

A Supporting Tool to Design with and for EM&Ts: The Materials Toolkit



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Abstract The chapter gives an exhaustive description of the so-called EM&Ts toolkit, a collection of tangible samples displaying emerging materials and technologies and containing five samples for each EM&Ts. Aim of the EM&Ts transfer toolkit is to provide a tool to facilitate the understanding and application potentials of emerging materials and technologies. Every material example has its box, containing: (1) Physical sample, (2) An “Understanding” card: it provides basic knowledge about the material and the manufacturer, Technology Readiness Level, crucial characteristics, and features. The sensorial qualities and performance, sustainability, and smart properties are listed for a clearer understanding of the materials potential; (3) A “Shaping” card: it contains information about the manufacturing process, the form in which the material is available and possible transformations. This information is useful to understand how the material can be processed for production, finishing, and transformation, to get to the final product. The card highlights, which processes that, have been associated with the material so far; (4) An “Applying” card: it gives information and pictures about the field the material is currently used. The material characteristics are compared with other better-known alternatives. In addition, other potential applications are listed, associated with meaningful case studies. The toolkit was created to be used as an aid in educational contexts with students and during workshops with companies and professionals. It is a powerful tool to provide students with information about the materials and their opportunities and limits, and to inspire them during the concept development. On the other side, it has potentialities to provide decision makers of the company with information about the emerging

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materials and technologies, their opportunities and limits, and to inspire them for innovation in product development. The chapter describes the continuous iterative process through which the toolkit was created and evaluated. Indeed, the toolkits have been used and tested in the academic context, with more than 100 students of diverse design backgrounds during EM&Ts workshops in Spain, Italy, Denmark, and Finland but also in professional context, during participative workshops with 94 companies, design studios, and professionals.

1 Introduction

Within the DATEMATS initiative, several outputs have been produced: the DATEMATS EM&Ts Transfer Toolkit is one of these, combining different project results in one tangible artefact.

The EM&Ts toolkit is a collection of tangible samples displaying five case studies for each of the four Emerging Materials and Technologies (EM&Ts) areas approached in the project:

- Advanced Growing EM&Ts
- Experimental Wood-based EM&Ts
- Interactive Connected Smarts (ICS) Wearable-based EM&Ts
- Nanomaterial EM&Ts.

Aim of the toolkit is to provide a means to facilitate the understanding and application potential of new materials and innovative technologies.

Traditionally in science and engineering, materials are characterized technically, through a series of studies aiming at probing and measuring the structure and properties of materials. In design, a holistic approach to materials is adopted which requires the characterization of materials for their experiential qualities, alongside the technical understanding. (Camera and Karana 2018)

The DATEMATS collection of materials samples, a total of 20, is not exhaustive but of illustrative nature to trigger interest in emerging materials or reconsider known physical matter under a new perspective.

The toolkit was created to be used in knowledge transfer activities in educational contexts with students, and during workshops with companies and professionals. It is a powerful tool to provide designers and producers with information about the material's properties, opportunities, and limits, and to inspire during the design process or innovate already developed products.

Each material sample is showcased in its box accompanied by an exhaustive description, and based on the developed DATEMATS methodology, that sheds light on the three main aspects to consider when designing with emerging materials and technologies. The explanations are summarised in *understanding*, *shaping*, and *applying* the EM&T, made easily assimilable through graphics, icons, and case studies.

Understanding material experiences can enrich designers' vocabulary and open up the design space for unique functions and expressions. (Barati et al. 2017)

The development of the DATEMATS EM&Ts Transfer Toolkits was planned in two separate project tasks which were led by the consortium partners Materially Srl (former Material ConneXion Italia) and FAD respectively. Nevertheless, strong spirit of cooperation and commitment throughout the whole creation process from both leaders and additional contributors characterised the collaboration. In the following paragraphs, the process that led to the first version and, after different evaluation steps, the creation of the final version is thoroughly described.

2 DATEMATS EM&Ts Transfer Toolkits—First Version

To start the creation process in a collaborative manner and ensure that expectations are met, a general brief indicating the goal and contents of the toolkits based on the available task description was shared with the all-consortium partners, to identify possible constraints and requests regarding the shape and collect suggestions for potential solutions. In addition, all task-related documents were shared online and made available for consultation and contributions.

2.1 Phase 01: Material Scouting

Materially, in collaboration with FAD, executed an in-depth scouting activity exploiting their in-house material database and established contacts with material suppliers, identifying more than 60 possible materials suitable for the DATEMATS EM&Ts toolkit. To facilitate collaboration and exchange of information between the partners, a shared spreadsheet was set up, categorising the scouted materials based on their characteristics responding to one of the four DATEMATS EM&Ts areas: Advanced growing EM&Ts, Experimental Wood-based EM&Ts, Interactive Connected Smart (ICS) Wearable-based EM&Ts, Nanomaterial EM&Ts. The data collected in the spreadsheet included basic information such as: pictures, commercial name, short material description, manufacturer, online references (supplier website), etc. The materials identified and pre-selected by Materially and FAD were presented to the experts of the four HEIs involved in the project—KEA for Advanced Growing EM&Ts, AALTO for Experimental Wood-based EM&Ts, POLIMI for ICS Wearable-based EM&Ts and TECNUN for Nanomaterial EM&Ts—which indicated their preferences and confirmed the final selection of at least five materials for each EM&Ts area (see Fig. 1).

