Report on "**Educational curriculum and planning**"

DELIVERABLE D4.1	Version 1 06.2022

Project Number: 101005435

Project Acronym: AMULET

Project title: Advanced Materials and Manufacturing Technologies united for Lightweight

Starting date: 01/09/2021

Duration in months: 39

Call (part) identifier: H2020-INNOSUP-2020-01-two-stage

Topic: INNOSUP-01-2018-2020; Cluster facilitated projects for new industrial value chains

Technical reference

Deliverable:	
Work Package:	4
Due Date:	30.06.2022
Submission Date:	30.06.2022
Start Date of Project:	01.09.2021
Duration of Project:	39 Months
Organisation Responsible of Deliverable:	Flanders Make
Version:	1
Status:	Final
Author name(s):	Isabel Van de Weyenberg, Ahmed Elmahdy
Reviewer(s):	Ricardo Del Valle, Jakob König, Katharina Götz, Annabelle Sion
Type:	X R – Report ☐ E - Ethics ☐ O – Other
Dissemination level:	x PU – Public ☐ CO – Confidential, only for members of the consortium (including the Commission)

ABSTRACT

This deliverable describes the topics that will be included in the educational curriculum for the SMEs. The curriculum includes both technical as well as business development aspects.

The report first starts with a thorough analysis of the challenges that were submitted during the 1st Open Call, which gives us an idea of what kind of topics would be most desirable to be covered. Next, the competencies of all the AMULET partners are listed, based on an internal questionnaire.

Furthermore, D2.1 (report on the diagnosis of the AMULET community) provides input as well on what markets and materials are of interest for the relevant SMEs.

Finally, this is all put together in a preliminary educational program, covering both technical and business topics.

List of acronyms

AERO	Aerospace & Aeronautics
AMULET	Advanced Materials and Manufacturing Technologies united for Lightweight
AUT	Automotive
BUI	Building
CMC	Ceramic Matrix Composites
ELCA	European Lightweight Cluster Alliance
ENE	Energy
IP	Intellectual Property
LMA	Light Metal Alloys
OoA	Out of Autoclave
PBC	Polymer Based Composites
RTO	Research and Technology Organization
SME	Small and Medium Sized Enterprises
TBS	To be specified
TP	Thermoplastic
TWGE	Thematic Working Group of Experts

Table of contents

1. Objective of T4.1

Within task 4.1 the AMULET consortium partners, under the task-lead of Flanders Make, will **define, develop and deliver educational content** to SMEs. The first step within this task is to define which content should be delivered to the companies: what are the challenges that the SMEs encounter? In what topics are they mainly interested? Which topics are highly relevant for the AMULET project? Based on the in-depth diagnosis of the AMULET community (D2.1), combined with the different topics that are delivered by the challenge givers, a list of topics can be synthesized.

Together with the internal expertise available in the consortium, or within the network of the cluster partners, an educational program can be created to be delivered to the SMEs. This program is a mix of different types of educational material: presentations and papers made available on the ELCA platform, as well as regularly organized webinars.

The topics will cover a broad range of knowledge and expertise: at one hand technical related topics, such as design, characterization & modeling, manufacturing processes, assembly & joining technologies, or circular economy. But on the other hand, the business related services will be important to cover as well, for example IP management, internationalization, funding programs, etc.

