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Development of a materials library within the university library: analogue and digital link

Desarrollar una materioteca en la biblioteca universitaria: con lo analógico y lo digital

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Abstract

Traditionally, students entering architecture studies came mainly from families that were involved in construction. Their practical knowledge of building materials was sufficient to complement the theoretical teaching they received at university on this subject. However, the situation has changed and the family background of students no longer guarantees this prior knowledge. Society, and the university, has fully entered the era of digitalisation. This has had an impact not only on the profile and skills of students, but also on the way they consult the building materials that are prescribed in their academic projects: they have left university libraries behind, in favour of browsers and websites. Thus, this joint initiative arose to create a collection of sample materials within a university library that links the analogue experience of materials with the digital knowledge on these samples that is available in libraries. The digital knowledge associated with each sample is selected in a cooperative way by the architectural students, under the supervision of the academic staff and with the help of an intern.

***Keywords:** materials library, digital link, university library.*

***Thematic areas:** learning spaces, technology of architecture, challenge-based learning, cooperative learning, virtual classroom.*

Resumen

Tradicionalmente, los estudiantes de arquitectura provenían de familias relacionadas con la construcción, lo que les permitía complementar los conocimientos teóricos con su experiencia práctica. Sin embargo, la digitalización ha cambiado esta dinámica, afectando el perfil y las competencias de los estudiantes, así como la forma en que consultan los materiales de construcción, ahora a través de internet en lugar de bibliotecas. Así surge la iniciativa conjunta de crear una colección de muestras de materiales de edificación dentro de nuestra biblioteca universitaria donde se vincule la experiencia analógica de cada material con el conocimiento digital disponible. Este conocimiento digital es seleccionado y editado por los propios estudiantes bajo la supervisión del profesorado y becarios.

***Palabras clave:** biblioteca de materiales, enlace digital, biblioteca universitaria.*

***Bloques temáticos:** espacios para el aprendizaje, tecnología de la arquitectura, aprendizaje basado en retos, aprendizaje cooperativo, aula virtual.*

Descriptive data

***Qualification*:** degree in Architecture

***Level/course with in the degree*:** all courses

***Official name of subject, teaching experience, action*:** materials library, BIBLIOMAT

Department/s or area/s of knowledge: Architectural Technology

***Faculty number*:** 2

Number of students: 180

***Number of courses taught*:** 3 semesters

***Website or social network*:** no

***Derived publications*:**
https://drive.google.com/drive/folders/1ZlU9VpWKnUR5qxxvqxI-FHJKbiunBXvr

1. Introduction

The degree in Architecture in Spain is characterised by the inclusion in the curricula of many subjects focused on building technologies. Technologies and materials have evolved considerably since the end of the Second World War and this is reflected in the large number of new products that have appeared on the building market since then.

Traditionally, students who took this degree came mainly from families that were professionally associated with the building sector. These students' previous practical knowledge on materials and processes of execution in buildings was sufficient to complement the theoretical classes they received at the university. The current situation is different. Students' backgrounds no longer guarantee this previous knowledge. Society– and therefore also universities– has fully entered the era of digitalisation. This has had an impact not only on the profile and skills of students, but also on the development of higher education.

In the specific subjects of the Department of Architectural Technology, a growing ignorance of the reality of building materials has been detected. This shortcoming translates into an impoverishment of the language of prescription, a lack of knowledge of materials' properties, invisibility of the industrial processes of transforming materials into products and a lack of fluency when materials are incorporated in the execution of students' design intentions (Azcona-Uribe, 2021).

University teaching aimed at training in materials science and associated technologies seems to have undergone a transformation in recent decades with the generalisation of laboratory practices, the consideration of the environmental impact associated with the handling of materials (Figure 1) and the dispersion of descriptive contents about materials in all the subjects that are focused on their direct application in building construction.

Fig. 1 The presentation and knowledge of building materials is changing rapidly in line with the new SDGs. Source: https://www.materialepyramiden.dk/

In recent years, UPC libraries have suffered significant cuts in resources as a result of the economic crisis that is affecting all public universities. Added to this situation are the constant changes produced by ICT in learning and research at the university. These factors have produced a new scenario that is full of challenges to be managed with more imagination and more effort, if necessary. One of the essential characteristics of the UPC libraries is their focus on users. Therefore, they are already used to adapting to and managing changes of all kinds:

technological, organisational and managerial (Servei de Biblioteques, Publicacions i Arxius, 2015).

