



Deliverable D7.1

Initial Dissemination & Exploitation Plan

WP7 Dissemination & Exploitation

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1. Introduction

Grade2XL's targeted impact is a breakthrough in the development of WAAM for high throughput (up to 10 kg/h) multimaterial deposition, leading to graded products of superior quality with minimum use of expensive materials (TRL 4-6). As next steps (TRL 6-9), the technology will be optimised from a cost perspective and WAAM modular equipment will enter the market by 2026. The **end-users** (MAN ES, EDF, Villeroy&Boch, GKN, Arrk Shapers, Gorenje, Kuźnia Jawor) will directly implement the technology to the products used as demonstrators. The scientific innovations stemming from related projects (such as AiM2XL) will be exploited by all project partners. **Research institutes and universities** (CEA, TU Delft, UGent, PWR, M2i) will exploit their IP through further research, on optimising grading strategies or exploring new materials combinations for WAAM. **Service providers** (RAMLAB, Naval Group) will be able to cater to a wider market, based on the experience built up with the challenging selection of Grade2XL application cases. **Equipment and software vendors** (Valk Welding, Air Products, RAMLAB) will directly implement the innovations in new, customised WAAM hardware and software – to enter the market within two years of the project's end. **Materials producers** (vaBWG, LSW) will optimise the WAAM wire materials (currently under development) and liaise with BV to prequalify these wires for the entire range of Grade2XL applications – thus accelerating their market entry.

The "Plan for dissemination and exploitation" document will be used to create a strong awareness about the project among all target groups and ensure the project achieves its full impact. The plan will be updated during the project, along with a database of stakeholders and technical/scientific networks of interest. The target audiences of the project are essentially its main stakeholders, or those affected or who could be affected by the project. The following table lists the main stakeholders of Grade2XL and our approaches to engage with them.

The audience is European. The targeted audience is at the crossroad between welding specialists, the additive manufacturing community and the smart industry/Industry 4.0 initiatives. It covers different kind of professionals: people involved in research as well as people involved in business. Communication materials will also be released to reach the decision makers and the general audience.







WAAM Technology is to be promoted as the « *Next Big Thing* » in the manufacturing world. The strategy is to generate a massive interest from all industrial sectors, as well as from young and experienced professionals who could (re)orient their careers towards mastering this technology. The WAAM through Grade2XL approach is to be branded as a regular product or process.

The brand will be reflected in a book of style including a logo, colour standards, presentation template and project factsheet. In addition, a professionally designed project website has been launched.

Table 1. Analysis of main Grade2XL stakeholders

Grade2XL stakeholders	Why approaching them?	Key message	How to reach/engage with them?
 SMEs	Main players on the emerging market for WAAM → we need critical mass to withstand competition from Asian countries.	WAAM is a unique business opportunity, with a massive growth potential requiring little investment: now is the moment to start!	<ul style="list-style-type: none">• WAAM Experience Days• WAAM Roadshow• Project website
	Business model WAAM is aiming to substitute → we need to offer an alternative	WAAM is reaching maturity and substitution of conventional processes is inevitable. It also provide	<ul style="list-style-type: none">• WAAM Experience Days• Presentations at technical events



Grade2XL stakeholders	Why approaching them?	Key message	How to reach/engage with them?
Large EU foundries	and preserve the competitiveness of the EU industry.	the opportunity of a new, sustainable business model.	<ul style="list-style-type: none"> • Project website
 Engineers in training	They are the future workforce in the EU industry → they need skills to ensure WAAM becomes a widely spread industrial practice.	WAAM is “the next big thing”, WAAM skills will be in very high demand on the market place.	<ul style="list-style-type: none"> • Trainings via International Institute of Welding (IIW) • WAAM Design contest • Scientific publications
 Welding professionals	They are the current workforce in a field WAAM will partially substitute → needs retraining on WAAM.	WAAM is “the next big thing”, WAAM skills will be in very high demand on the market place.	<ul style="list-style-type: none"> • Trainings via IIW • Webinars • Presentations at technical events
 Industrial designers	WAAM can spur innovation in many other sectors.	WAAM offers an enormous design freedom → mastering the technology can set you apart in your trade/ provides new business opportunity.	<ul style="list-style-type: none"> • WAAM Experience Days • Webinars • WAAM Design contest • Videos on YouTube
 Environmental experts	Address their concerns on the environmental impact of this new technology.	WAAM offers similar quality as conventional technologies – with 7-10 times less critical materials. WAAM enables important CO ₂ savings, too.	<ul style="list-style-type: none"> • Conferences and events on Industrial ecology • Training on the potential for CRM savings of multimaterial WAAM
 Policy makers	Inform them of the benefits of WAAM as compared to the conventional technologies.	Europe needs to invest in WAAM and preserve its competitive edge over the Asian manufacturing.	<ul style="list-style-type: none"> • Project website • Project deliverables • Position papers on WAAM
 General public	Make engineering attractive for very young people, especially girls.	Our industry is transforming, anything can now be printed with additive manufacturing.	<ul style="list-style-type: none"> • Open days at participating universities • Project website • Videos on YouTube

The Dissemination and exploitation plan includes measures meant to engage with the target audiences identified at the previous step. These measures are presented subsequently, clustered into communication, dissemination and exploitation activities.

2. Communication tools and materials

2.1. Book of style

A document summarizes the visual identity of the project for all kinds of documents. For example, the colour scheme to be used by the consortium is found. The book of style displays the set of project logos and icon. Templates for three kinds of documents were designed accordingly:

- Word for official letter
- Word for a report
- PowerPoint presentation

2.2. Tools

2.1.1. Project website

The Grade2XL website is accessible at: <https://www.grade2xl.eu/>. The website is the main online dissemination and communication tool of the project. It contains information on the project, the consortium, the objectives of the project, projects achievements, news and events. This information is addressed to all sorts of audiences, from scientists and industrial researchers to SME's, large EU foundries, policy makers and the general public.



Fig. 1: Homepage on 19/5/20

The public section displays the following sections:

- **Home:** the page starts with the project acronym, slogan and description of the project. A video showing features of 3D printing at RAMLAB gives the general audience a direct idea of what the project is about. This video will be replaced with the first project video as soon as this is finished. Further on the page, three boxes highlight objectives, ambition and consortium. Clicking on them will bring you to the subpages. At the bottom, the latest news is highlighted, and the contact form can be found. On the homepage, we can find links to the social media of the project: YouTube, Twitter and LinkedIn.
- **About:** information about the vision of the project, the goals and ambition.
- **Objectives:** the three basic objectives are highlighted and explained.
- **Consortium:** all consortium partners are listed. This page shows the diversity of companies and countries involved in the project. In addition, we can find here the international Industrial Advisory Group, with an option to join this group and instruction on how to join.
- **Contact:** the page jumps to the bottom of the homepage, where visitors can fill in the contact form. The contact form is mainly to express interest in the project and the events/trainings that are organized by the project. M2i manages the inbox and makes sure the messages are read and distributed to the right persons.
- **News & Events:** news about the project and its partners, Grade2XL meetings, events organized by the consortium for the project and related events. Here all published information about the project and public deliverables will be added as soon as the first public deliverable is available.