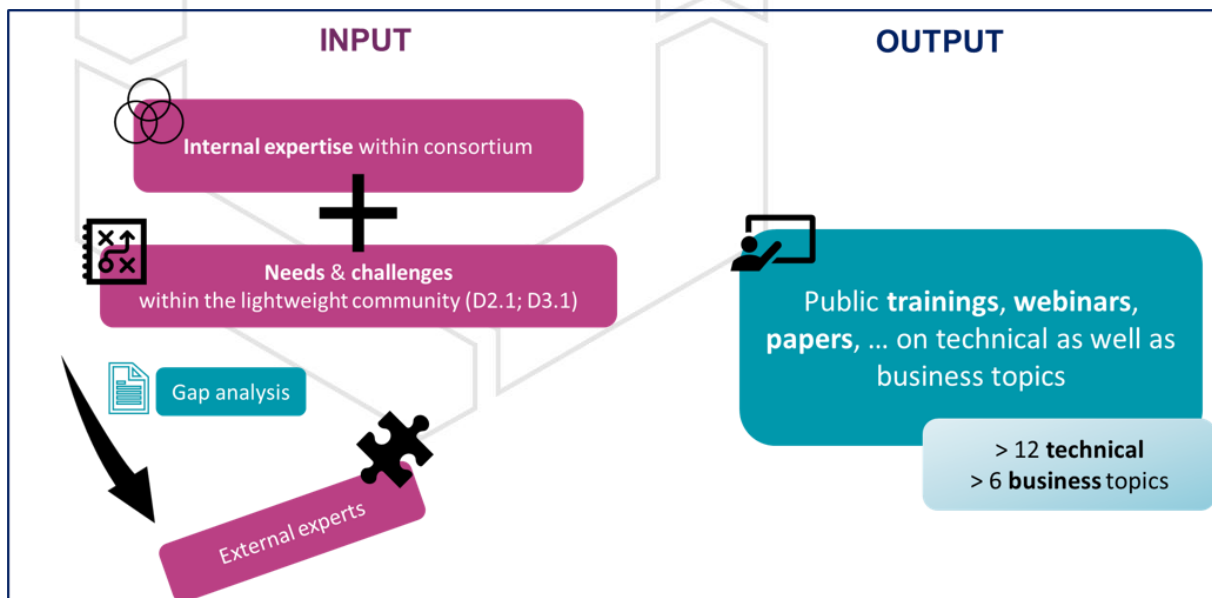The general approach of task 4.1 is illustrated in Figure 1.

Figure 1: Approach of T4.1

2. Analysis of the challenges

The challenges that have been submitted during the 1st Open Call are believed to be relevant for the themes that are of interest nowadays in the envisaged industries (Automotive, Aerospace & Aeronautics, Building & Energy). If it is noticed that the topics in the 2nd Open Call are differing significantly, we will revise our educational program and add or replace some of the programmed topics in the curriculum.

a. Scope of the analysis

The purpose of this analysis is to provide a first-level insight into the subjects of interest to the companies for each sector, in order to draft a proposal for the educational programs which fits these interests.

b. Approach of the analysis

The quantitative analysis of the challenges adopts a "data analytics" approach, and is divided into 4 analysis levels as follows:

- Clustering of the challenges based on **material type** (i.e., Polymer Based Composites, Light Metal Alloys, and Ceramic Matrix Composite)
- Clustering of the challenges based on the **cross-cutting topics** (i.e., Materials supply and development, Characterization and modelling, Assembly and joining, Design and smart functions, Manufacturing, and Circular Economy)
- Clustering of the challenges based on the **application sector** (i.e., Automotive, Aerospace & Aeronautics, Building & Energy)
- Clustering by **keywords**. These keywords are defined arbitrarily based on the description of each challenge.

The material-based and sector-based clustering were used directly from the division already listed in the challenges combined document. The cross-cutting topics based and keywords based clustering were proposed based on the nature of each challenges. The keywords clustering was based on two levels: general keywords covering broader themes similar to the cross-cutting topics, and specific keywords covering detailed technical aspects for each challenges. These keywords are intended to be used as a basis for the determination of the most suitable educational topic to be delivered. Table 1 lists the general keywords used.

Number	Keyword
1	Advanced material development
2	Composite manufacturing and quality control
3	Design, modelling, and optimization
4	Joining, adhesives, and sealants
5	Mechanical testing and durability
6	Energy generation and storage
7	Recycling, sustainability, and circular economy
8	Automation and robotics

Table 1: List of general keywords used

Each challenge was summarized into a short description and specific technical keywords were proposed. The specific technical keywords were then grouped into the general keywords listed in Table 1. The proportional occurrence of each challenge in the cross sectoral topics was recorded. Moreover, the proportional occurrence of the technical specific keywords for each challenge in the general keywords was also recorded.