University libraries have also found that the new sources of reference on building materials for university students in training are moving away from the university knowledge base to building material companies' websites, whose content is not comprehensive. Their language is advertisement and their objective is commercial.

It seems inadvisable to remain contemplative in the face of signs and trends that point to a deterioration of disciplinary training on building materials; training that is essential for the proper development of architecture. This is particularly true at a time when decision-making processes on the materials used in buildings have a clear social, economic and environmental impact.

For this reason, it is a challenge to add and promote students' knowledge of building materials that integrates both sensitive materiality (analogue) and technical materiality (digital) (Navarro Moreno et al., 2018). This is the challenge discussed in this communication.

2. Timeliness, interest and benefits of the proposal

Most high technical schools of architecture have samples donated mainly by the building materials companies that periodically visit them. However, these are distributed among offices and classrooms and do not form part of any common inventory or collection.

At the same time, there is a latent, cross-cutting concern among academic staff to introduce joint initiatives that can consolidate in future architects a sounder, more responsible disciplinary view of current building materials. This will enable them to make reliable decisions in their future professional work.

The UPC Institute of Education Sciences (ICE) recently promoted calls to support specific innovative learning initiatives, with the aim of renewing and enriching training practice with new dimensions that reflect the changing situation in higher education.

Due to its cross-cutting nature, providing a service for many higher technical degrees, the UPC Library Service (SBPA) is aware of the evolution of its task as a repository of published knowledge and a gateway to it, in competition with open networks. Its latest strategic plan reflects this situation (Servei de Biblioteques, Publicacions i Arxius, 2015).

Informally, some students who were interviewed consider that it is important to have 'limited and concise' information about building materials during their degree, especially in the initial stages of learning. Often, an overload of information (to which we now have access with internet browsers) confuses them or 'overcomes them'. They express a desire for specific, carefully selected, previously analysed information that facilitates their understanding of basic materials, which is essential to understand possible applications or combinations.

Within this framework, a joint initiative was developed to set up a collection of building materials, in collaboration with the library. This could be achieved with the cooperative work of university staff and students.

3. Objectives

The overall objectives of this initiative were thus diverse, but concurrent:

1. Make up for architecture students' knowledge gaps in terms of analogue information on building materials, which often prevent them from recognising, discussing and applying this information on educational issues.

2. Encourage students to be able to substantiate and support the architectural proposals that they develop and present in the classroom, not only by means of drawings, reasoning and models, as is usual, but also by providing samples of the specific materials that would actually be used in the planned building (Bonwell & Eison, 1991).
3. Bring the analogue world of building materials in contact with the digital world through remote consultation of bibliographic documents linked with building materials.
4. Extend the traditional educational role of university libraries as centres for printed documents by incorporating a collection of samples of building materials, for consultation and loan, as an additional academic resource to support teaching, for use by lecturers in the classroom and students in self-study.

4. Theoretical framework

A materials library is a collection of selected samples of materials to facilitate the learning process about their characteristics, properties, attributes and uses. In a materials library, the samples are collected and exhibited to their specific public according to classifications established by the institution that forms the collection (Dent et al., 2005).

Traditionally, some universities had learning collections of specimens. These were generally displayed in showcases but were not directly accessible to students. Such collections have decayed due to a lack of maintenance and the fact that nobody is in charge of them, and because digital networks provide texts, images and videos of great quality quickly and free of charge. This information is universally accessible at any place and at any time.

Building product companies are promoting fast renewal of their products, based on innovation, to adapt performance to the new demands of sustainability, efficiency and digitalisation. The divergence between the greater diversity of the commercial offer of materials and the loss of physical presence of materials in higher education curricula can lead to gaps in the knowledge of future prescribers. The choice of architectural materials has never been greater and architects use materials from around the world in innovative ways, as never before (Borch et al., 2004).

Information about materials has increased in volume. It is managed through databases that can be accessed free of charge in university libraries. Knowledge about materials has been developed traditionally in specific subjects, where aspects of the anatomy of materials and their expected performance are addressed. To understand anatomy, images and static models are required; to understand performance, sensorial experience or simulators are needed. Aspects of application criteria are examined in project workshops, where suitability, contingency and adaptation to the environment come together. In each case, students must learn to establish the prescription that best integrates all these factors in a timely manner. In the short term, learning all this knowledge is based on case studies and the corresponding discussion in the classroom. In the medium term, work experience guided by mentors completes the training of future building professionals.