In the website, there is a direct link to the intranet site PLAZA, by clicking on the 'wheel' on the top right of the page. It can only be accessed by the project's consortium members and has been created to exchange documents, files and other confidential information between the project partners.

Website statistics

Every three months, the following details will be tracked on the website statistics, assessing the activity:

- Total number of visitors (per month/day)
- Unique visitor
- Post views
- Post shares
- Form submission
- Origin of site visitors: how did they find the website?

During the period from 18 February 2020 to 18 May 2020 the site had 392 visits with 262 unique visitors. The first news items were viewed 182 times and were shared 6 times. As the last figure shows, the site was visited 249 directly, found 66 times via LinkedIn, 54 via search and 25 times via reference links on other websites.



Fig. 2: Statistics of website on 19/5/20

An enhanced version of the website will be released on M6. It will feature an improved map of the partners that will also include links to their corporate websites.

Partners were to be provided content by M2i to create a webpage dedicated to Grade2XL on their own website with link towards Grade2XL homepage. This will enable to increase traffic.

This is a set-up for the webpages for partners. M2i has already a similar page:

<https://www.m2i.nl/portfolio-items/grade2xl/?portfolioCats=194>

2.1.2. Plaza

The project Plaza is a project workspace, hosted by the M2i intranet. Such structures have been successfully used by M2i for document storage and management since 1997, for more than 600 projects. Due to the ease of use and large storage capacity, combined with safety features, such a Plaza was established to share, store and manage the documents related to the implementation of the Grade2XL project.

The project partners can access the Plaza via the project website, grade2xl.eu, by clicking on the wheel in the right corner of the site. The partners (current and any new members) are given access to the Plaza by the M2i administrators. Once added as members to the Plaza by M2i, they must then follow these steps:

- Click on this link: <https://promise.m2i.nl/promise/PRIVATE/guest/logon.aspx>
- Use your email address as user name and **request a guest code** to access the project Plaza. The code may end up in your Spam folder, so please check there if you do not received the code.
- Use the **code** to login on the Grade2XL project Plaza.
- Click **View** to access the Plaza.

The structure of the document library on the Plaza is shown in **Figure 1**:

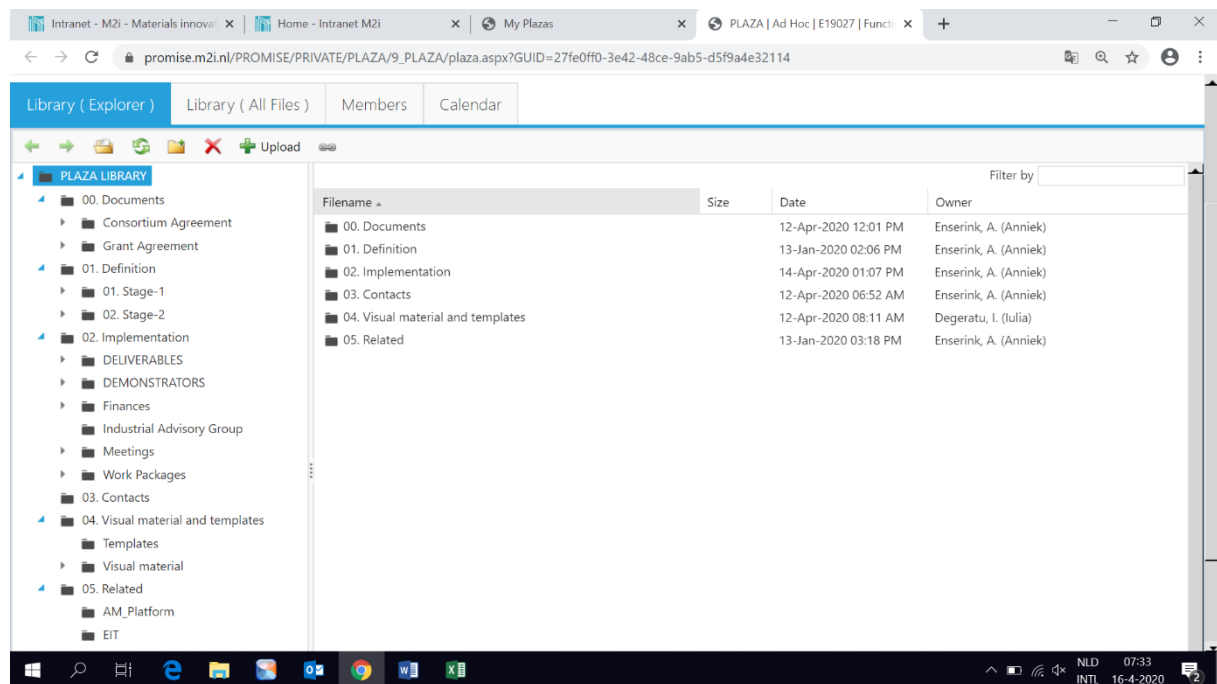


Figure 1. Structure of the Grade2XL Plaza – Library (retrieved on 16 April 2020)

The Plaza also records the uploads in chronological order – see tab Library (all files) in **Figure 2**.