c. Results and discussion

Analysis according to the material type

Figure 2 shows the proportional occurrence of challenges in each material type cluster. It can be clearly seen that the challenges focusing on polymer-based composites comprise more than 50% of the total challenges. Whereas the light metal alloys and ceramic matrix composites comprise both approx. 27% and 19%, respectively, of the total submitted challenges. This is expected since polymer-based composites are traditional lightweight solutions.
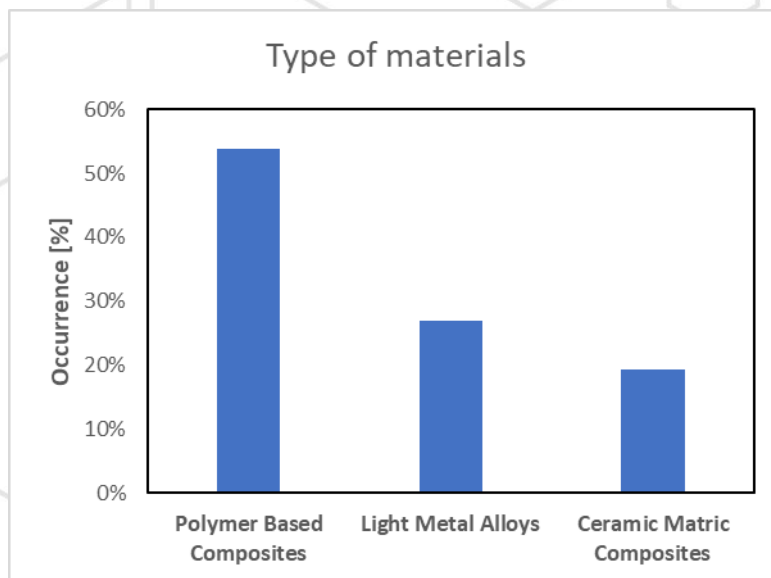

Figure 2: Analysis of challenges according to material type

Analysis according to application sector

Figure 3 shows the proportional occurrence of challenges in each application sector. It can be seen that the aerospace & aeronautics, the automotive, and the energy sectors are equally represented, with 27-35% share of the total challenges. The building sector is the least represented with approx. 11% of the challenges.
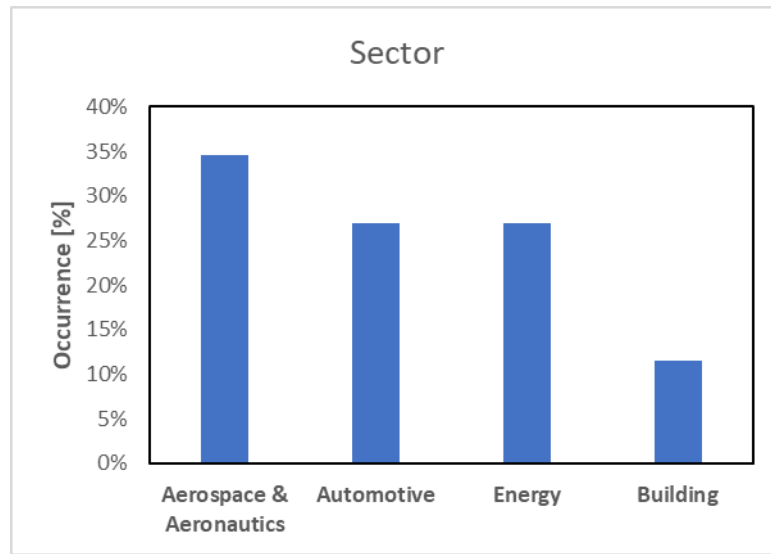
Figure 3: Analysis of challenges according to application sector