Any education training for design and building must deal jointly with sensorial, information, knowledge and application criteria aspects (Pedgley et al., 2016). Robison & Shedd (2017) defend the importance of the availability of collections of shared things in learning communities. Access to such collections raises the knowledge status of users. A collection of building material samples is a valuable resource for dialogue between designers, teachers, students and guilds. Direct contact with a sample enhances understanding of the vocabulary and organoleptic aspects of a material (Bonwell & Eison,1991; Rognoli, 2005). This also allows active self-

learning by relating and associating the materials with the senses and their actual application (Hegger et al., 2017).

Lyons (2007) notes the importance of knowing the characteristics of materials to understand their contribution to building systems. Many of the properties are not evident to the senses unless the materials are tested in laboratories. The materials library could include content provided by augmented reality if a link is established between digital content and physical samples (Riemer et al., 2018).

Following an online search, a case study of materials libraries was undertaken to explore the common and unique aspects of each library (Arboleda-Pulgarín,2023; Akin&Pedgley,2016).The compiled information was then entered into a series of fact sheets giving the name, website, location, consultation interface, information available for each material and classification of the materials (Figure 2).

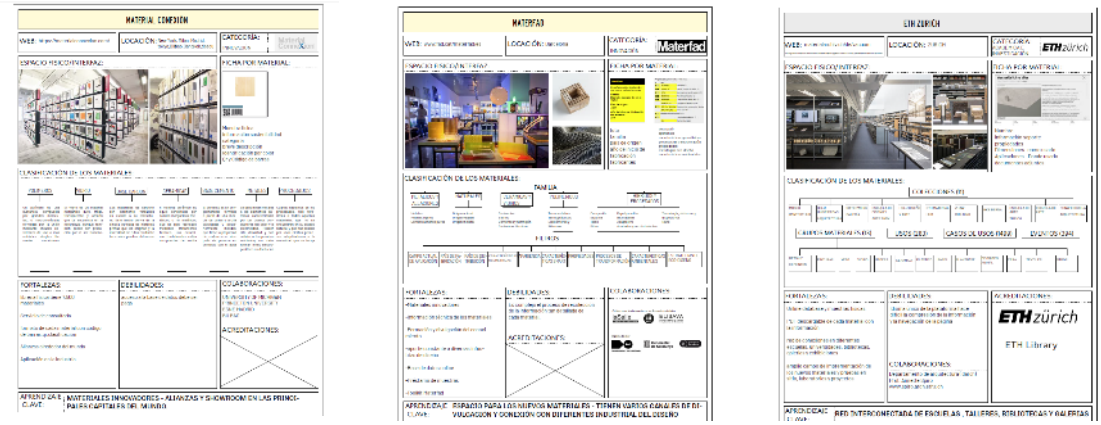

Fig. 2 Examples of the fact sheets on various relevant material libraries. Source: authors

4.1 Classification by focus

A first classification of materials libraries was established based on their main focus.

- Focus on innovation: materials libraries specialise in collecting recent materials that are being introduced and have innovative and evolving properties (Peters & Drewes, 2019). They also offer spaces for experimentation, as well as exhibition, workshops and discussion rooms where scholars can congregate.

- Focus on sustainability: materials libraries specialise in collecting materials that, due to their origin and manufacturing processes, are considered sustainable (Peters & Drewes, 2019).

- Focus on applied research: materials libraries are located within a higher research environment with the aim of forming a bridge between academia and industrial corporations. They are supported by research and development groups within the institution to which they belong. Their collections promote joint training, research and innovation campaigns.

- Focus on education: materials libraries aim to collect basic and conventional materials to provide a first approach for young professionals in training. They are the common basis from which other more specialised collections can be developed in the future (Hegger et al., 2017).

4.2 Identifying the variables of a materials library

The specific identity of each library results from a combination of:

- the type of primary user to whom the collection is addressed,

- the access that this user has to the materials samples and the associated digital information, and

- the resources, public or private, with which the materials library is developed. According to (Jansson, 2013), the availability of resources strongly influences the services provided by the library: guided tours, professional consultancy, institutional consultancy, etc.

In this respect, *MaterialConnexion*[1], one of the most extensive collections of materials in the world with over 20 years in existence, is a private materials library focused on professional users. Its main resources come from the fees that its subscribers pay to access its comprehensive database. This database feeds the constant flow of information that is displayed in all the associated media channels in which this materials library has a presence (books, web channels, showroom, etc.; Addington & Schodek, 2005).

