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MODULE 06

SUSTAINABLE TECHNOLOGY

DIGITAL RURAL EUROPEAN ART
AND MEMORY



Project partners



Project DREAM
Digital Rural European Art and Memory
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How to use this E-book

You can use this e-book before, during or after the learning session. The sections build on each other, starting with the basic idea of sustainability and moving towards practical choices about digital technology, equipment, resources and cultural heritage.

As you work through the module, you will explore where the environmental impact of digital technology comes from, why newer or more efficient technology is not always the most sustainable choice, and how devices and materials can be maintained, repaired, reused or shared for longer.

Short examples and reflection points will help you connect these ideas with everyday situations. At the end of the e-book, you will apply what you have learned by designing a Sustainable Digital Heritage Station for a local heritage item, place, story or tradition.



Aqueduct of Segovia, Spain.

MODULE INFORMATION

 Module number 06	 Level Beginner
 Topic Sustainable use of technology	 Format Hybrid learning
 Duration 3 hours	 Main output Sustainable Digital Heritage Station

About this module

This e-book supports the DREAM module on Sustainable Technology and the Environment. Digital technology is part of everyday life. We use phones, computers, cameras, online services and digital files to communicate, learn, work and preserve information. In cultural heritage, digital tools can help document buildings and objects, record traditions and memories, monitor historic places and make local heritage easier to access. However, digital technology is not separate from the physical world. Every device requires materials, manufacturing, transport and energy. For this reason, sustainable technology is not simply about using less technology or always choosing the newest and most efficient device. It is about making thoughtful choices.

Throughout this module, you will learn to look beyond labels such as digital, green or energy-efficient and consider the wider effects of a technology choice. The goal is not to find one perfect solution, but to make choices that are useful, realistic and responsible for both people and the environment.



Learning Objectives

- Explain the main environmental, social and economic dimensions of sustainability
- Describe the physical resources behind digital technology, including materials, manufacturing, energy, networks
- Consider the full life cycle of a digital device when making decisions about its use or replacement;
- Compare technology choices and recognise trade-offs
- Identify ways in which sustainable technology can support cultural heritage
- Recognise misleading sustainability claims, including greenwashing, burden shifting and rebound effects
- Choose technology according to its purpose, avoiding unnecessary equipment, data use and complexity
- Apply these principles creatively by designing a simple Sustainable Digital Heritage Station for a local heritage element.

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0. Before You Begin: My Starting Point

Before starting the module, rate each statement from 1 to 5. Use 1 when you cannot do the task yet and 5 when you can do it independently. This is not a test. It is a way to notice your starting point and later recognise your progress.

- I can explain why digital technology has environmental impacts.
- I can identify environmental, social and economic effects of a technology choice.
- I can decide whether equipment should be maintained, repaired, reused, replaced or recycled.
- I can plan an accessible and sustainable digital heritage activity.

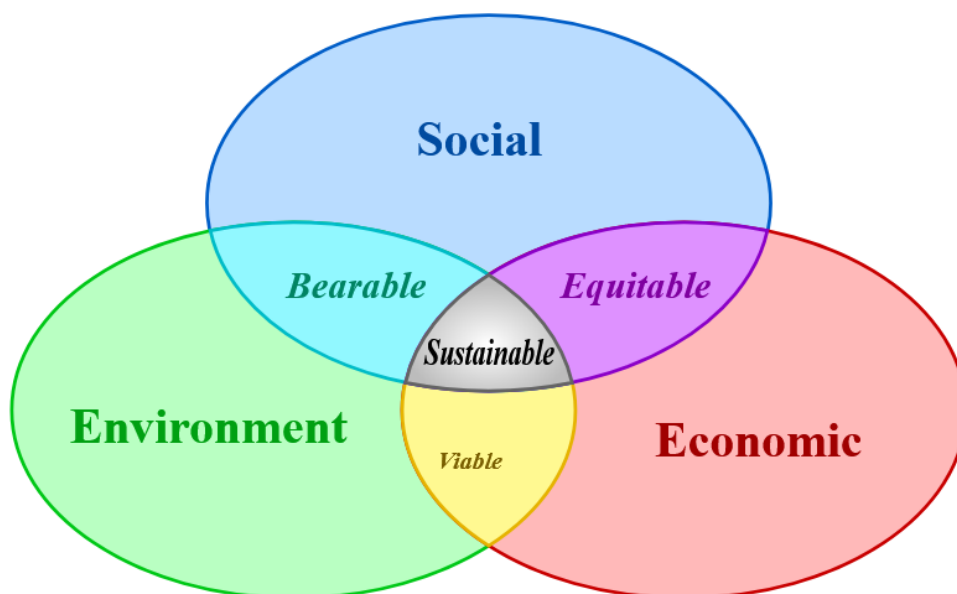
Keep your ratings. You will return to the same statements at the end of the module.

1. What is Sustainability?

The term „**sustainable development**“ gained attention during the 1970s, when concerns began to grow about the environmental and social consequences of economic expansion that relied on the continuous use of natural resources. Sustainable development is commonly understood as development that responds to present needs without reducing the ability of future generations to respond to their own needs (World Commission on Environment and Development, 1987). More precisely, it is a form of ethics in which “environmental and economic actions taken by present persons do not diminish the opportunities of future persons to enjoy similar levels of wealth, utility, or welfare“ (Meadowcroft, 2026). This definition connects present decisions of people with long-term responsibility and asks us to consider both human needs and the limits of natural systems.