Analysis according to the cross-cutting topics

Figure 4 shows the proportional occurrence of challenges in the clusters of cross-cutting topics. Here, the cross-cutting topics material supply and development, manufacturing, characterization and modelling, and assembly and joining cover together approx. more than 80% of the total occurrences of all challenges. In contrast, the cross-cutting topics design and smart functions, and circular economy are represented by less than 20% of the total challenges.
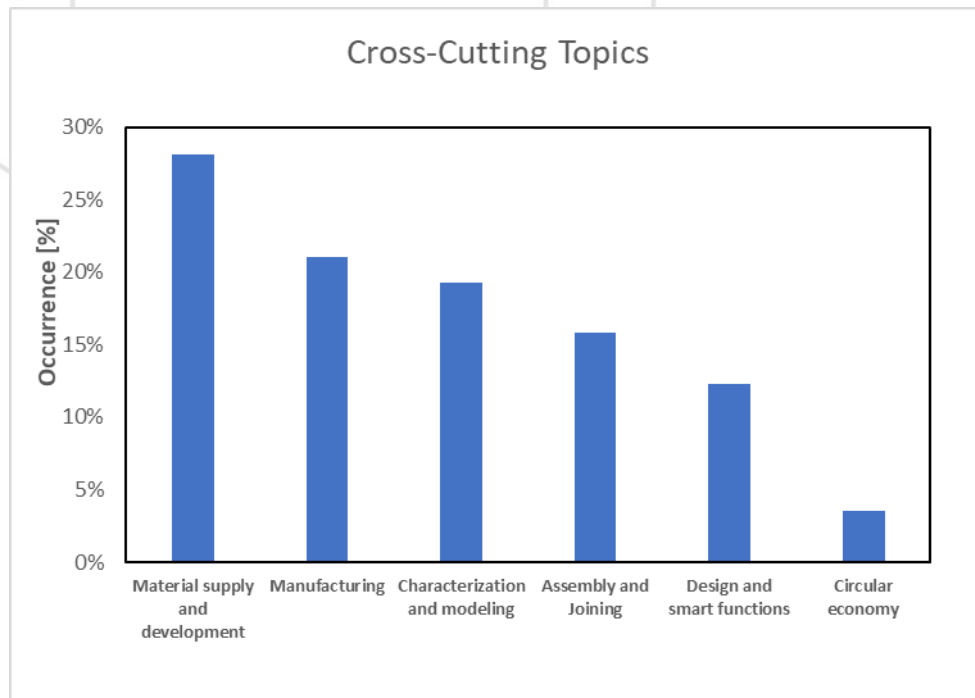