The data of the selected materials was subsequently integrated with additional description to provide information according to the pedagogical framework, defined

T3.5 - Datemats Tool Kit MATERIALS					T3.5 - Datemats Tool Kit MATERIALS				
File Modifica Visualizza Inserisci Formato Dati Strumenti Est					File Modifica Visualizza Inserisci Formato Dati Strumenti Est				
54:54 AREA 4 - EXPERIMENTAL WOOD-BASED EM&Ts (by Aslto)					T:1 AREA 1 - ICS: WEARABLES EM&Ts (by Polimi)				
		Nome of the material	Description	Company Name and Website			Nome of the material	Description	Company Name and Website
18		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	WOOD	1		CONDUCTIVE	Conductive materials are materials that allow the flow of electric current. They are used in a wide range of applications, from electronics to power transmission.	Various Material AG
19		Colorful Wood-Based Paper	Colorful wood-based paper is a type of paper made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Woo (Pungent)	2		CHROMATIC	Chromatic materials are materials that can change color or have a color that changes over time. They are used in a wide range of applications, from art to design.	Art/Color Polymers
20		FIBERCELL BIO	FiberCell Bio is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Wood Industry Group	3		AGNES	Agnes is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	System Advanced Materials, Inc.
21		PLANT FIBER-BASED	Plant fiber-based materials are materials made from plant fibers. They are used in a wide range of applications, from art to design. They are a renewable resource and have been used for centuries.	No Green Packaging	4		Single Textile Push Button	Single Textile Push Button is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Plug and Play
22		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Auto University	5		CONDUCTIVE PAPER & TAPE	Conductive Paper & Tape is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	St. Paul's Corp.
23		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Carbide Lab	6		HEALTHY PLANT	Healthy Plant is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Rock Composites
24		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	MyMatrix S.r.l.	7		ARTIFICIAL SKELETON	Artificial Skeleton is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	McGraw
25		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Rock Cloth	8		COAT	Coat is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Gold-In Technologies
26		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Rock Cloth	9		PROTECTIVE SENSOR TAP	Protective Sensor Tap is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Sealing Tap
27		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Rock Cloth	10		HEALTHY	Healthy is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Thermally
28		WOOD	Wood is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Rock Cloth	11		HEALTHY	Healthy is a type of material made from wood pulp. It is a renewable resource and has been used for centuries. It is a natural material made from the woody tissue of trees. It is a renewable resource and has been used for centuries.	Rock Cloth

Fig. 1 Over 60 materials scouted for the 4 EM&Ts areas

within the DATEMATS methodology, that identifies the following three aspects as crucial for designing with EM&Ts:

- Understanding—describing the EM&T with physical and senso-aesthetic parameters
- Shaping—describing the EM&T-specific transformation processes and techniques
- Applying—describing the EM&T application potentials with a real case example.

For each of these aspects, online freely available digital content related to the specific material was scouted, able to facilitate the knowledge transfer.

2.2 Phase 02: Collecting the Information

The collected information about each EM&T material is included in the toolkit on three separated datasheets, addressing the three aspects of DATEMATS's unique design method—Understanding, Shaping, Applying—and accompanying the show-cased physical sample. Several tools were created to gather the needed data about the

materials. These tools were shared with the consortium to be exploited and adapted for the creation of the final toolkit.

To facilitate filling in the datasheet for all the selected materials, an online form was created; a simple tool to uniform data collection and provides a standardised format useful for future integrations during DATEMATS project execution. In addition, using Google Form allows one to collect the answers in one excel file, thus creating a dedicated DATEMATS EM&Ts materials database (see Fig. 2).

The online form, divided into five sections, collects the following data:

- EM&Ts area.
- Understanding data to provide basic knowledge about the material and the manufacturer, Technology Readiness Level, crucial characteristics, and features. The sensorial qualities and performance, sustainability, and smart properties.
- Shaping data to provide information about the manufacturing process, the form in which the material is available and possible transformations. This information is useful to understand how the material can be processed for production, finishing and transformation, to get to the final product.
- Applying data to provide information and pictures about the field the material is currently used. In addition, data on significant case studies are collected.

To extract the gathered information easily from the online form (database) into the dedicated material datasheet, the architecture of the datasheet was defined via an excel file.

[illegible]

Fig. 2 Extract of list of selected EM&T materials

*All data required:

AREA

UNDERSTANDING

- Material name (include TM or ® if applicable)
- Website (if available in EN)
- Material producer
- Base material—the material belongs to the following material family:
- Main features—describe the material in one sentence
- Composition—components of the material
- Technology Readiness Level (TRL)
- Sensorial qualities
- Performance properties
- Sustainability properties
- Smart properties
- Variations—are there variations in colour, finishing, texture, pattern, etc. available?
- Testing—following testing results and standards are available for this material
- The material has the following certifications.

SHAPING

- Manufacturing process—how is the material made?
- Supply—the material is provided as
- Shape—the material is provided as
- Transformation processes—how can the material be shaped?
- Options—are there possibilities to customise the material?
- The material is compatible with
- The material system can be enhanced via.
- APPLYING
- Current application field
- Potential application fields
- Case study—commercial product applying the material (share a link)
- Concept applying the material (share a link)
- The material is comparable to
- The material is inspired by
- The material is better than similar commercially available materials because.

CONTACT DETAILS

2.3 Phase 03: Conceptualising the EM&TS Toolkit

Materially executed a series of activities—including desk research and benchmark on similar tools—to design the toolkit in an appropriate manner, involving whenever possible all-consortium partners (see Fig. 3).

