concrete could be used for describing its properties (e.g. Residential houses, buildings, skyscrapers...)

WORKING CONDITIONS

- The system should be designed to be as cost-effective as possible.
- The system should be designed to minimise its environmental impact.
- The system should be designed to be scalable, which means that it can be easily expanded or reduced in size depending on the demand for its services.
- The system should be capable of processing the most common building materials in Spain and Portugal, such as bricks, concrete, rocks, and other similar materials.
- You don't have to worry about the materials introduced in your system. The input of your system will be the materials you are specifically going to process.

USEFUL LINKS

- <https://www.aniwaa.com/buyers-guide/3d-printers/house-3d-printer-construction/>
- <https://www.amt-print.com/3d-printers/>

REQUIREMENTS AND DELIVERABLES

All the background information and research for your solution has to be delivered in a presentation in **.ppt format** through a google form (**open from 20:30 to 21:00h**).

The layout, technologies and materials of your solution must also be referred to and justified. Any special needs that the solution requires to function must be specified too.

Also a prototype of the solution is recommended for the final evaluation. There's no need for it being completely functional but it needs to reflect the technologies used for your solution.

The prototype must be brought to the presentation. You can support your presentation on the prototype.

RESOURCES AND MATERIALS

You can make use of your personal laptop, to write the report and make the presentation. You have access to the internet and can consult all available sources.

Moreover, if you need to, you can ask for paper, pens, pencils, erasers, etc. to the Topic Team or an organiser.

The use of any type of specialised software must be firstly asked to the Topic Team.

Also, you are given the lists of materials you can use for your prototype.

GENERAL RULES

- Help from outside the team and the competition is strictly forbidden.
- Copying or taking ideas from another team's solution is strictly forbidden.
- Please respect the schedule. You are able to work on your task during the given time. The task was made to be solved during Working Hours written on the schedule.
- Clean your working space after the competition. Failure to do so will lead to a penalty.
- Any question regarding the task has to be asked to Topic Team members.
- Respect everyone around you: your team, other teams, organisers, the jury, faculty staff, etc.

PRESENTATION RULES

You will have **15 minutes to present** your solution so be sure to use your persuasiveness to make sure that the jury gets your solution and finds it viable to be applied. You will only have access to the submitted presentation so be sure to rehearse your presentation beforehand so that everything goes smoothly. Not everyone has to speak during the presentation but make sure that the jury sees your team spirit as well!

You have a **5 second tolerance** window after the 15 minutes are finished and for **every extra second beyond the predetermined time of the presentation the penalty will be 0.1 points**.

The presentation will be completely cut after 1:15 extra minutes

After the presentation the jury will have **8 minutes to comment and question** your team, so make sure you answer concisely to clear any doubts the jury might have.

Note: the presentation time given is the total time you will have to present both your tasks, use that time wisely.

PENALTIES AND DISQUALIFICATION

- Any rule, requirement or deliverable deadline violation will lead to penalization.
- The extent of the penalization is up to the Topic Team/Jury.
- The penalty points will be subtracted from the team's final score.
- In some cases, if the violation is severe, the team may be disqualified.
- For every extra second beyond the predetermined time of the presentation the penalty will be 0.1 points.
- The use of any kind of AI tool (such as ChatGPT) is forbidden and can lead to disqualification.

EVALUATION CRITERIA

Presentation		10%	Quality of the presentation: checks the guidelines, visual aids, adequate for an academic context, quality of the explanation...
Economic and energetic efficiency	Economic efficiency	5%	Minimising the costs and having a realistic budget
	Energetic efficiency	5%	The solution minimises the energy costs
Prototype		20%	Representative prototype: it is representative of the real product (scaled, realistic, adapted to chosen scenario...)
Innovation		20%	Find a new way, or reinvent old ones by making improvements, to solve a problem that fits the context of this problem. Innovation is not restricted to just one aspect, an ideal solution should innovate across the whole process and every aspect of the development of this project.
Check objectives	Method for processing the debris	6%	System to process all the upcoming debris before turning them into anything else
	Method to convert that debris into concrete	6%	System to transform the processed debris into concrete
	Define the materials the system will need to be functional	6%	State the materials needed to build the system you are proposing
	State the impact of the solution for the society	6%	Make an impact study towards the society and the benefits this method provides
	List the properties of this new concrete	6%	State the feasible scenarios where this concrete could be used for describing its properties (e.g. Residential houses, buildings, skyscrapers...)
Systems distribution		10%	Shows the systems and methods used in your solution had been thoughtfully planned and used in an efficient way