4.3How to house and exhibit the collection

There are now several dimensions in which a materials library can be displayed:

- Physical dimension: the user can interact directly, and in a tangible way, with each material and with the accompanying information, which is usually printed. In a direct way, the properties that can only be perceived face-to-face can be appreciated (Hegger et al., 2017).

- Virtual dimension: this allows the provision of all kinds of digital content on each material and is very useful in research or suitability assessment activities. This type of library can be updated very quickly and can be accessed remotely. Its information can be linked to other data that are available openly on the global network (Spector et al., 2010).

- Hybrid dimension: the materials are displayed both physically and virtually, with the complementary potential that this entails.

4.4Taxonomic classification of samples

Materials libraries do not currently have a shared standard for taxonomic classification. Each materials library adapts its taxonomy according to the speciality of its sample collection: the nature of the material, the physical and/or chemical properties, the function of the material, and the form of the material or manufacturing process (Dantas & Bertoldi,2016). A collection of materials in user-friendly order makes it much easier for the user to navigate and consult (Peters & Drewes, 2019).

One of the main examples is MATERFAD[2], a materials library located in Barcelona and with delegations in Latin America. This library has existed for15 years. A face-to-face interview was held with its managers to find out about their organisation first-hand and learn from them. One of the pieces of advice that emerged in these conversations was to strictly delimit the information associated with each material sample because its management can occupy a large amount of future resources.

5. Methodology

In view of the various international examples that were consulted, in the development of this project it was vital to prioritise aspects that facilitate achieving the initial objectives in Chapter 3:

[1] https://www.materialconnexion.com/

[2] https://www.fad.cat/materfad/es

- Develop the project **in a cooperative way**, among the students themselves, guided by an academic and assisted, if necessary, by an intern for support. The students themselves must agree on the names, representations and contents that are most useful to them to discern and understand the immense wealth and complexity of building materials.

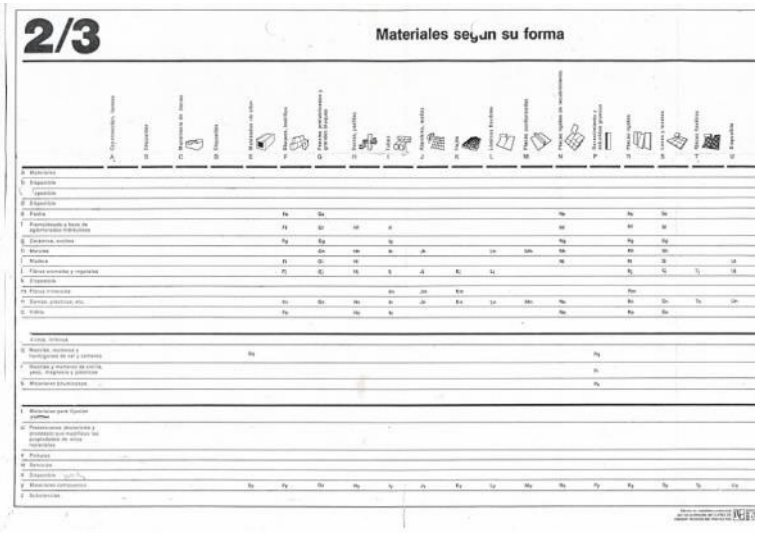

Fig. 3 CI/SfB classification taxonomy adopted by RIBA. Source: CAU

- One of the aims of this materials library is that each sample of material is **linked by QR** code to the information available about it in the university library (Azcona-Uribe, 2021). This linkage should foster the conventional library as a useful tool for self-education and learning, for present users and online visitors. This alignment should facilitate the possibility of continuously updating and expanding the information, by collecting data that is available online in BIM models, and fostering interactive and collaborative learning (Scoble & Israel, 2016). The digital information relating to each material is compiled in a short thematic guide (12 pages) edited by groups of students, with links to books, journals, congresses, patents, architects, singular works and commercial companies. The sources of this digital content should primarily be those that are already available in the Library Service, which manages both its own and external production. It will probably be possible to create our own materials in the future.
- The process of generating the materials library **is in itself a formative activity** because it allows students to play a leading role in their training and to leave at the university a legacy of their activity that can be shared.
- The student should have this autonomous educational resource **available at any time thanks to self-loaning**, deciding how to use and consult it, either in response to their own concerns or to the challenges that arise in the subjects. The samples that make up the materials library should not be locked away in a cupboard but should be available on loan, like any other educational resource (book, video, measuring device, etc.), so that students can use them in any situation that they are faced with (work experience, project workshop, exam preparation, report writing, etc.).
- The materials library **cannot be static, closed and merely descriptive**. Instead, its contents and extensions must be updated by each student's cohort that can use them and adapt them to their reality. This same task of selection and updating must be evaluated as it forms part of the competences to be acquired by a future professional.