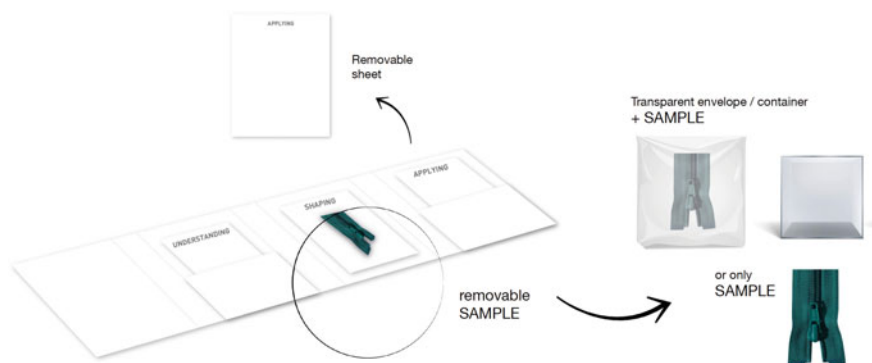


Fig. 5 Final concept sketches

After the presentation of the two initial concepts during the 3rd consortium meeting, the feedback and suggestions collected were integrated into a third proposal, optimising the advantages of the two previous ones in this final concept.

The final concept, called the “folder/book”, provides a single container for each material, but the sample and datasheets are removable offering the possibility to organise the knowledge transfer activities in an explorative manner (see Fig. 5). This guided interaction enhances material exploration, where manipulating the samples is appropriate, while assuring integrity and good conservation of the samples.

2.4 Phase 04: Prototyping and Production of the EM&T Toolkit Version 1

Materially decided to optimise the dimensions of the single material container to be complying with the international standard format DIN A5, in this way the toolkits are handy and easily adjustable for the final version. In consultation with a local typography able to produce the 20 containers, Materially chose using laminated cardboard and foam board to create the toolkit drafts, applying die cutting and digital printing to trim and customise each EM&T material’s container. A mock-up was created to verify dimensions, functionality, and finalise the graphic layout. Finally, the manufacturers of the materials featured in the toolkits were contacted to receive the needed material samples (see Fig. 6).

The material sample container’s graphic layout was created based on the project’s visual identity (see Figs. 7 and 8). References include general information about the project’s goals, focus points—the four EM&T’s areas—involved partners and project funding references. Special attention was adopted to create coherence with the visual impact of the datasheets.

The graphic layout of the datasheets was designed based on the project’s visual identity and includes several infographics to convey the data in an effective and



Fig. 6 Toolkit mock-up inside view with sample placeholder



Fig. 7 Toolkit graphic layout, outside and inside

immediate manner, enhancing the user experience while exploring the materials. Format of the datasheet is conformed to international standards (A5 DIN) to foster large-scale fruition and dissemination.

Figs. 9, 10, 11, and 12 showcase the three datasheets (front and back page) of the product “Fenix NTM”, selected for the Nanomaterial EM&Ts area.



Fig. 8 Toolkit (first version) inside view



Fig. 9 Material Fenix, card Understanding



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SUPPLY



SHAPE



Filament



TRANSFORMATION PROCESSES



ADDITIVE MANUFACTURING



DIE CUTTING



LAMINATION



STITCHING



BLOW MOLDING



EXTRUSION



METAL WORKING TOOLS



THERMOPLASTIC COMPRESSION MOLDING



CASTING



INJECTION MOLDING



PRINTING



WELDING



COLD PRESSING / DEEP DRAWING



LAB GROWING



ROTMOLDING



WOOD WORKING TOOLS



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SHAPING



SHAPING



Fig. 10 Material Fenix, card Shaping

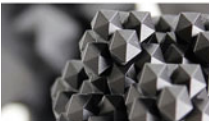


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INSPIRED BY
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CASE STUDY



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APPLYING



APPLYING



Fig. 11 Material Fenix, card Applying



Fig. 12 Toolkit (first version) Closed



Fig. 13 Toolkit (first version) Open

2.5 Phase 05: Evaluation and Handing Over

Materially created this first version of the DATEMATS EM&Ts transfer toolkit in tight collaborations with FAD, both hosting a material library, based on their experience of managing and using physical samples for knowledge transfer and consulting activities (see Fig. 13).

The consortium partners, especially the four involved HEIs, are the main users of the Toolkit in support of the ad hoc developed Design Teaching Method (DTM). Valuable feedback to improve the “EM&Ts transfer toolkits version 1” was gathered during the knowledge transfer activities where the DATEMATS DTM and its tools were validated. Subsequently, the following aspects were assessed and optimised in the final version:

MATERIALS—physical samples have been selected based on the needs and suggestions provided by the responsible partners of the four EM&Ts areas and their

availability; some materials might be substituted or added for the final version in order to effectively communicate the essence of the DATEMATS EM&Ts.

DATASHEETS—the content of the EM&Ts material datasheets are based on the DTM guidelines describing each material from three different point of view and providing information to enhance understanding, shaping, and applying of the materials; information provided on the datasheets might be substituted or extended in the final version in order to effectively communicate the DATEMATS EM&Ts properties and potentials.

FORMAT—the proposed format aims at providing an efficient and easy manageable tool with a strong attention to material exploration while facilitating interactive and module-based knowledge transfer activities; shape, dimension and material of the container might be modified in the final version in order to adjust the flaws and integrate insights gained during the project execution.

3 DATEMATS EM&Ts Transfer Toolkits—Final Version

In the process of updating and finalising the definite version of the EM&TS transfer toolkits, the materials kits continued to be shown to students and companies in dedicated knowledge transfer activities in 2020 and 2021 (Knowledge Transfer Labs held in Sweden, Italy and Spain and Mobility Workshops at Tecnun and Polimi) as a flexible tool to experience, understand and interpret each of the selected materials by providing data and tangible examples of the EM&Ts to transfer.

At the same time, the prototypes were examined exhaustively with the experts of each EM&Ts to obtain their suggestions and possible substitutions of the current showcased materials for their respective area.

Experts were also asked for new projects, references, and inspirations on their specific area to create digital mood boards for each EM&Ts that were then linked to the QRs of the toolkit boxes to be used by students during the upcoming activities. These mood boards were also intended to show that each EM&Ts has much more materials and projects than the five featured in the toolkit and the aim is to serve as an inspirational visual document that can be even more expanded.