Figure 1

Sustainable Development Diagram



Note. From Sustainable development.svg [Vector graphic], by nojhan, 2012, edited by AnonMoos, 2012, Wikimedia Commons, ([https://upload.wikimedia.org/wikipedia/commons/archive/7/70/20190210220826%21Sustainable_development.s](https://upload.wikimedia.org/wikipedia/commons/archive/7/70/20190210220826%21Sustainable_development.svg)vg). CC BY-SA 3.0.

In practice, **sustainability** has several interdependent dimensions. Environmental sustainability concerns climate, ecosystems, natural resources, pollution and waste. Social sustainability concerns wellbeing, equality, accessibility, human rights and the strength of communities. Economic sustainability concerns affordability, responsible resource use and the ability of a solution to remain viable over time. Treating these dimensions separately can hide important consequences. For example, a low-energy solution that excludes people with disabilities is not fully sustainable.

Apart from that, sustainability also involves values, knowledge, skills and attitudes. This means that sustainability is not only a technical calculation; it is a **competence** used to interpret connected effects, imagine possible futures and act responsibly in a particular context (Bianchi et al., 2022).

Dimension	Questions to ask	Everyday solution
Environmental	<i>What materials, energy, data, transport and waste are involved?</i>	Use an existing projector and a compressed image instead of buying a new display.
Social	<i>Who can access the activity?</i> <i>Who may be excluded?</i> <i>Whose rights must be respected?</i>	Provide captions, alternative text, a printed fallback and an assisted option.
Economic	<i>Can the community afford, maintain and continue the solution?</i>	Choose a format that local volunteers can update without a paid specialist.

2. Sustainable Technology

The environment faces pressures from climate change, resource depletion, pollution, and biodiversity loss. Technology can worsen these problems (for example through high energy use or waste) or help solve them. Sustainable technology aims for the latter: lower emissions, circular resource use, cleaner production, and resilience.

Sustainable technology is technology that fulfils a meaningful purpose while considering environmental, social and economic effects throughout its life cycle. It remains useful for as long as possible, uses energy and materials responsibly, can be maintained or repaired where appropriate and does not create unnecessary barriers for the people it is supposed to serve.

This does not mean that the oldest or simplest tool is always the best. A newer device may provide essential accessibility, safety or reliability. The important question is whether the choice is proportionate to the need and whether its benefits justify the additional resources. Sustainable technology is therefore a way of selecting, using, maintaining, sharing and eventually managing technology, not a label attached to a product.



Practical Task

List three technologies you use daily (phone, transport, home energy).
For each, note one positive and one negative environmental effect.

Share or journal: *How might a more sustainable version change the system?*

Key domains of sustainable technology include renewable energy, low-carbon materials, water and waste management, sustainable manufacturing, and nature-based solutions. Recent reviews show rapid technical progress in these areas, though wider adoption still faces policy, finance, and governance barriers.



Practical Task

Imagine a village exhibition with one *historical photograph* and one *recorded memory*.

Try designing three versions: a technology-heavy version, a minimum sufficient version and a no-internet fallback. Compare how access, cost, and maintenance can differ among them.

3. The Physical Footprint Behind Digital Tools

Digital technology can sometimes feel invisible. We take a photograph, upload a video or save a document, and the action happens on a screen. However, every digital activity depends on physical resources. Taking a photograph requires a device made from minerals, metals, plastics, glass and batteries. Storing or sharing the photograph requires networks, servers and data centres, which use electricity, equipment, cooling systems and other resources. When devices eventually become unusable, they can also contribute to electronic waste. This means that a digital activity has an environmental footprint even when we cannot see it directly.



Reflection

Imagine that a community wants to create a digital archive of old photographs.

The visible result may simply be a website containing scanned images. Behind that website, however, several things are needed.

Old photographs → scanner or smartphone → computer → internet connection → online storage → devices used to view the archive

Think about the whole process:

Which parts of this digital archive use resources or energy?

What could the community do to reduce its environmental impact while still preserving and sharing the photographs?

However, this does not mean that digital technology is automatically unsustainable. Digital tools can reduce travel, replace some physical materials and make information easier to access. The important point is that **digital choices still have environmental impacts**, even when those impacts are not immediately visible (European Commission, 2020; Lange et al., 2020).

It is therefore useful to think of digital technology as having **a life cycle**. The cycle begins before a device reaches the user and continues after the user stops using it. A responsible decision looks beyond the moment when a screen is switched on. It asks where the technology comes from, how long it can be used, what resources it requires during its lifetime and what happens when it is no longer needed.