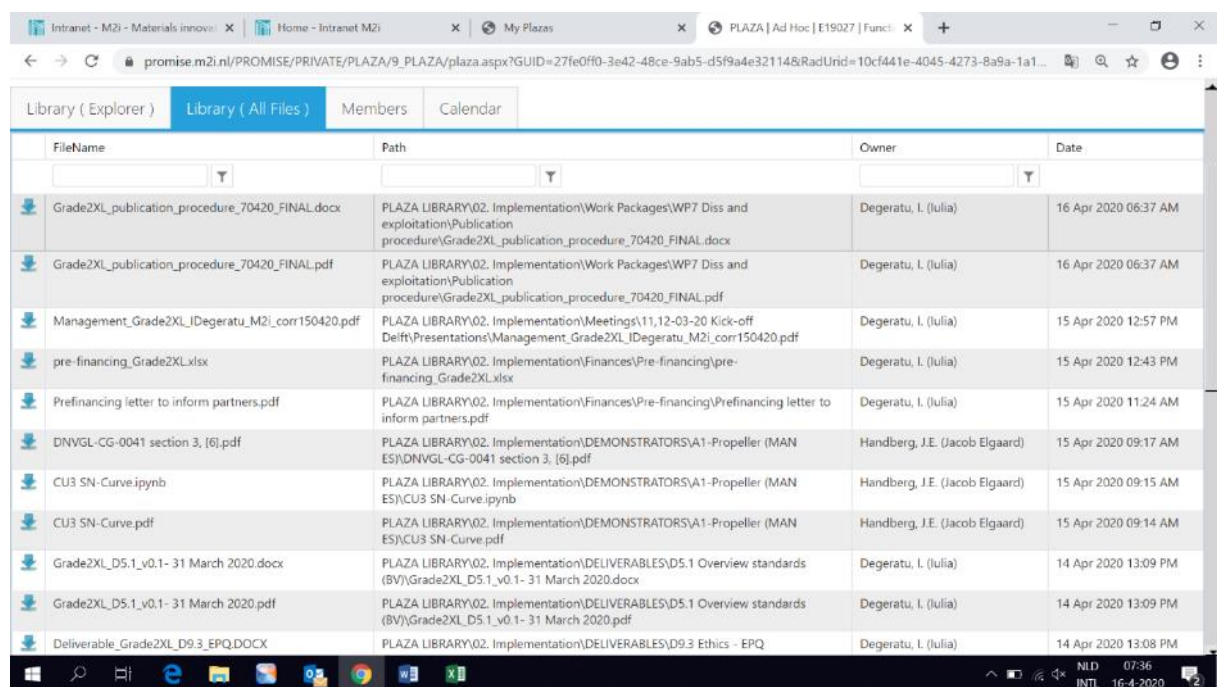


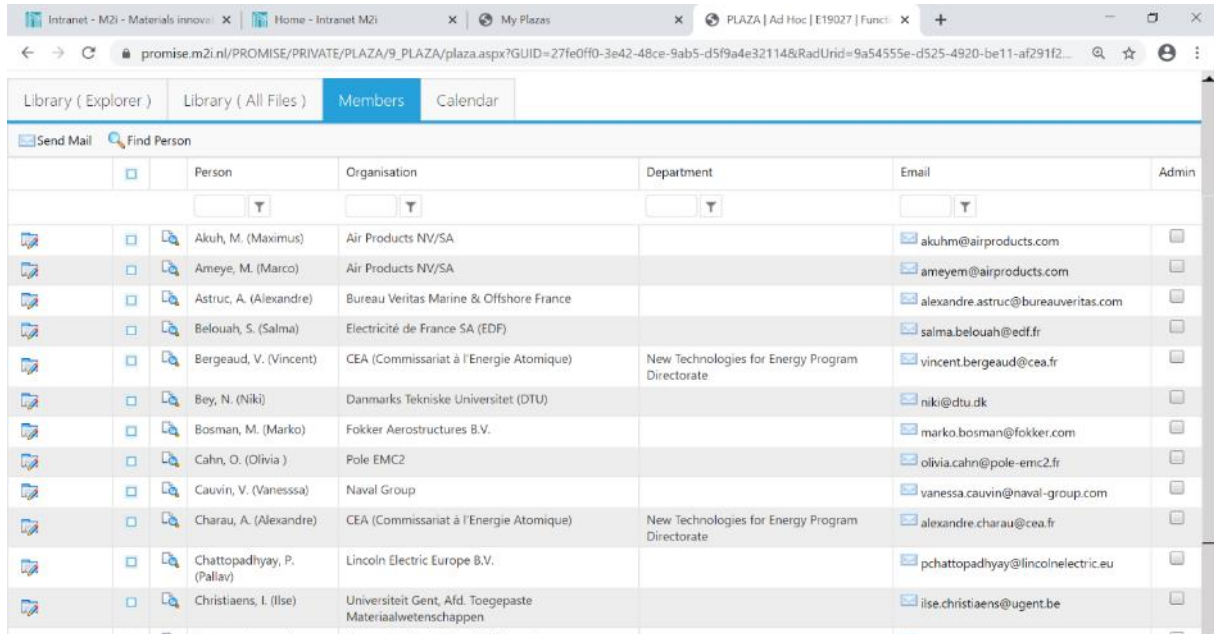
Figure 2. Document uploads on the Plaza (retrieved on 16 April 2020)

Way of working:

- Upload and removal own files is permitted (Library explorer).
- This system does not allow several persons to work on the same file. Therefore, partners were instructed to either send a reviewed version to M2i, either to upload a revision as a new file,

renamed to include their initials and date. M2i ensures that on the Plaza, there is a single version at all times.

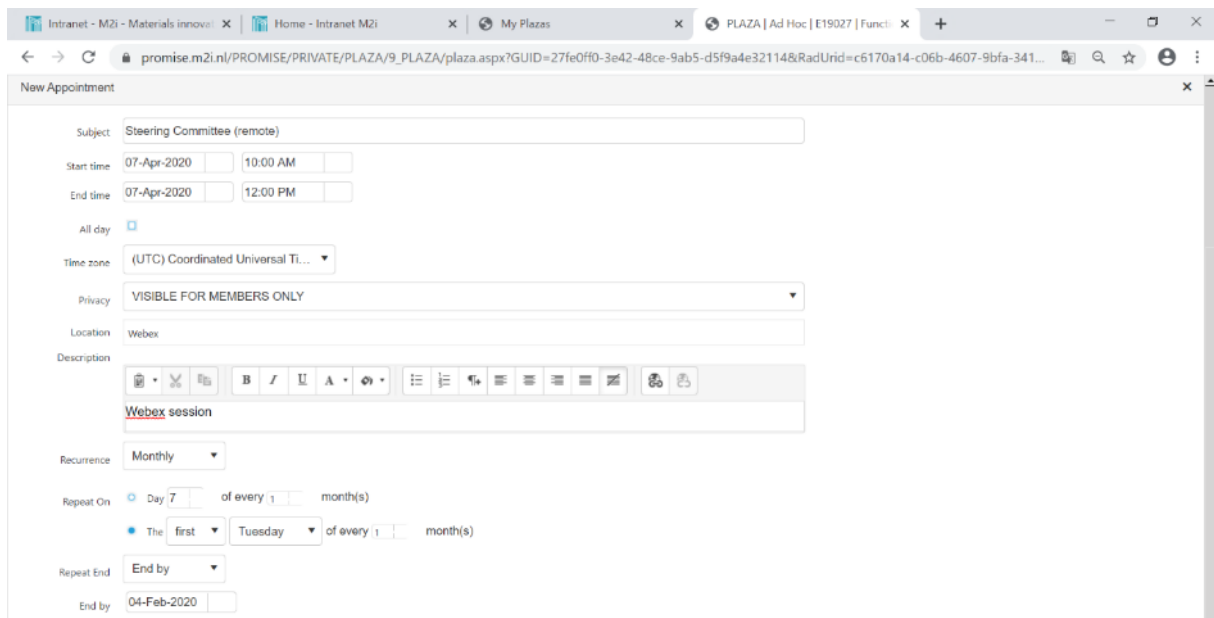
The contacts of the Plaza members are listed on the Members tab. Emails can be sent directly by using the Send Mail function – see **Figure 3**.