The collected feedback for digital as well as physical improvements in form and content of the datasheets and boxes from the draft version was then analysed and filtered after testing them in the above-mentioned activities.

In addition, a booklet describing the knowledge transfer method and the related DMT (Design Methods & Tools) guidelines to interpret the samples for that specific EM&Ts, was integrated into the final version of the materials kits.

Finally, images with higher resolution were scouted by FAD and Materially so that the graphic designer could implement all digital changes. With the amendments and improvements, she also created a new graphic layout of the boxes and coordinated the production and printing of the final version of the EM&Ts transfer toolkit.

All this information was organised into spreadsheets.

Source	Areas	Feedback Toolkit v1 (Live revision of physical toolkit with experts via zoom May 2021)	Type of Feedback (POSITIVE / IMPROVEMENT vs.)	Type of Improvement (FORM / CONTENT)	Comments
Anke Pasold (May 26, 2021)	Advanced Growing - Materials' samples	Would be great to have 5 "families": 1. Mycelium (2 samples) 2. Algae based → add 1 (Ref: AlgaBriQ) 3. Cellulose based (process) (2 samples) 4. Mineral based (bacteria) → add 1 (Ref: biomason) 5. IPHA	IMPROVEMENT	CONTENT	- Materials samples - Anke could link with the 2 new companies (AlgaBriQ+biomason): Any update? Exact references to get from local providers? - Which ones do we keep from the samples where we have 2 samples? Mycelium + Cellulose based
Anke Pasold (May 26, 2021)	Advanced Growing - Datasheets (digital)	Change datasheets where samples will be modified	IMPROVEMENT	CONTENT	- Change digital +physical datasheets according to Anke's indications
Anke Pasold (May 26, 2021)	Advanced Growing - Datasheets (digital)	7 new projects showcased in the respective moodboard (i.e. open source biolabs)	IMPROVEMENT	CONTENT	- QR on digital datasheet with moodboard for 1st Mobility WS Tecun.
Anke Pasold (May 26, 2021)	Advanced Growing - Datasheets (digital)	Categorization: compostibility, biodegradability, toxicity A lot of empty sheets (i.e. smart properties due to area) link them to the one that have the properties in other toolkits Shaping: Transformation processes, might be useful to have link to processes /comments/resources	IMPROVEMENT	CONTENT	tbd
Anke Pasold (May 26, 2021)	Advanced Growing - Datasheets (physical)	Problematic of datasheets attachable/detachable Pre: you can take them out Con: you have to do the sorting afterwards. Box is complex and difficult to put them in order, a lot of box material (during presenting i.e.) Rubber/elastic bands, open like a fan, bookbinding, click to toolbox with a ring that could be detached	IMPROVEMENT	FORM	tbd
Anke Pasold (May 26, 2021)	Advanced Growing - Sustainable Box (physical)	Sustainable "feeling" in terms of biomaterials, color: white is problematic (gets easily stained with liquids and pastes), certification FSC not really circular, more important how the box is produced in terms of circularity	IMPROVEMENT	FORM	- ask Veronica how it has been produced for the prototype - change color white?
Anke Pasold (May 26, 2021)	Advanced Growing - Miscellaneous (physical)	Microflex material: "pitty to say don't touch it" Comparison to other toolkits: what is it "inspired by"? same info? in a lot of them no reference	IMPROVEMENT	FORM	tbd

Fig. 14 Excerpt from “Feedback Toolkit v1 | Transnational Milan + KTL 2020 | Experts 2021 | Mobility WS 2021” [EM&T Advanced Growing]

Below (from Figs. 14, 15, 16, and 17) is an excerpt of all four EM&Ts comments gathered during the feedback sessions and responses:

3.1 Phase 06: Revision and Update of Datasheets, Creation of DATEMATS Mood Boards and Glossary (Final Version)

All links to the 20 digital datasheets and layout for the boxes were included in the follow-up spreadsheet of the final toolkits for the completion of all tasks concerning the revision of the material parameters and design changes.

Fig. 18 shows the four respective EM&Ts mood boards created for Advanced Growing, ICS Wearables, Nanomaterials and Wood-Based.

For the 20 digital datasheets corrections of all four EM&Ts (each document accounting for 5 materials per area and 6 pages) the same schematic structure was used as follows:

- Understanding:
- Materials features and composition
 - Physical qualities
 - Performance properties
 - Availability (TRL)
 - Sustainability properties
 - Smart properties
 - Certificates & Tests.