Life-cycle stage	What happens	Questions for a community project
Materials	Raw materials and minerals are extracted and processed.	<i>Do we need a new device, or can an existing one be used?</i>
Manufacturing	Components are produced and assembled using energy and water.	<i>Can the useful life of existing equipment be extended?</i>
Transport and packaging	Products and parts move through supply chains.	<i>Can equipment be borrowed locally?</i>
Use	Electricity, networks, storage and accessories support the service.	<i>Can the content work offline or with smaller files?</i>
Maintenance and repair	Updates, cleaning and component replacement may extend life.	<i>Who can maintain the equipment safely?</i>
Reuse or end of life	Equipment may be passed on, refurbished, recycled or discarded.	<i>Where will it go after the project?</i>



Practical Task

Choose one familiar digital activity, for example:

- uploading a video
- scanning and storing an old photograph
- making a video call

Write the activity in the centre of a page. Around it, identify everything that makes the activity possible.

Think about:

device – charger – electricity – router – internet network – server or data centre – storage – maintenance – replacement parts – end-of-life treatment

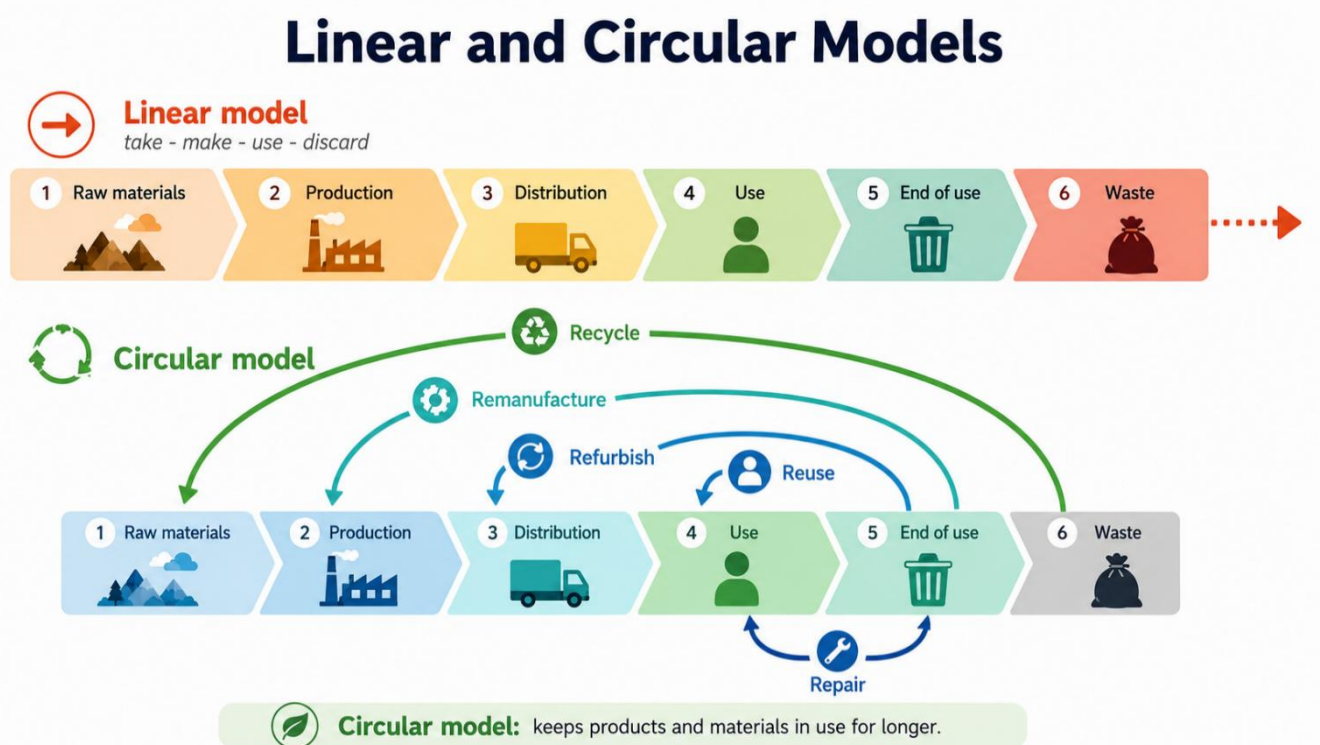
Then answer:

1. Which of these resources can you influence directly?
2. Is every element necessary?
3. Could you use something you already have, borrow equipment or reduce the amount of data needed?
4. Choose one realistic improvement you could make now.

4. From a Linear to a Circular Approach

Digital devices may seem easy to replace, but every phone, computer or tablet contains valuable materials and requires resources and energy to produce. For this reason, sustainable technology is not only about what happens when a device becomes waste. It is also about how we use, maintain and keep devices useful for as long as possible.

A **linear model** follows a simple pattern: take materials, make a product, use it and discard it. As opposed to that, a **circular approach** aims to prevent waste and preserve the value of products, components and materials for longer. In the digital context, circularity begins before recycling. It includes avoiding unnecessary purchases, using existing devices longer, maintaining equipment, repairing components, sharing resources and preparing functioning devices for reuse (European Commission, 2020).



This means that recycling should not be the first solution we think of. If a device can still be used, repaired or passed on to another person, keeping it in use usually preserves more of the resources and work that went into producing it.

The EU waste hierarchy (European Parliament & Council of the European Union, 2008; 2012) also gives priority to **prevention and preparation for reuse before recycling and**

disposal. Recycling remains important because electronic equipment contains materials that should be recovered and substances that require controlled treatment. However, recycling cannot restore all of the value already invested in a functioning product.