	Person	Organisation	Department	Email	Admin
	Akuh, M. (Maximus)	Air Products NV/SA		akuhm@airproducts.com	
	Amey, M. (Marco)	Air Products NV/SA		ameyem@airproducts.com	
	Astruc, A. (Alexandre)	Bureau Veritas Marine & Offshore France		alexandre.astruc@bureauveritas.com	
	Belouah, S. (Salma)	Electricité de France SA (EDF)		salma.belouah@edf.fr	
	Bergeaud, V. (Vincent)	CEA (Commissariat à l'Energie Atomique)	New Technologies for Energy Program Directorate	vincent.bergeaud@cea.fr	
	Bey, N. (Niki)	Danmarks Tekniske Universitet (DTU)		niki@dtu.dk	
	Bosman, M. (Marko)	Fokker Aerostructures B.V.		marko.bosman@fokker.com	
	Cahn, O. (Olivia)	Pole EMC2		olivia.cahn@pole-emc2.fr	
	Cauvin, V. (Vanessa)	Naval Group		vanessa.cauvin@naval-group.com	
	Charau, A. (Alexandre)	CEA (Commissariat à l'Energie Atomique)	New Technologies for Energy Program Directorate	alexandre.charau@cea.fr	
	Chattopadhyay, P. (Pallav)	Lincoln Electric Europe B.V.		pchattopadhyay@lincolnelectric.eu	
	Christiaens, I. (Ise)	Universiteit Gent, Afd. Toegepaste Materiaalwetenschappen		ise.christiaens@ugent.be	

Figure 3. Plaza members (retrieved on 16 April 2020)

The feature Calendar allows setting appointments for all Plaza members, such as steering committee meetings that can be exported to Outlook, see example below:



New Appointment

Subject: Steering Committee (remote)

Start time: 07-Apr-2020 10:00 AM

End time: 07-Apr-2020 12:00 PM

All day: ☐

Time zone: (UTC) Coordinated Universal Time

Privacy: VISIBLE FOR MEMBERS ONLY

Location: Webex

Description: Webex session

Recurrence: Monthly

Repeat On: Day 7 of every 1 month(s)

Repeat End: The first Tuesday of every 1 month(s)

Repeat End: End by

End by: 04-Feb-2020

Figure 4. Calendar feature of the project Plaza

2.1.3. Social networks online

2.1.3.1. Accounts on YouTube, Twitter, LinkedIn

The profiles of Grade2XL on social networks had been created and will be kept alive by EMC2 with information provided by all partners and contents specifically created by EMC2 and M2i.

Accounts were created on YouTube, Twitter and LinkedIn where the number of visits and views can be monitored. These online platforms are complementary. As soon as there is a news or an event of the project, it will be announced on these social media in addition to the project website.

- **YouTube** hosts the videos about the project.
- **Twitter:** To release short breaking news. It can also display photos and videos (from the YouTube platforms). It gathers professional journalists, industrials and a more general audience. It works with a system of followers of account, which is useful to keep professionals posted.
- **LinkedIn:** To release breaking news which should remain short. It can also link towards press articles hosted by this social network or on the project website. It is a platform for professionals where a Grade2XL community can be established. It also gathers corporate accounts and other H2020 projects. It is a dedicated medium to release corporate news such as the vacancies of companies and universities hiring for the project.

2.1.3.2. Contents

Many things are newsworthy for social media. Grade2XL's profile on Twitter and LinkedIn can share different types of information:

- New steps in the project: new steps in demonstrators, materials sent or received, test performed, milestones reached...
- Grade2XL website's articles about the project;
- Project meetings;
- Nice pictures (WAAM process, equipment, the designed parts, samples) – this will bring life, dynamism to the project's accounts. Moreover, visual elements work better on social media;
- Relay of the partner's posts related to the project (major progress, ...);
- The vacancies at the universities (or companies) recruiting for the project;
- New dates of the events related to the project (Design Contests, Experience Days, Roadshow)
- Call for participants to the Roadshow
- Project videos
- ...

2.1.3.3. Process

The partners must contact EMC2 / M2i whenever they have news to share and provide them with the content. For example, when partners meet for any reason, they are invited to take a picture of themselves and send it to EMC2 and/or M2i. It is important to publish frequently to get a positive impact online. Moreover, news should be collected from the partners during Steering Committees or Consortium meetings.

When EMC2 / M2i posts something major about the project, the partners are invited to share it as well on their websites and/or social media.

In order to facilitate the process, there will be a list of contact persons in charge with communication for the project (it can be the current contact or a person from the communication department). There should be one contact person per partner of the project. This list will be made by EMC2.

These contact persons will be in charge of providing the content for new items to EMC2.

In this process, the contact persons have to make sure the information they share with EMC2 / M2i is **not confidential**.

2.1.3.4. *Template to fill in for new items related to the project*

Whenever a partner has a new to share, here is a template to complete with basic information to enable EMC2 to draft a post as accurate as possible.

This list of basic information has to be sent at EMC2 per email: marion.poncet@pole-emc2.fr, maxime.ezequel@pole-emc2.fr

Date	
Location	City, country / Online
Topic	New equipment, tests, article, events...
Your text	Describe the new item. What is the message?
Partners involved	Were there other people/structure present?
Target audience of the post	Researcher, technician, business, policy-makers, general audience
Photo	Yes/No

2.3. Materials

2.1.4. General presentation of the project

A PowerPoint document featuring general information had been created. It is distributed to all partners in a format that enables modifications (.ppt). Thus, each partner has a base that can be adapted according to their needs and preferences to present the project and disseminate it more easily.

2.1.5. Project videos

Two videos. One at the beginning of the project to promote the goals to a wider audience and a second one at the end of the project.

A first introductory video was due to be created and released on YouTube within the first three months of the project start. At the end of the project, a **second, longer video** will be developed to summarize the results in an understandable way, for both specialist and non-specialist audiences.

At the kick-off meeting in Delft on 11-12 March 2020, the partners discussed the prospective content of the movies, as well as the filming locations:

- RAMLAB (also showing the Autodesk container – to be agreed)
- Naval Group
- Arrk Shapers (same town as Naval Group)
- Villeroy & Boch (show how products are made, e.g. bathtub, like in the 'How it is made' series)
- TU Delft to show off research and education efforts.

The final movie would capture the production of demonstrators (filming days spread throughout the project).

Current status: Due to the corona crisis, filming is not possible outside the Netherlands. Currently, no selection of offers has been made, this action is delayed. Three options will be discussed with the

partners at the Steering Committee meeting on June 2. In the meantime, a request for offers will be organised. The following options are currently being considered:

- Option 1: postpone the first movie until travel (and filming) becomes possible abroad and proceed with filming as planned.
- Option 2: make a movie featuring strictly locations in the Netherlands.
- Option 3: make a movie featuring locations in the Netherlands – and add other footage from other locations, once filming becomes possible there. This is likely a more expensive option than Option 1.

2.1.6. Factsheet, posters, kakemono, leaflets and stickers

At M6, a second batch of communication materials will be released by EMC2. It will include:

- A template of email for invitations to events organized by the project.
- A Kakemono (which is a vertical hanging banner) to promote the project at fairs. A Kakemono is a visual support that must remain simple to be eye-catching. Thus, it will feature the project logo, a photo of WAAM and the logos of the partners as well as the EU flag and sentence.
- Project factsheet (one pager): PDF document introducing the project (goals, technology, industrial impacts).
- Three different posters (size 0) to introduce the project. One for scientific event, another targeting industrials and a third for the general audience. They will be complementary enabling thus to be presented altogether at main events where many visual materials are needed to occupy the space.
- A promotional leaflet to be distributed during events featuring the general information as on the other materials.