Source	Areas	Feedback Toolkit v1 (Live revision of physical toolkit with experts via zoom May 2021)	Type of Feedback (POSITIVE / IMPROVEMENT)	Type of improvement (FORM / CONTENT)	Comments
Venere Ferraro, Stefano Parisi (May 28, 2021)	ICS: Wearables - Materials samples	PTF inks not sustainable; change it for a shape memory alloys/polymers or OLED, "Light Touch Matters" example	IMPROVEMENT	CONTENT	- First ask MaterFAD for samples inhouse - ask Materiality for pool of LTM materials, i.e. OLED (sth that is a system)
Venere Ferraro, Stefano Parisi (May 28, 2021)	ICS: Wearables - Datasheets (digital)	7 new projects showcased in the respective moodboard (i.e. LTM example)	IMPROVEMENT	CONTENT	- QR on digital datasheet with moodboard for 1st Mobility WS Tecum.
Venere Ferraro, Stefano Parisi (May 28, 2021)	ICS: Wearables - Datasheets (digital)	FAD: Proposal skip toxicity, smart + sustainable properties in glossary; Polimi experts said it's empty, useless. Negative perception of sth that is missing or an error. Just put smart properties, otherwise too many blanks, e.g. Carbon footprint empty. Understanding: Vocabulary confusion: "physical properties" are actually qualities of the material (expressed qualitatively) Bars often don't make sense, info often confusing (pre-consumer waste) i.e. whether it is a shape memory or not. Meaning of gradient colors; FAD: intuitive system. Arch not clear; properties i.e. opaque or transparent, stiffness. Linear line like a bar more effective. TRL, positively appreciated, a lot of value for company: Suggestion to put in a more predominant way Shaping: tricky to understand terms: manufacture (how is it done) + transformation processes (possible processes applicable), maybe put "other possible processes". Supply: Arch "Product" Some samples named as products, others at systems, semi-finished. Designers and companies as users have to know what this concept means. Applying: "Comparison" Similar to Better than-inspired by not clear. When it's empty it's confusing. Depends on data available. Suggestion: avoid n/a. Maybe Novelty/Innovation instead of comparison: get rid of similar to better than-inspired by and just put case study. "Application fields" i.e. Chromosome datasheet Experimental interactive textile surfaces. Potential application: wearables, dynamic soft surfaces, interior design, signaling, interactive flags, and automotive. Check Put examples of limits of materials in terms of applications, washable or not, sustainability. Inspirational tool to understand potentiality of application. (Forget about materials' limitations) Also check excel with feedback from Polimi's experts	IMPROVEMENT	CONTENT	- Standard sheets for every toolkit of the 4 EM&Ts or adapt to every family? E.g. smart+sustainable properties (ICS wearables + Wood-based) - Change graphic system (some are yes or no) - Integrated glossary in box to put more parameters? i.e. another QR that leads to glossary + if technical sheet needed by user, put a link to company's website. - Replace physical "qualities" not "properties", suggestion for every category. - TRL indication more evident - Confirm concept "product" in Shaping in "Supply" - Check references with Materiality - Check Applying: section "Comparison" Similar to Better than-inspired by.
Venere Ferraro, Stefano Parisi (May 28, 2021)	ICS: Wearables - Datasheets (physical)	Smaller box+materials' samples. Detachable datasheets that fell out. No images to put them in order again. Suggestion of layers, getting rid of lateral wings (TRL2)	IMPROVEMENT	FORM	tdb
Venere Ferraro, Stefano Parisi (May 28, 2021)	ICS: Wearables - Sustainable box (physical)	Suggestion: Do not use polylat, but cardboard self-assembling (no sustainability and transport complications). Lifecycle of toolbox: 3 years because of materials' evolution and become obsolete very fast. Bottom-up-approach and populate toolkit with online interaction of users, seed of database. Open source (open source file that can be copied and replicated, but also because it can be updated by users, ref. openmaterials by Catarina Mota or Materiom.org, with peer-review.)	IMPROVEMENT	FORM	tdb
Venere Ferraro, Stefano Parisi (May 28, 2021)	ICS: Wearables - Miscellaneous (physical)	Put name of project and image of materials to place them on the cover and/or edge of toolbox to be able to compare it.	IMPROVEMENT	FORM	Consider putting name of projects on edge of book + images on cover

Fig. 15 Excerpt from "Feedback Toolkit v1 | Transnational Milan + KTL 2020 | Experts 2021 | Mobility WS 2021" [EM&T ICS: Wearables]

Shaping:

- Manufacturing Process
- Supply + Shape
- Transformation Process.

Application:

- Application Fields
- Comparison
- Case Study or some inspirations of applications.

One of the general changes is that the datasheets are now composed of 7 pages in the new version in a leaflet format (instead of the 6 previous pages).

Another big change is that the entire content and images of three new materials samples for the specific datasheets PTF inks (EM&Ts ICS Wearables), Fenix

Source	Areas	Feedback Toolkit v1 (Live revision of physical toolkit with experts via zoom May 2021)	Type of Feedback (POSITIVE / IMPROVEMENT n.)	Type of improvement (FORM / CONTENT)	Comments
Robert Thompson (May 19, 2021)	Nanomaterials - Materials' samples	Materials' samples still ok, interesting way of presenting it. FTM 3DP Maybe change content presentation to be less monotone, textures different colors (maybe other colors), patterns, ornamental, gold version of wire, color texture, out of your senses. Visual aspect to understand technology: the series, i.e. bionox (nanocoding) 9 new projects showcased in the respective moodboard	IMPROVEMENT	CONTENT	- Any suggestion on a material sample change for a more colorful/striking one? - Prevent from opening the samples and greyish association - QR on digital datasheet with moodboard for 1st Mobility WS Teconur.
Robert Thompson (May 19, 2021)	Nanomaterials - Datasheets (digital)	different type of uses/applications: scale, states of carbon: surfaces, powder, fibers, foam power of images	IMPROVEMENT	CONTENT	- Maybe change graphene carbon nanofiber for another reference (since not everything is in English)
Robert Thompson (May 19, 2021)	Nanomaterials - Datasheets (digital)	Too many physical references that limit. Different states and shapes of materials: define more classical ones and decontextualize new one. Redefine textiles, materials in solid states, how surfaces are made, integration with higher intelligence (digitalization, communications like comparing computing systems to nanotech)	IMPROVEMENT	CONTENT	- new selections or add examples, imagery to curate some more examples "look&feel" to get unstocked from grey colors
Robert Thompson (May 19, 2021)	Nanomaterials - Datasheets (physical)	Ergonomic part of detachable datasheets: you shouldn't lose things before you open it. The way it is glued in with a lip that hits the sheet. Make them more differentiated, they all look the same, loose time putting them into order.	IMPROVEMENT	FORM	- Make them more differentiated, datasheets all look the same, loose time putting them into order again.
Robert Thompson (May 19, 2021)	Nanomaterials - Sustainable box (physical)	How long should the box last? certification of paper, ink!	IMPROVEMENT	FORM	td
Robert Thompson (May 19, 2021)	Nanomaterials - Miscellaneous (physical)	Overall less nano-scary, grey, more colorful examples. Should be more fun looking at it in general. Maybe stand the box up, better way to keep them open in the middle of the table to have a better look at the sheets.	IMPROVEMENT	FORM	td