5. Maintaining, Repairing, Reusing and Recycling Devices

Maintenance is usually the first practical step in extending useful life. It can include protecting equipment from heat and moisture, keeping ventilation openings clear, installing appropriate updates, using compatible chargers, managing storage and replacing worn accessories. Maintenance should be proportionate: it is intended to prevent avoidable failure, not to encourage unsafe home repair.

Repair can preserve a device and reduce the need for replacement, but electrical equipment and batteries can create fire, electrical and data-security risks. Tasks beyond the user's competence should be handled by an authorised or qualified repair service. Before handing over a device, back up important files, remove accounts or use a repair mode where available, and ask how personal data will be protected. A sensible repair decision compares cost, safety, expected additional lifetime, availability of parts and whether the device can still receive necessary software support.

Before repair: back up essential files and record the condition of the device.

Protect data: sign out, remove sensitive accounts or use an official repair mode when available.

Ask for evidence: request an estimate and clarification about parts, warranty and expected lifetime.

Respect safety limits: do not open swollen or damaged batteries and do not attempt electrical repairs without the required competence.

Prepare for reuse: erase personal data securely and provide the next user with compatible accessories and essential information.

Recycle correctly: use an authorised system when a device or battery can no longer be reused safely.

6. Making Sustainable Technology Decisions

Sustainability is not a checklist in which every positive action automatically produces a positive overall result. For example, streaming an exhibition can help people join from home, but it may exclude those with slow internet. Replacing printed materials with screens may reduce paper use, but screens also require electricity, equipment and maintenance. Buying a new energy-efficient device may use less electricity, but producing the new device also requires materials and energy, especially if the old one still works well.

A **sustainable decision** therefore looks beyond the most obvious benefit. It considers whether something is really needed, how long it can be used, maintained or repaired, what resources it requires, who benefits or may be excluded, and whether a simpler alternative could achieve the same purpose. It also considers both immediate and long-term effects rather than choosing the option that only appears more sustainable at first sight. This can also be understood as embracing complexity and exploring possible futures rather than searching for a single perfect answer (Bianchi et al., 2022).



Key Concepts

Sustainable decision: A choice that considers environmental, social and practical effects, both now and over time.

Trade-off: A situation in which improving one aspect may create a cost or disadvantage in another.

Inclusive alternative: A different way of achieving the same goal that may use fewer resources or create fewer barriers for participants.

Remember: *A trade-off is a situation in which improving one aspect may weaken another. Sustainable design does not hide this tension. It explains the choice, reduces avoidable harm and records what should be improved next.*



Video Resource

What Earth in 2125 could look like - Iseult Gillespie

https://www.youtube.com/watch?v=4UJTtk_2ly0



Reflection

Think of a situation from everyday life when a technology seemed useful at first, but also created a problem, extra cost or barrier.

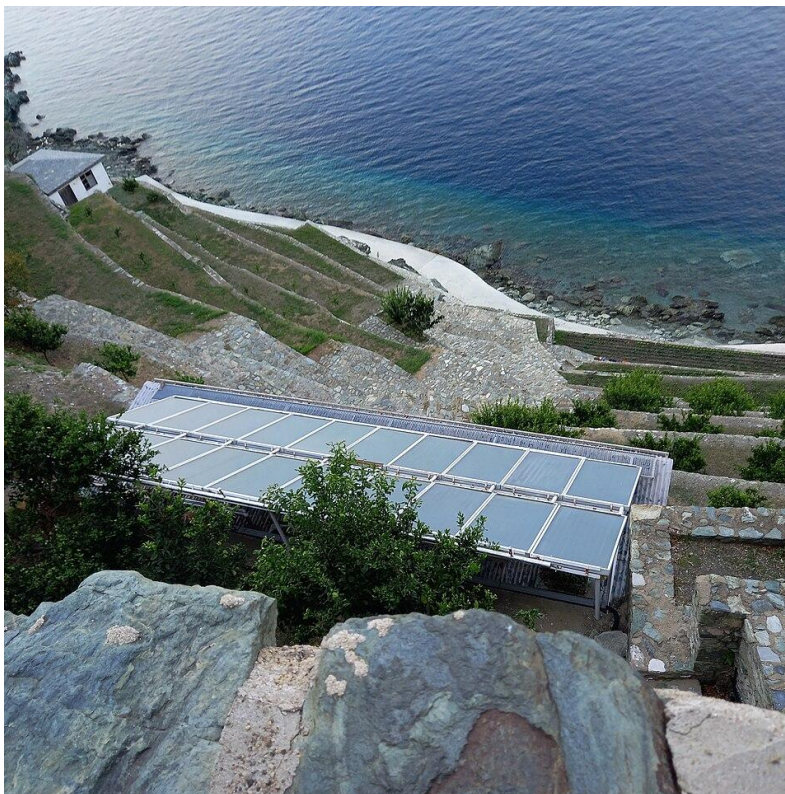
What happened, and how could the situation have been improved with a simpler, more sustainable choice?