Stickers for hardware will be designed by EMC2. It will feature the project logo and its baseline as well as the EU flag and the mention of the grant agreement. It will be distributed to all partners during the steering committee of M6.

2.4. Communication tools and materials status

Because of the lock down in March and April 2020 in many European countries due to COVID19, only the release of the initial project video is delayed.

Tool or material	Partners involved	Status
Logo	EMC2	Delivered
Templates	EMC2	Delivered
General Presentation	EMC2	Delivered
Leaflets	EMC2	To be delivered on M6
Posters	EMC2	To be delivered on M6
Stickers	EMC2	To be delivered on M6
Roller-Up/kakemono	EMC2	To be delivered on M6
Website	M2i	Delivered
Social network pages	EMC2	Delivered
1 st video (introductory)	M2i	Delayed because of Covid19 crisis
2 nd video (summarizing results)	M2i	Planned for M48

3. Dissemination of project results

A wide network of multipliers will be contacted, including the companies from supply chains of the Grade2XL partners, national welding societies, toolmakers association, foundries, robot manufacturers, materials suppliers. Furthermore, information on WAAM will be included in the trainings already delivered by current partners and replicate the sessions beyond the project end-date. In Grade2XL, we will consider demands for coaching sessions from all over Europe and expect to reach at least twice as many countries as those represented in the consortium. Webinars will also be considered where the demand is meaningful but in low volume (e.g. less than 10 SMEs per location).

3.1. Dissemination to industrials

3.1.1. Overall of the training and coaching programme for SME

More than 1.000 SME on the continent will be offered the opportunity of witnessing a WAAM prototyping demonstration and receiving coaching to start a WAAM business or equip with a WAAM system. (see « WAAM Experience day », « WAAM Roadshow » and “Adapted Industrial Trainings”)

Synergies will be sought with the network of EIT Manufacturing (of which TU Delft, vaBWG and CEA are partners) to further enlarge the selection base. With Autodesk in the Industrial Advisory Group, we will leverage its customer community and attract media interest.

The coaching sessions during the WAAM Experience Days will be widely advertised through professional networks and associations – such as the International Welding Institute. A wide network of multipliers will be contacted, including the companies from supply chains of the Grade2XL partners, national welding societies, toolmakers association, foundries, robot manufacturers, materials suppliers.

Furthermore, information on WAAM will be included in the trainings already delivered by current partners and replicate the sessions beyond the project end-date. In Grade2XL, we will consider demands for coaching sessions from all over Europe and expect to reach at least twice as many countries as those represented in the consortium. Webinars will also be considered where the demand is meaningful but in low volume (e.g. less than 10 SMEs per location).

A list of industrials is created. The WP7 leader updates it. It aims at enabling an easy and exhaustive involvement of dissemination targets and keeping track of the interactions.

Organization name	Type (SME, mid-cap, large)	Domain (AM techno-providers, industry 4.0 manufacturers (WAAM end-users))	Contact name and position	Contact details (email)	Status (with date of last contact)

3.1.2. WAAM Experience days

This action will ensure the delivery of simple and fast routes for the rollout of WAAM technology in the relevant industrial sectors and promote WAAM as an attractive business opportunity for SMEs.

Objective and targets

The experimentation is the best way to understand the technology and assess its business potential. Due to the low CAPEX involved, we can expect that most of players on the emerging WAAM market will be SMEs. The target audience for this action are therefore SME interested in starting a WAAM

business or in using WAAM for prototyping or for repairing. Large manufacturing companies will also be involved. People expected to attend are process engineers, production engineers. A maximum of two representatives per SME will be selected on a “first come first served” basis, provided that their business has proven relevance with WAAM potential.

Evaluation & follow-up indicators

Participants will be required to register to the event and specify a few information about their expectations of the day and their business. They will be asked sign an attendance sheet so the consortium can report to the EC. At the end of the day, attendees will be asked to answer a “satisfaction survey” so the impact can be measure qualitatively. This feedback would also be extremely useful for the business plans of Valk Welding & RAMLAB (updated market study).

Then, interested companies will be coached one-by-one in a personalized way to build their business case. Interested companies are known thanks to the satisfaction survey done at the end of the experience day.

The key performance indicator for such dissemination event will be the total number of participants compared to the number of companies building a business case and finally investing in WAAM (conversion rate). It is monitored by EMC2 as *WP7 leader*.

Places and organizers

Experience days will occur at five different places. At RAMLAB facilities (Rotterdam area, NL), at Naval Group facilities (Nantes area, FR) and at Valk Welding (Czech Republic, Denmark, France, and the Netherlands).

Organizer	Partners involved	Location	Nb of session*Nb of SMEs = Total
M2i	RAMLAB	Rotterdam, NL	4*50 SMEs = 200 SMEs*
EMC2	Naval Group	Nantes, FR	2*50 SMEs = 100 SMEs
M2i	Valk Welding & RAMLAB	Czech Republic, Denmark, France, Germany	4*30 SMEs = 120 SMEs
M2i	Voestalpine Böhler Welding	application technology center (ATC) in Hamm, Germany.	Additional sessions: 4 times of 30 external people and 4 times of 30 corporate people

*Maybe more sessions with less people in each are more appropriate. The number of 50 companies per session is quite high because it means a big conference room is needed instead of a small meeting room, the demonstration in workshop must be done by two different speakers because the group must be split into two of 25 people, it implies more logistics. So, Experience Days may finally aim to gather 25-30 people and multiply the number of sessions.

Agenda

An experience day is divided into 4 key moments:

1. Technical description
2. Demonstration
3. WAAM business model explanation
4. Individual use-case definition

Appropriate coffee breaks and a lunch will be provided to the participants, to allow opportunity for networking and bilateral exchanges. Within a week after the event took place, one-to-one coaching for financing is offered to interested companies so they are supported until they become early adopters.



Step 0. Welcome introduction

Length: 30min.

Objective: Participants get the basic knowledge about the context (H2020 project Grade2XL) and the agenda of the day is reminded.

1. Welcome word from the host - 5min.
2. Reminder of the context (general project presentation .ppt + video) - 20min.
3. Schedule of the day – 5 min.

Contents used by speaker: PowerPoint presentation + project video.

Step 1. Technical description

Length: 60min.

Objective: SMEs should understand what is possible to realize with the WAAM technology as developed within Grade2XL.

Contents provided to the audience:

- a) What is possible? Design possibilities in terms of shapes, size of parts, materials available, multimaterial capabilities, lead time.
- b) How does it work?
 - a. General knowledge about WAAM (difference with other AM techniques).
 - b. Grade2XL solution: the WAAM cell process.
- c) Manufacturing constraints are explained: multimaterial deposition (supplying), production time (kg/hours), cooling impact on quality of the parts.
- d) What are the necessary equipment? List and define machines such as 6 axes robots, the cooling system for WAAM? The NDT machine. In case of subcontracting (WAAM-as-a-service), what are the preliminary works and equipment necessary? (adapt CAD? specifications ? calculate stiffness do determine material ?).

Contents used by speaker: PowerPoint presentations.

Person responsible (speaker): technical person from RAMLAB or Naval group (engineers).