Fig. 16 Excerpt from “Feedback Toolkit v1 | Transnational Milan + KTL 2020 | Experts 2021 | Mobility WS 2021” [EM&T Nanomaterials]

Source	Areas	Feedback Toolkit v1 (Live revision of physical toolkit with experts via zoom May 2021)	Type of Feedback (POSITIVE / IMPROVEMENT n.)	Type of improvement (FORM / CONTENT)	Comments
Pirjo Kälänäinen, Tarja-Kaarina Laamanen (May 27, 2021)	Wood-Based - Materials' Samples	Change Arboceel for pulp sheets Background 2 Categories: Raw materials (for experimenting, Arboceel, materials produced out of raw materials (loncell, Timberfel, Sulapac, Huhtamaki) for B2B commercial materials. Auto and KEA more in an experimental, early-stage environment.	IMPROVEMENT	CONTENT	- Pulp sheets shipped? small bag with wood chips, grinded pulp - Provide description/explanation for datasheet (early-stage or basic part of any of the 4 examples produced with pulp sheets in the toolkit).
Pirjo Kälänäinen, Tarja-Kaarina Laamanen (May 27, 2021)	Wood-Based - Datasheets (digital)	7 new projects showcased in the respective moodboard (i.e. more experimental projects)	IMPROVEMENT	CONTENT	- QR on digital datasheet with moodboard for 1st Mobility WS Teconur.
Pirjo Kälänäinen, Tarja-Kaarina Laamanen (May 27, 2021)	Wood-Based - Datasheets (digital)	Parameters: toxicity (skip it) Introduce short, simple glossary for sustainability + smart properties (compostability, biodegradability) loncell-F: take out "F" TRL appreciated Indicate from who the info comes from (company ref.) Manufacturing processes: only etching; add textile processing Applying: Comparison "similar to" better cotton + viscose	IMPROVEMENT	CONTENT	- Indicate that info comes from company - add textile processing in "Manufacturing processes" - Introduce short simplified glossary with some sustainability+smart properties with some parameters? - Revise and add comments directly on datasheets for more errors/updates (i.e. take out "F", cotton + viscose)
Pirjo Kälänäinen, Tarja-Kaarina Laamanen (May 27, 2021)	Wood-Based - Datasheets (physical)	Problem of lose datasheets: n/a	IMPROVEMENT	FORM	td
Pirjo Kälänäinen, Tarja-Kaarina Laamanen (May 27, 2021)	Wood-Based - Sustainable box (physical)	Lifecycle of physical box and adequate materials: feel "plasticity", in Finland this is recyclable and no problem, maybe a more "look-feel more sustainable" Maybe cardboard corrugated instead of the foam of the boxes.	IMPROVEMENT	FORM	- ask Veronica how it has been produced for the prototype - explore cardboard alternative
Pirjo Kälänäinen, Tarja-Kaarina Laamanen (May 27, 2021)	Wood-Based - Miscellaneous (physical)	Heavily reminds of video format! Add a sentence kind of: "What is it for" This is your toolkit for ... purpose/inspiration on the first page	IMPROVEMENT	FORM	-consider changing size of box

Fig. 17 Excerpt from “Feedback Toolkit v1 | Transnational Milan + KTL 2020 | Experts 2021 | Mobility WS 2021” [EM&T Wood-Based]

(EM&Ts Nanomaterials) and Arboceel (EM&TS Wood-Based) were substituted for “Flexinol”, “Nnf Ceram” and “Kraft Pulp” respectively.

To better familiarise the user with the specific terminologies used in the datasheets, a new section called “Glossary” was curated and included in the new datasheet’s layout. (Confront the section of this Book called Glossary)



Fig. 18 Mood boards of the four EM&Ts

3.1.1 Understanding Section

The information shown on the datasheets was improved: The infographics were changed, the TRL levels more highlighted, more colour gradients shown, and arches and bars redesigned (see Fig. 19).

A more clear and intuitive graphic system was created to showcase the parameters of each EM&TS (i.e., a graphic intuitive 4 level system with “lack, low, medium, high” and scales from 1 to 5 were applied).



Fig. 19 Understanding section

3.1.2 Shaping Section

The Supply arche and Shape icons were redesigned into more clearer indicators (see Fig. 20).

3.1.3 Applying Section

The “Comparison” section was changed into “Comparison and Innovation”. Also, all case studies were reviewed as well as updated, and wherever possible, added when missing (see Fig. 21).

3.2 Phase 07: Box Layout (Final Version)

Based on the feedback received for adopting the final version of the EM&Ts toolkits’ box, the main considerations were to find a solution to the datasheets falling out of the box when displaying it. The comments received from experts and users had indicated that it was a good thing to take out the datasheets of each EM&Ts box to explore the data more in depth, but that it was not easy to do the sorting afterwards. Some ideas on how to attach-detach datasheets were that they could be open like a fan, book