Figure 4: Analysis of challenges according to cross-cutting topic

Analysis according to the general keywords

Figure 5 shows the proportional occurrence of challenges in the clusters of general keywords. The purpose of this plot is to provide more details into the technical aspects of the challenges compared to the broader cross-cutting topics. Advanced material development represents the highest demand among challenges, with approx. 30% of the total frequency occurrence. The second highest demand is the composite manufacturing and quality control topics, represented approx. 16% of the total frequency occurrence. The topics of design modelling and optimization, energy generation and storage, mechanical testing and characterization, and joining, adhesives and sealants each represent from 10% to 12% of the total occurrences. Finally, the topics of recycling, sustainability, and circular economy, and automation and robotics represent the least demanded topics, with percentages of 6% and 1%, respectively.
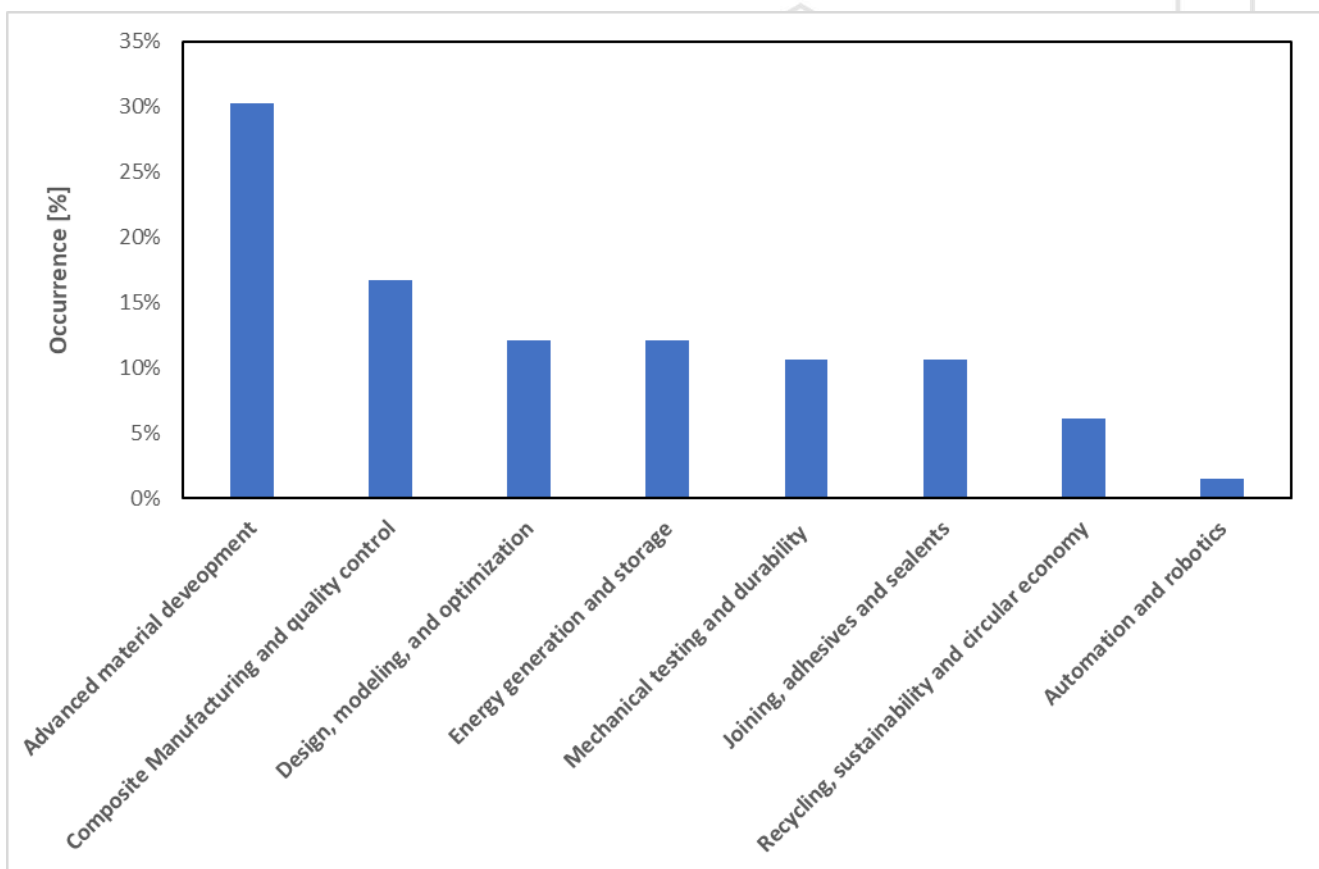

Figure 5: Analysis of challenges according to general keywords

d. Conclusions on challenge analysis

The following points can be concluded from the previous analysis:

1. Polymer-based composites were the most demanded material in the challenges, with most applications in aerospace & aeronautics sector, followed by automotive, and energy sectors.
2. Based on the cross-cutting topics defined in the project proposal, material supply and development, manufacturing, characterization and modelling represented the most demanded topics for the challenges.

3. In general, the educational programs should provide more focus on advanced material development and composite manufacturing/quality control topics, specifically for polymer-based composites. Additional topics could include design/modelling/optimization, mechanical testing and durability, mechanical joining, and energy generation and storage applications.

3. Proposal of topics

a. Technical topics

As stated earlier, **6 cross-sectoral topics**, which could be further labeled according to **8 key-topics**, can be listed. In each of these topics, sublevels can be defined depending on the material or sector that is being envisaged.