7. Sustainable Technology and the Environment in the Context of Local Cultural Heritage

Local cultural heritage includes buildings, sites, landscapes, objects, and living traditions that give a place its identity. Climate change, pollution, resource scarcity, and intensive tourism threaten these assets. Sustainable technology offers tools that reduce environmental pressure while respecting heritage authenticity and community values. Sustainable technology can help protect heritage while reducing harm to the environment. The aim is not to replace traditional methods or change the character of a heritage place. Instead, technology should be used carefully, in ways that respect the original materials, appearance, meaning and values of the local community. Through this lens, environmental sustainability and cultural sustainability are closely connected. Protecting a historic building, traditional landscape or local craft also helps preserve the identity, knowledge and memory of a community. Technology can support this process, especially when local people are involved in deciding how it is used.

Figure 2

Solar Panels at Dionysiou Monastery



Note. From Solar panels and terraces at Dionysiou Monastery [Photograph], by Florificapis, 2022, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:Solar_panels_and_terraces_at_Dionysiou_Monastery.jpg). CC BY-SA 4.0.

Examples of sustainable technology in cultural heritage

1. Renewable energy in architectural heritage

Carefully integrated solar, geothermal, and other renewables can improve energy performance and cut carbon emissions. However, these systems need to be added carefully. When changes are made, they should respect the original building and, where possible, be removable or reversible in the future. For example, solar panels should not unnecessarily damage or change the appearance of a historic roof.

Figure 3

Example of renewable energy in architectural heritage



Note. Solar panels installed on the roof of St. Mark's Lutheran Church in Pleasant Hill, California. From Solar Panels on Church Roof full [Photograph], by Bastique, 2024, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:Solar_Panels_on_Church_Roof_full.jpg). CC BY 4.0.

2. Digital tools for monitoring and documentation

Digital technologies can help people understand the condition of a heritage site without constantly touching or changing it. Such technology enables real-time environmental monitoring, predictive maintenance, and non-invasive documentation. For example:

3D scanning and photogrammetry can create a detailed digital record of a building, monument or object.

Figure 4

Example of photogrammetric 3D model



Note. From B9217 photogrammetry - 81317b3b573f4df4b35418a20b6eacd7 [Digital image], by Transylvanian Museum of Ethnography, 2021, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:B9217_photogrammetry_-_81317b3b573f4df4b35418a20b6eacd7.jpg). CC BY 4.0.

Figure 5

Process of 3D scanning

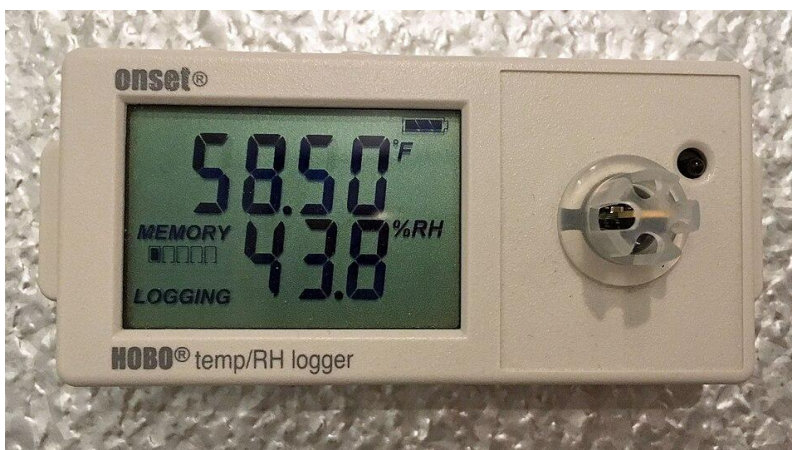


Note. From 3D scanning of Gribshunden figurehead [Photograph], by Ishkabibble, 2023, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:3D_scanning_of_Gribshunden_figurehead.jpg). CC BY-SA 4.0.

Sensors can measure changes in temperature, humidity, movement or other environmental conditions.