Step 2. Demonstration

Length: Possibilities will be defined according to the possibilities at each site. The targeted activity is a practical exercise, of approximately 90 minutes so the audience gets familiar with the machines.

Person responsible (speaker): Technical person from RAMLAB, Naval group (engineers).

Objective: Have the participants see and thus experiment the WAAM cells in motion, to help them better understand the process and try to see if it fits in with their own business and shop floor.

Contents provided to the audience: Manufacturing of a part. Explanation of the process. From theory (part 1 Description) to practice (part 2 Demonstration).

2 possibilities:

- Option a) Usual parts produced (to be discussed with RAMLAB) possibility to keep production that was already planned for that very day.
- Option b) Parts of a participating SME (from its own CAD) are produced.

The demo case should be representative of the capabilities of the technology: complex shape, multimaterial etc. What will be showed should convince the participants to adopt the technology. The ideal demo part is to be discussed with engineers. The part produced should be ready in a few hours: it must fit within the experience day length.

Contents used by speaker: hardware and software of the WAAM cell in the experience centre, knowledge of the speaker.

Step 3. Business Model explanation

Length: 90min (60 min about the 8 use-cases + 30 min on economical facts)

Objective: Participants get info on WAAM business model, so they are then able to determine their relevant use-case.

Contents provided to the audience:

The ways to access to WAAM manufacturing is described:

- WAAM-as-a-service at RAMLAB facilities.
- Buying complete cell from Valk Welding.

The interest for Grade2XL-WAAM solution of the eight use-case are detailed. It shows the accuracy of this manufacturing technology on a business perspective. The industrial use-cases are also reassuring and enable a positive feeling of emulation.

A generic timeline for manufacturing within the global Grade2XL schedule is given, so that the participants get an idea of the schedule for their own production with WAAM technique.

For **example:**

2023				2024				2025				2026				2027			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Grey: Operational prototype WAAM Cell available at RAMLAB for WAAM-as-a-service

Navy Blue: TRL9 WAAM Cell available on the market

Obviously, it also depends on the results of the research carried out during the project and of the need of the potential user. A straightforward part (bulk, monomaterial) may take much less to execute. So this timeline and scheduling will be discussed with engineers and researchers in due time.

Return-On-Investment (ROI): basic info is given so the audience knows the criteria on which calculate their ROI when adopting WAAM.

Financing tools available such as grants and loans are introduced e.g. support by BPI France, regions, Digital Innovation Hub (DIH), EC funding, EIT Manufacturing, etc. Each Grade2XL partner will investigate funding instruments in its countries on Q1 2023 to provide the info that will be integrated to the *Experience Day* PowerPoint presentation which could help SME to adopt the technology.

Step 4. Use-case definition

Length: 90min (60min of BM drafting + 30min of feedbacks)

Objective: Participants determine their relevant use-case and understand how WAAM as offered by Grade2XL meets their requirements. First data about budget/investment is drafted, so the ROI appears interesting to the companies.

Contents provided to the audience: A questionnaire is provided to help the company to precise its use-case and determine how WAAM as offered by Grade2XL should be the most relevant. First technical constraints can be identified. The audience fills the form.

This questionnaire could be an enhanced "BM canvas". How to ensure that an accurate and usable business model is created? The speaker(s) should support each participant.

This would be done in two steps: firstly, description of the technical use-case in itself, secondly, definition of the use-case from a business perspective (putting figures on the technical use-case previously described), cost estimates, revenues forecasts.

Person responsible (speaker): Maxime (EMC2), Viktoria (M2i), Vincent (RAMLAB), Peter at (Valk Welding)

Contents used by speaker: PowerPoint presentation, Questionnaire

Focus on **The satisfaction survey**

Audience that attends the day **should answer a “satisfaction survey”** at the end of the day so the impact can be measured qualitatively. This feedback would also be extremely useful for the business plans of Valk & RAMLAB (i.e. updated market study).

Although the contents of such survey are to be defined, see below some examples of questions:

1 - Do you foresee a use-case in your company for Grade2XL solution?

1.a - If yes: describe.

- How many kg/ hour?
- Dimension of part.
- Tact time.
- Which metals or alloys?
- Etc.

1.b - If not: what prevent you to use this technology?

2 - What in the Grade2XL solution are you interested in:

- Multimaterial.
- Cooling capabilities
- Large parts.
- Design of part: complex shapes.
- Quality of NDT solution.

3 - Are you interested in a further coaching service from the Grade2XL partners to investigate the funding possibility for your company? Yes/No + Contacts details.

Next step: One-to-one coaching for financing

Objective: Transforming the use-case in a business case enabling to invest, in order for the company to become an early-adopter of Grade2XL solution (exploitation of results)

Contents provided: Personalized support

Person responsible: Maxime of EMC2. Perhaps external companies such as innovation consultancies in support. Maybe, in the future, the DIH orchestrators could play this role.

Contents used by speaker:

- The BM as draft during experience day
- ROI calculation form
- Technical feedback from RAMLAB/Valk
- Template for project proposal (EUcalls for SMEs for demonstration projects or loans from public innovation banks).

3.1.3. WAAM Roadshow

The Roadshow is based on the same principle of the Experience Days but is the mobile WAAM system to reach others area and SMEs that would not travel to one of the 5 facilities in Europe offering Experience Days.

Using a mobile WAAM system, prototyping and coaching sessions will be delivered at any other location in Europe. EMC2 and M2i will lead the selection of SMEs to receive coaching, by reaching out to both their national and European networks, including the clusters dedicated to advanced manufacturing technologies (such as Produtech Portugal, TCS Tools Slovenia, Manufacturías Spain, Smart Industry Netherlands and incubators, to ensure a wide geographical coverage).



Figure 6. Example of a mobile WAAM system (developed by Valk Welding and owned by Autodesk): shown during transportation (left); installed and ready for operation (centre) and during operation (right).

Organizer	Partners involved	Location	Nb of session*Nb of SMEs= Total
RAMLAB/ TU Delft	EMC2	Italy, Spain, Greece, Portugal	4* 30 SMEs = 120 SMEs
RAMLAB/ NavalGroup	According to the occasion	On demand , any location	4*15 SMEs = 60 SMEs

Voestalpine Böhler Welding volunteered to join the Roadshow team. They offered to participate to the explanations. Their engineers could for instance contribute on topics such as basics on the materials used in AM:

- impact of heat input and temperature control on the material metallurgy,
- mechanical technological data
- material selection and optimization.


3.1.4. Adapted Industrial Trainings

Adapted industrial trainings aim at creating more awareness about WAAM and making people consider using WAAM in their production processes. It targets people with a little background in welding-process. Valk Welding involves dedicated experienced people giving training in robot programming.

Valk Welding will organize trainings at Alblasterdam in the Netherlands with the objective of reaching 480 SMEs. It is initially planned to be divided into 40 trainings per year during 4 years with trainees from 3 different SMEs at each session. Valk Welding will contact the SMEs through its newsletter and through the industrial exhibitions the company takes part in. Besides, the company will spread the news about WAAM among its sales-engineers throughout Europe so they can contact the customers in their region which could be interested in this process. The company will also spend a part of its regular programming-trainings, which they give to all their customers, to instruct about WAAM. Herewith they would spread widely the knowledge about WAAM.