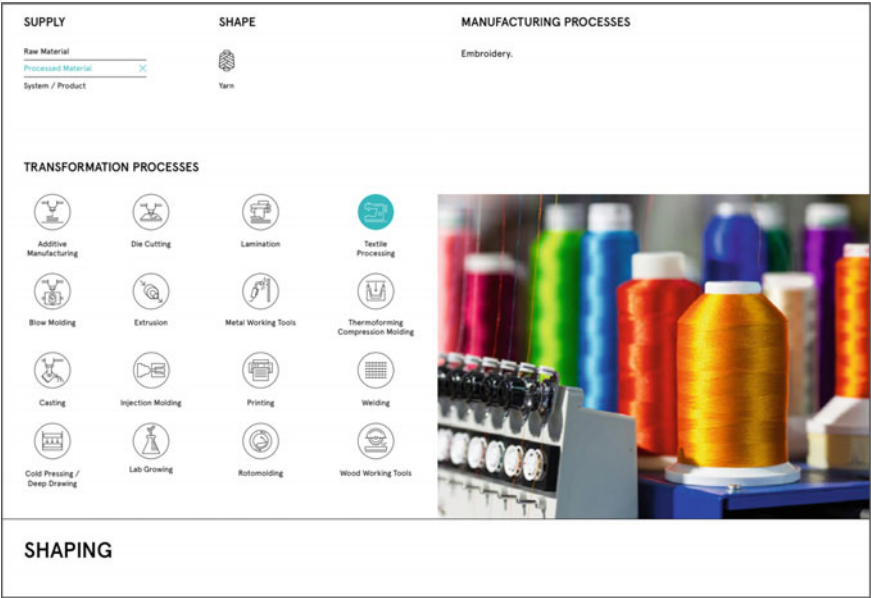


Fig. 20 Shaping section

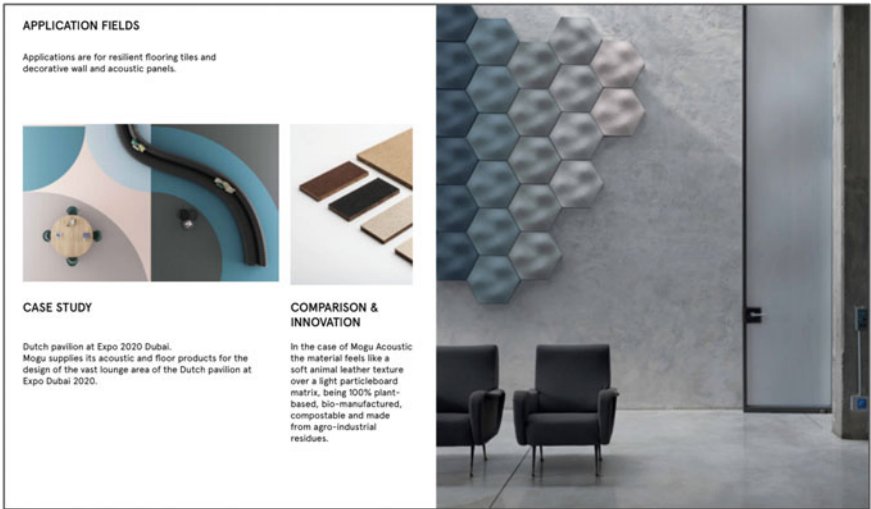


Fig. 21 Applying section

bended, or clicked to the toolbox with a ring. Also, more differentiation, for example with rubber bands or more distinctive datasheets might help to put the datasheets into order and each EM&Ts toolkit again. Another input was to maybe stand the box up, as a better way to keep them open in the middle of the table to have a better look at the sheets.

The format of the datasheets and box of the prototype version was to be maintained since it is conformed to international standards (A5 DIN) and easier to foster large-scale fruition and dissemination of the toolkits.

Furthermore, in the process of revising the box, it was decided to keep the project's visual identity, while improving the design in a graphic, tactile, and logical sequence sense. Above all, it was important to give a clearer more intuitive twist for exploring the toolkits' data and materials as non- expert users while fostering their learning experience for later applicability to their own projects.

The content of the box was expanded with a text referring to the description and purpose of the EM&Ts and DATEMATS project.

At the spine of the box the DATEMATS logo, EM&T area, and specific showcased material was inserted (see Fig. 22).

All social media, email, and contact were also added to the part of the logos of the consortium partners. To add the DMT (Design Methods & Tools) into the toolkit, FAD decided to put two additional QR on the toolkits' box with the links of the correspondent references with texts that lead to the information.

Also, and in line with the DATEMATS project values, a more sustainable production of the box with a sustainable "look & feel" was considered.

For this, an improved design of the box and datasheets layout for printing was proposed, reviewed, and implemented. The main inputs were to use a self-assembling