Figure 6

Data Logger for Environmental Monitoring

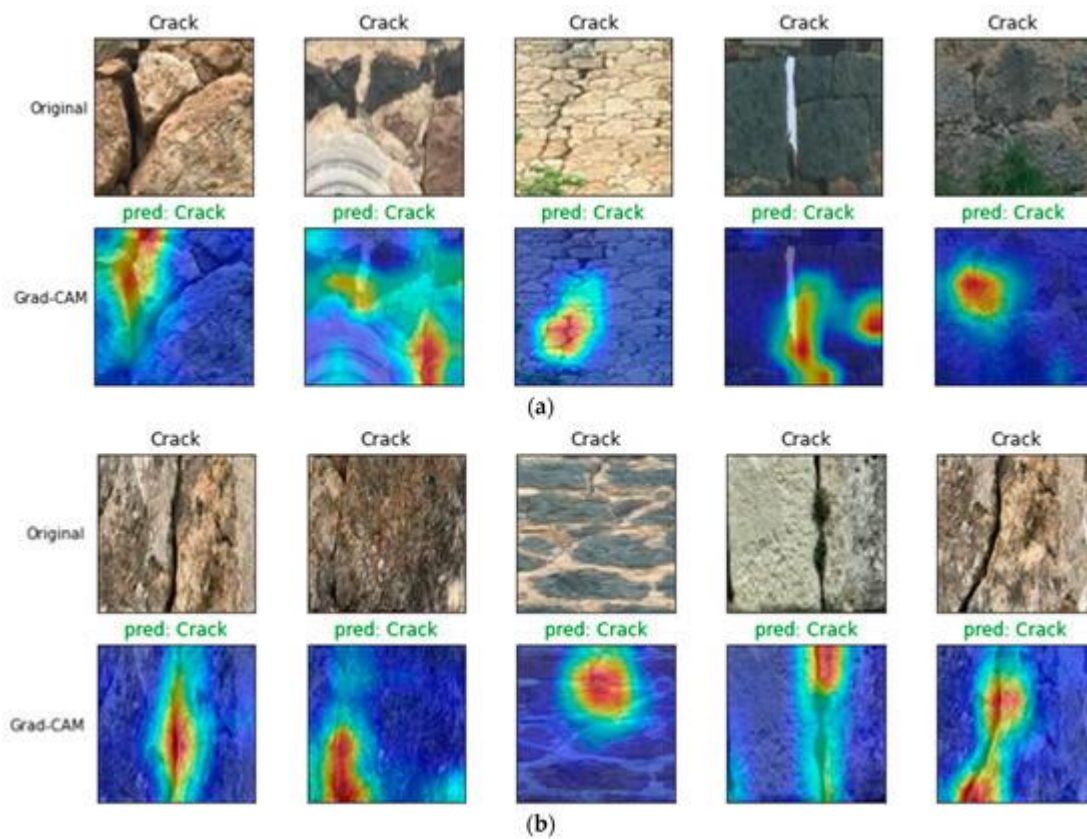


Note. From Data Logger [Photograph], by Aperegoy, 2017, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:Data_Logger.jpg). CC BY-SA 4.0.

AI-supported tools can help identify patterns or changes in large amounts of data. For example, AI can analyse images of a historic wall and highlight areas where cracks may be present. Experts can then examine these areas more closely.

Figure 7

Example of AI-supported detection and visualisation of cracks

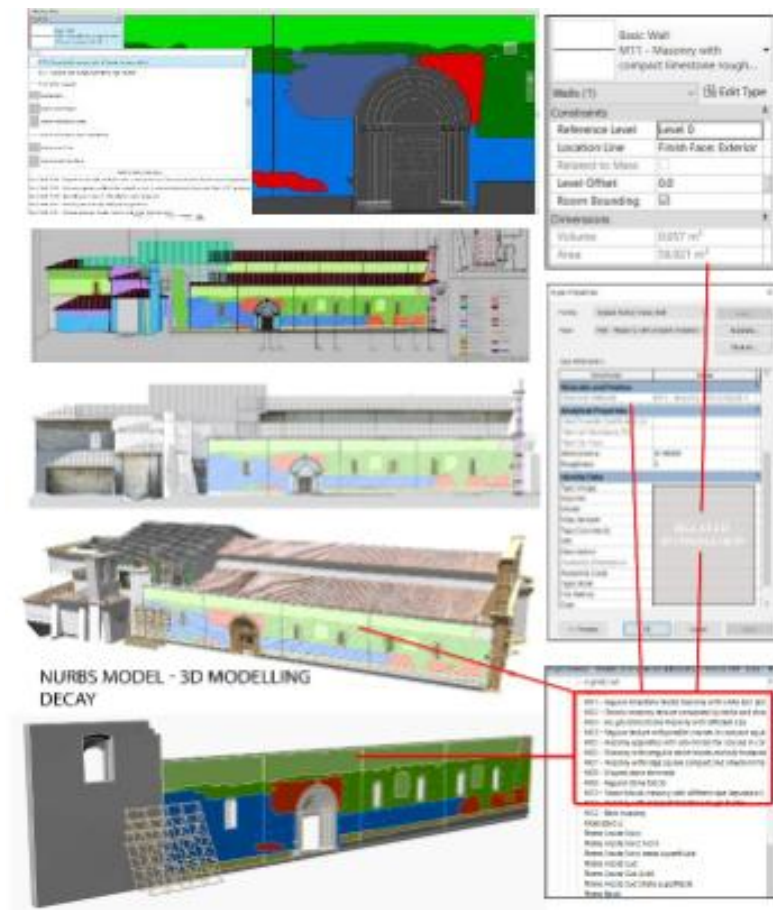


Note. From Figure 11 in “Deep Learning-Based Automated Detection of Cracks in Historical Masonry Structures,” by K. Hacıfendioğlu, A. C. Altunışık, and T. Abdioğlu, 2023, *Buildings*, 13(12), Article 3113. CC BY 4.0.

Digital twins can create a digital version of a real place that can be studied and monitored over time. For example, Brumana et al. (2017) created a detailed digital model of the *Basilica di Santa Maria di Collemaggio in L'Aquila* using laser scanning and photogrammetry. The model does more than reproduce the shape of the building. Information about materials, damage and the condition of different parts of the structure can also be added to it.