- Advanced material development
  - Trends in material development in each of the material families (PBC, CMC, LMA)
- Composite manufacturing and quality control
  - OoA techniques
  - TP composite manufacturing
- Design, modelling, and optimization
  - Geometric design optimization
- Joining, adhesives, and sealants
  - Adhesive bonding
  - Mechanical fastening techniques
  - Welding
  - Hybrid joining techniques
  - Multi-material joining
- Mechanical testing and durability
- Energy generation and storage
- Recycling, sustainability, and circular economy
  - The fundamentals for a circular economy (this will also cover some more business-related topics)
  - Recycling techniques for PBC
- Automation and robotics

b. Business -related topics

As for the business-related topics, also **6 main areas** could be defined:

- IP management
- Market research
- Internationalization
- Business planning
- Technical surveillance
- Funding (with geographical division)

These topics can be further subdivided along application domain and/or geographical difference when applicable.

4. Competencies of AMULET consortium partners

Based on an internal questionnaire as well as the output of D2.1, the competencies of the AMULET consortium partners have been identified, both with respect to their technical and business-related experience and knowledge.

In the tables below, an overview of the main topics is given (Table 2 for technical topics and Table 3 for business-related topics), as well as the consortium partners covering this specific topic.

Technical topic	JSI	FM	UNIBO	NTNU	TUC
Materials	CMC	PBC	LMA & PBC	PBC	PBC & CMC
Sector	ENE & BUI	AUT & AER	AUT & AER	AER & AUT & ENE & BUI	AUT & AER
Material supply & development	x				x
Characterization & modelling	x	x	x	x	x
Design & smart functions		x	x	x	x
Manufacturing		x	x	x	
Assembly / Joining		x	x		
Circular economy				x	

Table 2: Technical topics covered by the RTO's and universities within the AMULET consortium.

Business related topic	AKL	BIC	IMAST	MAV	MECH	POL	SWHEC	BAX
IP management	o		x		o		x	
Market research	o	x				x	o	x
Internationalization	x	x		x	x	x	x	x
Business Planning		o					o	x
Technical Surveillance	o		x	x		x		x
Funding	o			o		x		x

Table 3: Business-related topics covered by the non-RTO organizations within the AMULET consortium.
"x" : provided by the partner itself; "o": via subcontracting/indirect support.

It can be stated that most of the proposed **technical topics** can be covered by the AMULET RTO consortium partners, although for LMA only one partner is identified (UNIBO). Most of the in-house expertise can be found on PBC, which relates as well to the findings of D2.1 where the cluster network also shows a large expertise in PBC and less in CMC and LMA. Also, the proposed challenges in the 1st Open Call are mainly oriented in the PBC materials, and less in CMC and LMA. Therefore, it is estimated that the consortium partners will be able to cover most topics that are relevant and required by the interested SMEs. When expertise is needed in specific domains which are not in the expertise of the consortium partners, the thematic working group of experts will be called to action.

However, the topic on **material supply and development** is only covered poorly by the consortium partners (only for CMC materials this will be covered). Therefore it is recommended to find external experts to cover this topic, firstly reaching out to the TWGE members.

The **business-related topics** on the other hand are nicely covered by our AMULET cluster partners. On each of the suggested topics, one or more partners can cooperate in elaborating educational material. The experience reported by other H2020-Innosup-01 projects tells us that these business topics will be mainly asked for in individual coaching sessions, part of T4.2. Nevertheless, each of the topics will be handled in a separate webinar as well.

5. Preliminary educational program

a. Educational material

The proposed curriculum is made based on the knowledge that was gathered in the first 9 months of the project. Hence, it is highly possible that adaptations will be made along the course of the project, according to the interest of the SME's.

The technical and business topics will be covered by material stored on the ELCA platform (i.e. papers, presentations, tutorials) as well as live webinars. The latter will be uploaded after broadcasting on the ELCA platform to be freely available for platform visitors.

The educational material will be provided **continuously** along the duration of the project. This means that from M14 (October '22) onwards, the database on the ELCA platform will be enriched with new materials on a regular basis, following the proposed topics in paragraph 2. Technical topics will be provided by all RTO partners of the AMULET consortium, under the lead of Flanders Make. Business topics will be mainly provided by the cluster organization partners of the consortium, under the lead of Polymeris.