The trainings will be split into two parts: a theoretical one and a practical one. The theoretical training consists on an explanation of the possibilities of the WAAM process. This theoretical part teaches the WAAM principles, when it is interesting to use it and for which kinds of parts. The practical part teaches how to generate a robot-program for making a WAAM-part. As indicator, there won't be final test (so the trainees are not frightened with some sort of exam to pass). If the trainees are convinced that WAAM is a serious alternative for other production methods, the training is considered as a success.

Valk Welding will contact the SMEs through its newsletter and through the industrial exhibitions the company takes part in. Besides, the company will spread the news about WAAM among its sales-engineers throughout Europe so they can contact the customers in their region which could be



interested in this process. The company will also spent a part of its regular programming-trainings which they give to all their customers to explain about WAAM. Herewith, it will spread widely the knowledge about WAAM.

The premises in Alblasserdam consist of several buildings that are particularly appropriate to organise industrial trainings featuring Assembly halls, Warehouses for welding wire, a training centre of 360 sqm and classrooms of 90 sqm as well as a demo centre of 360sqm. In addition, Alblasserdam facility lays in the industrial heart of Holland, close to Rotterdam and close to RAMLAB. Alblasserdam is surrounded with all kinds of metal industries. The premises are located directly at the highway A-15 and therefore easy reachable by car, train or from the airport.

3.1.5. Training of professionals

Courses for training of professionals will be crafted having in mind the skills needed for the future engineers operating robotic WAAM machines. RAMLAB and Naval Group will guide the content of these courses. The International Welding Institute and other professional associations, such as the European Welding Federation will be involved in the development of the course providing contents.

All this with the intention to organise further trainings during and after the project. The course content will remain dynamic to incorporate new developments in the technology and will serve as a tool to re-educate the welding professionals in the spirit of WAAM.

These courses for WAAM professionals will be organised by TU Delft with the support of the International Institute of Welding (IIW) and the European Welding Federation – through links via the national welding institutes. This training is facilitated by having key members of our team in leading positions at the International Welding Institute.

Grade2XL consortium will also liaise with other AM projects and initiatives to ensure a good fit with the needs for AM workforce development at European level: Made in Europe (EIT Manufacturing, the I4MS project, the AM-platform (via M2i), CECIMO (via Valk Welding) and the TMS Materials Societies (via TU Delft). The aim is to create synergies and reach a critical mass of welding engineers and professionals who are trained on WAAM.

The training would go on the AM and specifically WAAM topic. This is typically of interest for manufacturing schools for instance.

The targeting audience for this training is:

- The European Welding Federation
- Manufacturing schools
- National welding institutes
- Certifications bodies
- Designers (how to incorporate Graded WAAM into the design aspects)
- Software developers: tool path generation

It concerns the operators level as well as the European welding engineers level.

Training program would deal with the following topics:

- Naval & RAMLAB would emerge as trainers.
- Robotic deposition
- WAAM process (printing strategies, heating & cooling as well as NDT)
- NDT as specific topic
- Design aspects



The training will be offered in a compact version of four hours and a more extended version up to 40 hours.

The length of the course would depend on

- a) Level of knowledge to be reached (from general introduction to detailed information)
- b) The background / entry level of the participants at the beginning of the training

The training will be dealing with both **theoretical aspects and manufacturing-applied aspects**. Training and coaching by manufacturers (Naval Group & Valk Welding) could show their welding capacity. These players are members of Grade2XL consortium. They have extensive experience in welding. An academic partner (TU Delft) would add scientific knowledge.

The outcome could be some sort of presentation in combination with supplementary document (featuring comments remarks) about **the entire flexible manufacturing system** or on **specific functions of the system** (hardware, software).

Such training would be a perfect base that could be adapted by Valk Welding for **maintenance training** to prepare their clients to use and maintain their Grade2XL installation. The aforementioned presentation would be used in addition to Valk Welding's tailor-made content for Adapted Industrial Training (see dedicated paragraph).

Emerging business to be investigated: A possible new business could emerge from Grade2XL. It would concern the "training industry". **On-site training on WAAM** could be envisaged. Typical welding schools could extend their activities towards WAAM. Personnel can be certified by the teaching programs approved by the national Welding Institutes. It could be performed by RAMLAB (as future owners of the state of the art). This is not in the core-business of the company. There is no business unit on "training to professionals" and not even anything planned in this direction. It remains an idea at this step. It will be discussed with RAMLAB later. Because it is not in their strategy at the moment (see business case in the Exploitation part). Nevertheless, RAMLAB and also Naval Group are open to explore the idea of organising professional trainings after the project is ended.

Focus on [the platform](#) of the European Welding Federation

- Promotion platform. A topic is dedicated to Additive Manufacturing. 20 competences are listed. They mention certification of personal. Guideline on arc welding, on laser cladding etc. Grading of parts could be discussed within this event. Both with industrial and academic participants.
- Related European projects [are listed](#) (with links on the Cordis website).
- Training & certification platform. It should design programmes for certification of personnel. Grade2XL would contribute to this platform. TU Delft will contact EWF via the national welding institute, to promote Grade2XL with the objective of creating a programme available for education (by M6). A set of presentations could be sent, as input for the training programme of these organisations.
The training is based on the concept of "Competences units". It features 40 hours on AM. Grade2XL may contribute by adding a competence on grading structures. The content will include a presentation on the current capabilities of WAAM, after which will introduce grading and its potential in terms of materials and cost savings - as well as on the process requirements and possible adaptations of current hardware.

Focus on policy making platform: [the European Technology Platform in Additive Manufacturing](#)
Currently, the community appears to be less active, most probably due to the COVID-19 crisis. M2i, who is leading the policy-making actions within WP 7, will liaise with the persons in charge and will investigate the options to link and promote Grade2XL on this platform (by M12).

Many Grade2XL partners are also members of this platforms, the others will again be encouraged to register.

Focus on Training of certification companies (classification societies such as Bureau Veritas, DNV GL and Lloyd's Register)

Certification is given by the classification societies to the industrial users of WAAM. The certification procedures for WAAM are only recently developed and could be further adapted, to reflect the developments in the field, for example emerging topics such as NDT applied to WAAM. For example, if a system is equipped with an NDT equipment, the operator should have certification on NDT.

The certifying bodies could attend trainings to learn the possibilities of the technology. The trainings would enable them to further train their own inspection staff.

Bureau Veritas (BV) and DNV GL are classification societies involved in Grade2XL, one as partner, also leading a work package on certification, the other one as member of the Industrial Advisory Group. Training possibilities for such organisations will be investigated by EMC2 with BV directly and, if interest is found, it will be confirmed by talks with DNV GL during the first IAG meeting.

3.2. Dissemination to academia and scientists

3.1.6. Scientific Papers for conferences and articles in peer-reviewed journals

The consortium estimates a number of at least **33 scientific publications** generated by the research partners: TU Delft, UGent, PWR, DTU, CEA and M2i.