Figure 8

Example of adding material and deterioration information to a 3D heritage model



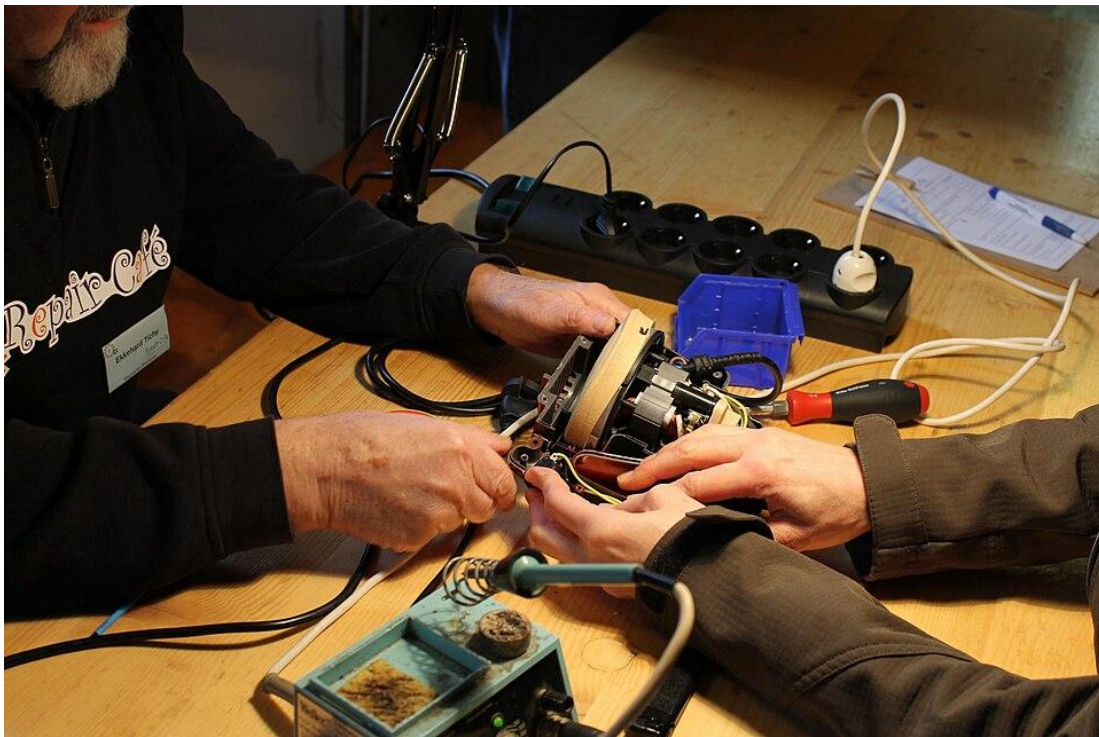
Note. From Figure 13 in “HBIM Challenge Among the Paradigm of Complexity, Tools and Preservation: The Basilica di Collemaggio 8 Years After the Earthquake (L’Aquila),” by R. Brumana et al., 2017, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLII-2/W5, p. 103. <https://doi.org/10.5194/isprs-archives-XLII-2-W5-97-2017>. CC BY 4.0.

3. Other approaches

Sustainability can also mean **making better use of what already exists**. Instead of demolishing an old building, it may be possible to adapt it for a new purpose while preserving its important features. Traditional or local materials can also be repaired and reused rather than immediately replaced. A laptop, camera or other electronic device may only need a new component, battery or simple repair to remain useful.

Figure 9

Example of community repair of electronics



Note. From Repair Café Trier Reparatur [Photograph], by RaMa2016, 2015, Wikimedia Commons (https://commons.wikimedia.org/wiki/File:Repair_Caf%C3%A9_Trier_Reparatur.jpg). CC BY-SA 4.0.

Digital technology can also support intangible heritage, such as crafts, oral traditions, local knowledge, music or traditional skills. Videos, photographs, recordings and digital stories can help preserve and share this knowledge without requiring large physical resources.

Figure 10

Example of residents and volunteers scanning historical photographs



Note. From Residents and volunteers scanning photos at Greater Rosemont History Day (5073284671) [Photograph], by Baltimore Heritage, 2010, Wikimedia Commons ([https://commons.wikimedia.org/wiki/File:Residents_and_volunteers_scanning_photos_at_Greater_Rosemont_History_Day_\(5073284671\).jpg](https://commons.wikimedia.org/wiki/File:Residents_and_volunteers_scanning_photos_at_Greater_Rosemont_History_Day_(5073284671).jpg)). CC BY 2.0.

8. Greenwashing, Rebound Effects and Trade-offs

Sustainability language can make a decision sound responsible without showing the evidence. **Greenwashing** occurs when environmental claims are vague, exaggerated or unsupported. In technology, a claim may highlight energy efficiency during use while ignoring manufacturing, short product life, data demand or end-of-life treatment.

A **rebound effect** occurs when efficiency lowers the cost or effort of an activity and total use increases, reducing or reversing the expected savings. Research on digitalisation shows why efficiency must be considered together with total demand and user behaviour (Lange et al., 2020; Santarius et al., 2023).