- The materials library must **establish external collaboration alliances** with other nearby entities, such as building product companies, research groups or museums, to improve their contents and make them universally accessible.

6. Development and assessment of the proposal

6.1 Origin and selection of the samples

There are samples of materials scattered around the faculty, without any order or classification. These can potentially be reused for the materials library project. Therefore, the plan was to initially collect these samples and add them to the materials library in formation. Once this first internal compilation stage has been completed, the academic community will have to decide on the profile of new materials to be incorporated, according to the specific focus of the subjects taught in the curricula.

Fig. 4 View of the current arrangement of specimens in the BIBLIOMAT material library. Source: authors

6.2 Taxonomic classification

In this case, the materials library project is part of the university library, which already has its own classification system (Joudrey et al., 2015). The challenge is how to interface with the taxonomic classifications that are already in place in the building industry, such as CI/SfB (RIBA cpd.com[3]). At the moment, this problem has not been tackled head-on. Instead, a decision was made to continue with a classification that is specific to the building sector, as is already the case with other new items in collections on loan in the university library (Figure 3).

[3] https://www.ribacpd.com/subjects.aspx

6.3 Location

The first physical space for the location of the materials library was inside the faculty library, housed in rolling chests named after the nature of the ten main materials. The chests made iteasy to transport the materials in this first development stage.

Due to upcoming works in the current library space, the collection of materials was moved provisionally to a room in the Technology Department. The rolling chests were abandoned and the materials moved to shelves so that students, in groups of four, could select, classify and label the samples themselves. In the future, a better display will be necessary, to visually display the samples and facilitate self-loaning with the help of a smartphone (Figure 4).

Collections emerge with the intention of increasing in size. The lack of space is often one of the main obstacles for managers of this type of space. In a School of Architecture, the materials with which architecture is built should always be physically present at all times. If they are not distributed throughout the entire space, then at least they should occupy those areas in which the subject of the materiality of architecture is addressed. The first years of architecture study should be permanently accompanied by samples of building materials and products. A well-lit space is required with sufficient storage capacity and workstations in which to teach and learn, and with no need to turn the sensory experience into an occasional visit (Azcona-Uribe, 2021).

Fig. 5 Front cover of one of the thematic digests produced by the students for a specific family of materials. Source: authors.

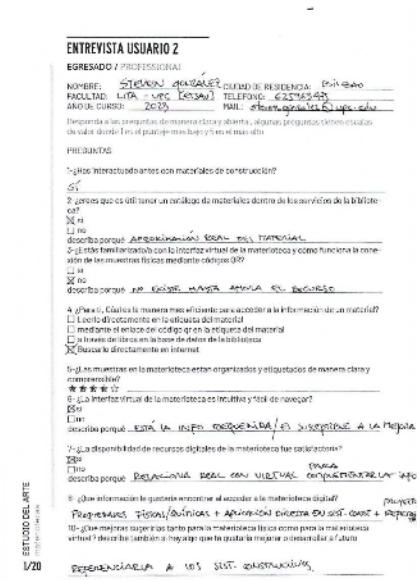

Fig. 6 Sample of the initial survey of potential users .Source: authors

6.4 Augmented reality

One of the goals of this materials library is for each sample of material to be linked to the digital information available about it in the university library itself. This linkage should enable the conventional library to be fostered as a useful tool for self-education and learning, both for present users and online visitors. The alignment should facilitate the possibility of continuously updating and expanding the information by collecting data available online and fostering interactive and collaborative learning (Scoble & Israel, 2016).In the first step, groups of four students sponsored a family of samples. They drew up a first digital guide of contents selected

from those available in the digital collection of the Library Service about the family of samples: patents, books, architects, buildings, articles, regulations, etc. (Figure 5).

6.5 Current project development

The project has now been underway for three semesters and is expected to be rolled out over several years, progressively increasing the number of samples and associated information. Up to now, the entire development of the project has been carried out in collaboration with the students, with the technical support of the university library and founded by the Department of Technology. The following actions have been undertaken.