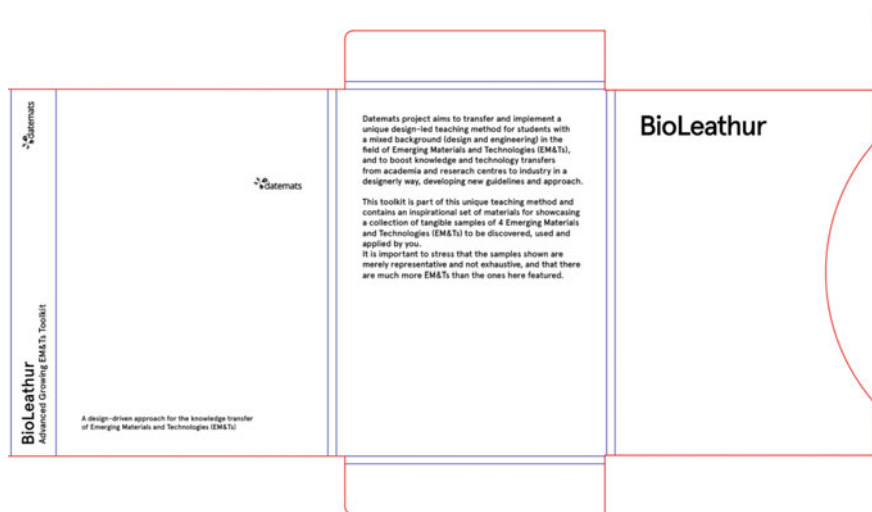


Fig. 22 Die cut template transfer toolkits final version outside

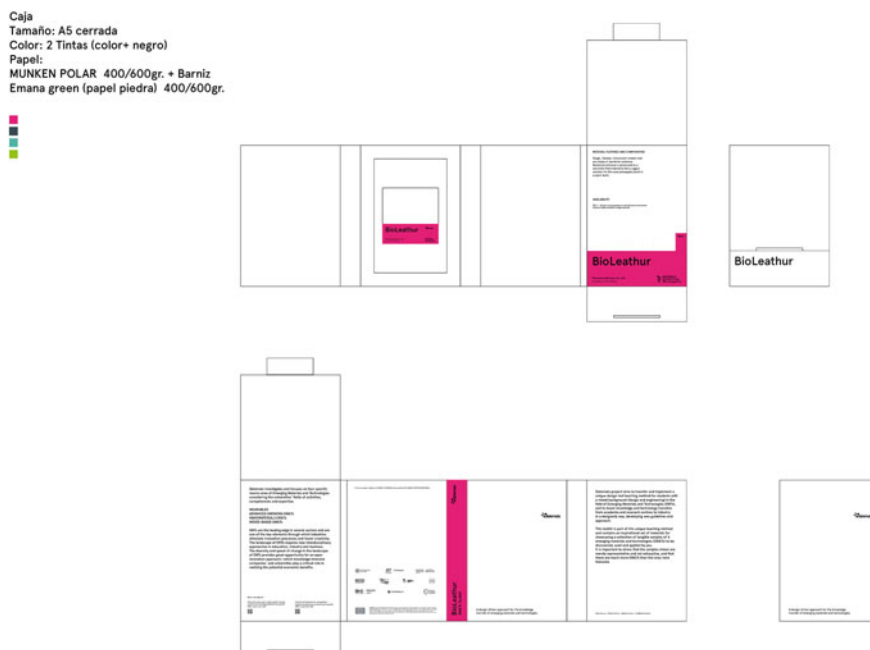


Fig. 23 Proposal box Munkén polar

corrugated cardboard, sustainable paper, and ink for production. A substitute to the foam board where the materials samples lie in each EM&Ts box was to be found. It was decided to indicate on each box the materials that are being used for the toolkits' production, so a sentence explaining the purpose of the transfer toolkit was added.

Figures 23 and 24 show two options assessed, of which the craft version was the chosen one:

Finally, a booklet for each EM&Ts was designed and put into each box in an envelope. Also, each box was differentiated and marked with a rubber band of the respective colour of each area. The space for the materials samples had been also redesigned and the foam removed.

3.3 Phase 08: Production Result of the EM&TS Toolkit's (Final Version)

Fig. 25 shows some images of the results of the final production of the 20 EM&Ts toolkit boxes:

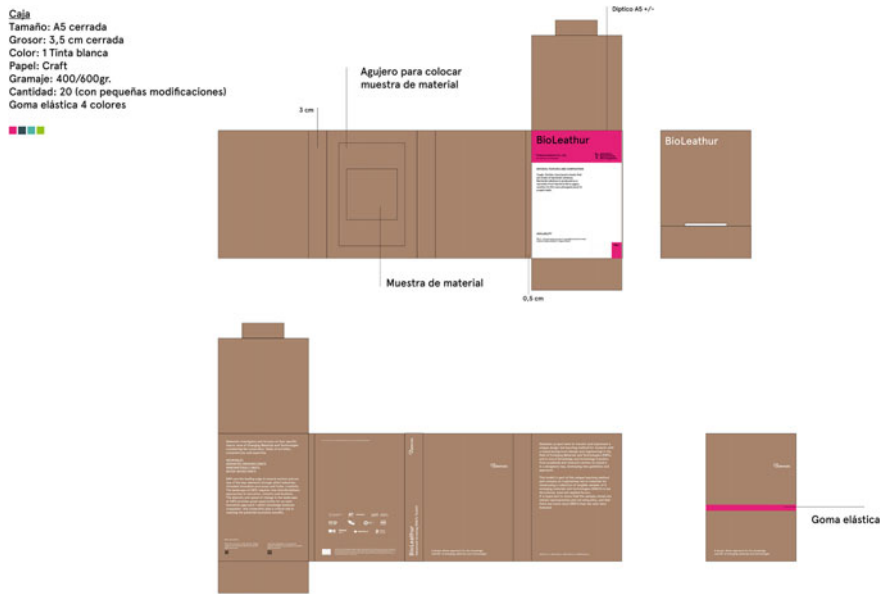


Fig. 24 Proposal box craft



Fig. 25 Final Toolkit images

4 Final Remarks on the EM&Ts Transfer Toolkit Process

During the process of improving the form and content of the toolkit from the first prototype to the final version it was important to maintain an inspiring and engaging set of materials to showcase a collection of tangible samples of all four EM&Ts, to be used by the target groups/potential beneficiaries such as academia and design professionals.

Also, it was important to stress that the samples shown in the toolkits are representative and not exhaustive, and that there are much more EM&Ts than the ones featured in the boxes.

The lifetime of the toolkits thus its material composition is approximately three years (because of the obsolescence of the materials samples or rather due to the evolution of the EM&Ts).

As part of the dissemination process the datasheets and layout of the box are going to be available as an open-source tool in a downloadable version on the DATEMATs' website.

Finally, the execution process of the toolkit provided a great opportunity to the involved partners' staff to assess and extend their expertise on emerging materials and knowledge transfer tools.

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Geraldine Kann with studies in International Trade, Business and Marketing and a transversal career in project management in Spain, Germany and Bolivia. In 2018, she completed a post-graduate degree at IED in Trends Research on megatrends and consumer behavior to complete

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