As for the webinars the following schedule is proposed: each **3rd Tuesday of the month** a webinar will be broadcasted, with a duration of approx. 1.5 hour, and in which the participants will have plenty of opportunity to ask questions. The webinars are scheduled only in non-holiday months, since the experience learns that no audience is reached during summer or winter holidays.

Topics until summer 2023 are already specified, as can be seen in Table 5. The period after M24 will be specified as soon as the challenges of the 2nd Open Call are being analyzed, as well as the feedback that is being received from the interested SME's.

Besides the webinars, educational materials will be uploaded on all relevant topics as well, starting from M14 onwards.

The lead partners in collecting relevant information are listed in Table 4. The lead partners will coordinate the collection of the right educational material, by contacting the appropriate consortium partner, reaching out to the TWGE, and to their network.

Topic	Lead partner
IP management	SWHEC
Market research	BIC
Internationalization	AKL
Business Planning	BAX
Technical Surveillance	MAV
Funding	POL
CMC	JSI
LMA	UNIBO
PBC	NTNU

Table 4: High level overview of educational topics and their lead partners

Scheduled date	M14 18/10/2022	M15 15/11/2022	M16	M17 17/01/2023	M18 15/02/2023
Preliminary topic	IP management	Geometric Design Optimisation	X-Mas Holidays	[PBC]: OoA techniques	Market Research
Organising partner	SWHEC	FM		NTNU	BIC

Scheduled date	M19 21/03/2023	M20 18/04/2023	M21 16/05/2023	M22 20/06/2023	M23
Preliminary topic	Adhesive Bonding techniques	[CMC]: Trends in material development	Internatio-nalisation	[LMA]: Trends in material development	Summer Holidays
Organising partner	FM	JSI	AKL	UNIBO	

Scheduled date	M24	M25 19/09/2023	M26 17/10/2023	M27 21/11/2023	M28
Preliminary topic	Summer Holidays	TBS	TBS	TBS	X-Mas Holidays
Organising partner		TBS	TBS	TBS	

Scheduled date	M29 16/01/2024	M30 20/02/2024	M31 19/03/2024	M32μ 16/04/2024	M33 21/05/2024
Preliminary topic	TBS	TBS	TBS	TBS	TBS
Organising partner	TBS	TBS	TBS	TBS	TBS

Scheduled date	M34 18/06/2024	M35 - M39
Preliminary topic	TBS	
Organising partner	TBS	

Table 5: Time & topics schedule for webinar broadcasts. "TBS" = to be specified

b. Intended audience

The audience that will be targeted, will differ from topic to topic.

For the technical related topics, the primary target group will be **technical-skilled personnel**, or people interested in the technical details of certain matters. For the webinars, the level of teaching will apply rather to senior engineers, decision makers, etc. The content that will be placed on the platform in the form of documents and tutorials, will be more targeted to engineers and technicians, providing more level of detail.

For the business topics, the target group exists mostly out of **business developers** and account executives.

c. Approach

While we will cover as much of the challenge topics as possible, we will keep a fixed approach for each of the topics during the webinars. This will make clear for the SME's what kind of info they can expect. Therefore, each webinar will start with a **state of practice** concerning the topic, followed by the **trends and challenges** that are identified. Finally, **state of the art** can be further discussed. In that sense, SMEs will be inspired and get a concise overview of the possibilities in that certain domain. They then know who to contact to further explore their opportunities.

6. Conclusions

Based on the analysis of the 1st Open Call challenges, the in-depth diagnosis of the AMULET community and the internal expertise mapping of the AMULET consortium partners, the format of a very complete educational program is being created.

The program exists of a **mix of webinars**, spread over the complete project duration, starting in M14, and broadcasted at least once a month. Next to that, a **collection of documentation, tutorials and papers** will be put on the ELCA platform which can be freely accessed by the interested SMEs. The material will be a variety of technical topics as well as business-related topics, all envisaging a different target audience, from CEO's, over business developers to technicians.

The roll-out of the educational program will be carried by **all AMULET consortium partners**, each contributing in their domain of expertise. For those domains in which the AMULET consortium hasn't got any expertise, the TWGE will be consulted to give advice on relevant educational material.