1. Collection of samples that were already available, but dispersed, their taxonomic classification, photography and deposit in wheeled chests.
2. Initial validation through interviews with students, teaching staff, researchers, librarians, etc. The aim of the validation was to determine users' needs and expectations, to gain a global vision of the resource offered and the most convenient way of structuring the search and the information (Figure 6).
3. Labelling of the samples and referencing in the library catalogue REALIA (Figure 7) so that they can be borrowed and linked by QR code to the associated virtual content.
4. Edition of the virtual contents linked to each sample: books, articles, videos, patents, doctoral theses, applications, companies, etc.
5. Presentation of the materials library project to the university community in the framework of the last ICE Call (2024). The project has gained unique two-year funding, a commitment to pay for the display and recognition of the work of the academic staff involved.

Its success will be measured by the extent to which the subjects in the syllabus refer to it in their sessions and the students personally make it their own as a basis for self-learning.

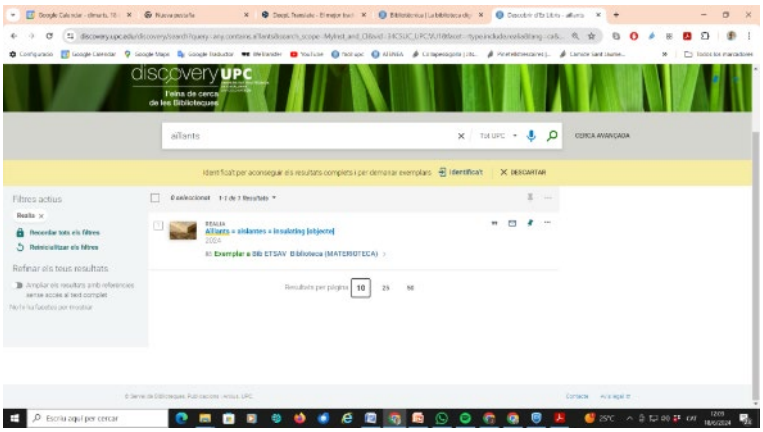

Fig. 7 Screenshot of one of the first samples entered in the REALIA catalogue of the SBPA Library Service.
Source: authors.

6.6 Future challenges

BIBLIOMAT, our material libraryis a project in progress. It is continuing to advance and is facing new challenges in the coming semesters:

- Agreement with the faculty's board and library staff on the cession of an open and central space to house the collection, within the framework of the current restructuring of teaching spaces (Figures 8 and 9).

Fig. 8 Current distribution of the surface area of the spaces in the current faculty building. Source: ETSAV

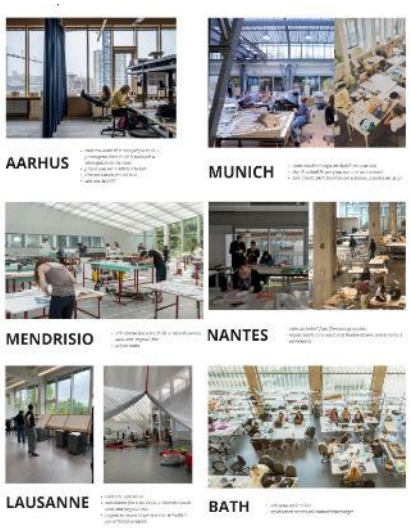

Fig. 9 Configuration of the workshop spaces in different faculties of architecture. Source: ETSAV

- Disseminate the initiative of our library among all the subjects and departments that could potentially collaborate with the initiative to contribute content to the collection and develop academic activities based on it.
- In agreement with the student association, propose exhibitions and tailor-made educational activities in the BIBLIOMAT space, with credit recognition, on materials of interest to them that can enrich and focus the collection in the future.
- Organise a meeting between the various university material libraries in Spain (UPM, Cartagena, EHU, etc.) to find out how they are organised and what importance they have within each institution.
- Establish a code of good practices that will allow the BIBLIOMAT materials library to form alliances with industrial companies that are interested in collaborating with the initiative, sponsoring a family of materials, providing samples or data on their products.

There is a conviction in the project itself that the available resources will always be limited and that the collection's deployment will therefore have to be collaborative (could each student sponsor a material sample?), participative (the opinion of the educational community must prevail) (Azcona-Uribe, 2021) and alliances must be established with other bodies (companies or associations) along the lines of that already started with the university library service.

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