Problem	Meaning	Community example
Greenwashing	A product or activity is called green without clear evidence, criteria or life-cycle information.	A new screen is marketed as “eco” without explaining why the old one must be replaced.
Burden shifting	One impact falls while another rises elsewhere.	Printing decreases, but more displays, storage and electricity are introduced.
Rebound effect	Efficiency makes a service easier or cheaper, so total use grows.	Smaller video files lead to many more videos being produced and stored.
Problem substitution	A new action replaces one problem with another.	A functioning device is recycled instead of being repaired or reused.

A useful response is to ask for **boundaries** and **evidence**. It is useful to think about the situation and ask questions such as:

Which part of the life cycle is included? Compared with what alternative?

Is the claim about efficiency per task or a reduction in total impact?

Who benefits, and who manages the new risks?

The aim of such questions is to make the claim more testable and the decision more honest.



Practical Task

Claim Check

Read the following statement:

“Our exhibition is paperless, so it is environmentally friendly.”

Do not decide immediately whether the statement is true or false. Instead, look at the whole digital process behind the exhibition.

Try to answer the questions:

1. Has environmental impact been reduced, or has some of it simply shifted from paper to digital technologies?
2. What information would you need before you could decide whether the exhibition has a lower environmental impact?

9. Final Activity: Sustainable Digital Heritage Station

The main task is to **design one small digital heritage station** that presents a local heritage item, place, story or tradition in a simple and sustainable way. Imagine that your station could be placed in a village hall, library, community centre, museum or local event. A visitor should be able to approach it and discover something meaningful about local heritage.

You do not need to build a real technological system. Your final outcome will be a **prototype** showing what the station would look like, what the visitor could do and what technology would be used. You may draw the prototype by hand, make it from reused paper or cardboard, or create it digitally in PowerPoint, Canva or another simple programme.

The process explained

Your station begins with the **heritage**, not with the technology. First decide what you want people to discover and what kind of experience would communicate it best. Only then choose the technology needed to make that experience possible.

While designing the station, apply the sustainability principles introduced in this module. The aim is not to remove technology completely. The aim is to use **enough technology to achieve the purpose without adding equipment, data or complexity that is not needed.**

Step 1: Choose the Heritage Focus

Choose one local heritage element that you would like visitors to discover (e.g. an old photograph, a traditional object, a song or oral tradition, a historic building or place). Then decide on one simple purpose.

“Our station will help visitors _____.”

Step 2: Decide What the Visitor Will Experience

Now decide what a person will actually do when they arrive at your station. Choose the format that communicates your heritage idea most clearly.

The visitor might:

- look at a photograph
- read a short story

- listen to a recording
- watch a short video

Step 3: Choose the Technology

Once you know what the visitor should experience, decide what technology is actually needed.

You might use:

- a smartphone
- a tablet
- a laptop
- a projector
- headphones

Step 4: Make the Design More Sustainable

Look at your prototype and apply at least three sustainability ideas from the module. Ask yourself: *Could I remove or simplify any technology without making the heritage experience worse?* Choose the ideas that genuinely improve your design.

Remember: *Sustainable technology does not mean avoiding technology. It means choosing technology carefully, using resources responsibly and avoiding unnecessary equipment or digital activity.*

10. Digital Wellbeing Tip



Digital Wellbeing Tip

Good Enough Is Useful

Trying to make every digital task perfect can increase stress and make learning more difficult. It can also lead you to use more tools, repeat work unnecessarily or create something more complicated than you need. A clear and usable first version is often enough to help you move forward.

Try this: Start with the smallest version that does what you need. Before adding more features, details or tools, check whether the basic version already works and is easy to understand. Then improve only what is really necessary.

Reflection question: What is the simplest useful version of what I want to create today?

11. Basic Glossary

Burden shifting: Reducing one impact while increasing another impact in a different place or stage of the life cycle.

Circular economy: An approach that aims to prevent waste and preserve the value of products, components and materials for longer.

Digital sufficiency: Strategies that reduce absolute energy and resource demand from producing or using digital technology while meeting meaningful needs.

E-waste or WEEE: Waste electrical and electronic equipment requiring appropriate collection and treatment.

Greenwashing: An environmental claim that is vague, exaggerated, selective or unsupported by sufficient evidence.

Life cycle: The stages from raw materials and manufacturing through use, maintenance, reuse, recycling and disposal.

Minimum sufficient technology: The simplest reliable technology combination that meets the purpose, including access, safety and inclusion.

Rebound effect: An increase in total use that reduces or reverses the savings expected from greater efficiency.

Repairability: The extent to which a product can be diagnosed, opened, repaired and returned to useful service.

Sustainable technology: Technology selected and managed to fulfil a meaningful purpose while considering environmental, social and economic effects.

Trade-off: A decision in which improving one aspect may weaken another.

Module Closing

Digital technology can help rural communities preserve heritage, reduce distance, improve access and create new forms of cooperation. These benefits are real, but they do not make every digital solution sustainable. Devices and services depend on physical materials, energy, infrastructure, maintenance and people. Their value depends on whether they solve a meaningful problem and remain accessible, safe and manageable over time.

The most responsible choice is often not the newest technology or the smallest possible file. It is a proportionate choice: enough technology to communicate the heritage meaning, protect community rights, include the intended audience and continue beyond the workshop without unnecessary resource use.

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