The criteria for the selection of the scientific journals are: *i) Open access* (using the gold or green access model); *ii) high impact* journal; *iii) minimum delays* for publication, to ensure the real time dissemination of the research results.

A selection of the scientific and technical journals and conferences considered by the Grade2XL partners is presented in the following table, per target group.

Table 2. Selection of relevant journals and events, per target group

Target group: materials and process scientists, researchers, engineers in training.	
Scientific journals	Scientific conferences
<ul style="list-style-type: none"> • Acta Materialia (open access) • Materials and Design (open access) • Metals (open access) • Metallurgical and materials transactions • Materials Characterisation • Materials Science and Engineering • Journal of Materials processing technology • Journal of Advanced manufacturing processes • Additive Manufacturing • Materials and Design • Journal of Industrial Ecology 	<ul style="list-style-type: none"> • EUROMAT congress (every two years) • THERMEC (every 2-3 years) • TMS annual meeting • Materials Science & Technology • International Conference in Advances in Materials and Processing Technologies AMPT • International Institute of Welding annual congress and assembly • Conference of the International Society for Industrial Ecology (ISIE) – bi-annual • Circular economy
Target group: welding professionals, process technologists, automation engineers.	
Technical journals	Conferences and fairs
<ul style="list-style-type: none"> • The Netherlands: TechniShow Magazine (issued by fpt vimag¹); Metallerie; Lastetechniek; Metaal & Techniek; Metaal Nieuws; Vraag & Aanbod; Metaalmagazine; Vision & Robotics; Metaalvak. • Belgium: Metallerie; Vraag & AanBod; Metaalinfo; Metaalvak. • France: Tolerie; Soudage et techniques connexes; Metal industries; Journal de la production; L'usine nouvelle; ETMM, A3DM magazine. • Germany: BRP Umformtechnik; Der Praktiker; Schweissen und Schneiden; Robotik und Produktion Blech. • Denmark: Teknovation; Jern og maskin. 	<ul style="list-style-type: none"> • International: IIW Conference (annual event); EUROFORGE Conference & Fair (annual event); ManuFuture Conference (annual event) • The Netherlands: TechniShow; TIV Hardenberg; Metavak 2019 • Belgium: Welding Week. • France: Industrie Paris; Sepem Industries, ICWAM. • Germany: Hannover Messe; Schweissen & Schneiden. • Denmark: HI Industri Herning. • Czech Republic: MSV Brno.

¹ Fpt vimag – Federatie Productietechnologie, member of the European Association of the Machine Tool Industries and related Manufacturing Technologies (CECIMO). Valk Welding is a member of Fpt vimag.

We estimate the following breakdown per scientific partner. The actual distribution per partner or per type of paper (journal/conference proceedings) may differ; however, the total number will be met or exceeded.

TU Delft	4 PhD x 2 journal papers (mandatory)	8
UGent	2 PhD x 2 journal papers (mandatory) + 4 conference proceedings	8
M2i	2 papers on the TO model, probably at conferences	2
DTU	2 PhD x 2 papers + 1 conference proceedings	5
PWR	2 PhD x 2 papers or conference proceedings	4
CEA	Considering the novelty of the application of NDT to WAAM	6
TOTAL		33

3.1.7. Concluding Conference

In 2024, a **concluding conference** will be organized for Grade2XL and have its proceedings published in a high-impact journal. The conference will be organised as a side event at an established AM event (such as the IIW conference) and with its proceeding published in a high-impact journal.

The conference will also host tailored events for SMEs and industry (including an exhibition displaying the prototypes of the project), which will give the industry the possibility to witness the developments and discuss ways to contribute to the uptake of WAAM innovations in their businesses.

3.1.8. M2I design contest

The automate features of WAAM and its endless design freedom make it a very interesting technology for young engineers, both in academia and industry. During its annual conference Meeting Materials (the largest materials event in Benelux, with a tradition of over 20 years), M2i will organise an **Open design contest for young engineers**, challenging them to design a novel WAAM product. The following criteria will shape the selection process:

- Novelty: new Geometry, impossible to manufacture with conventional processes
- Functionally graded: showing added value of multimaterial composition i.e. different properties at different locations
- Purpose: the design should be intended for a real engineering application.

The academic participants (MSc, PhD students or postDocs) will be incentivised by the possibility to build a full-scale prototype to enrich their portfolio, whereas the young industrial engineers may get the chance to convince their management to consider WAAM as alternative production method.

The contest will be organised annually during the project, launching a new tradition. The upcoming M2i conference will take place on 14-15 December 2020. The conference takes place annually on the second Monday and Tuesday in December.

For the avoidance of doubt, “Young” means younger than 35 years at the date of the M2i conference.

3.1.9. Scientific lectures for engineers in training

Undergraduate students of the academic project partner will be reached through lectures and seminars on multimaterial WAAM. The participating universities and research centres (TU Delft, U. Gent, PWR) will develop dedicated scientific contents, also suitable for online training. Technical schools (School of Applied Sciences Utrecht, Ecole Centrale de Nantes for example) will be invited to implement the course. The impact will be multiplied via the involvement of the Grade2XL scientists in the activities of the TMS committee on materials and the International Institute of Welding.

Information on WAAM processes, materials and applicability will be added to existing curricula at the university partners (as pilot). The networks of the EIT Manufacturing will be used to roll-out the pilot training to other universities in Europe – Starting with the university partners of EIT Manufacturing.

3.3. Dissemination to decision makers

3.1.10. Position papers

Position papers goal is to foster and accelerate the emergence of the European WAAM supply chain in Europe. Position papers will be prepared by the coordinator M2i and disseminated to European and national policy makers.

Although the position papers will be issued towards the end of the project, taking into account the lessons learnt and the needs for further public research funding throughout the value chain, the consortium will start early by discussing relevant calls and funding mechanisms at every Steering Committee meeting, seizing early the opportunity to acquire additional funding for exploitation activities.

Many partners are already part of the most relevant lobby group – the AM Platform, www.rm-platform.com, and thus aware and/or participating to major consultations and events on AM topics. We will seek to establish a closer link to this platform, in view of further exchanges with other EU-funded projects on the topic.

3.4. Dissemination to general audience

3.1.11. Press releases

Obviously, each partner is encouraged to make available to its network of journalists its own press release during project lifespan and to try to give interviews about Grade2XL challenges and achievements.

The foreseen releases are expected:

1. At the beginning of the project
2. at the beginning of the experience days and/or roadshow tour
3. at the end of the project for the concluding conference to launch the exploitation activities to be carried out after the project lifespan.

For example, at EMC2, a master plan of communication was established in the beginning of 2020. It deals with the cluster strategy and is meant to highlight the realizations to reach the objectives set up for 2025. The publishing is scheduled in a planning. A process describes how to reach each kind of audience targeted. Grade2XL is obviously a main piece to be talked about e.g. a first article about Grade2XL was published on the website on May 2020.

If partners of Grade2XL wish to establish the same kind of plan, they can ask EMC2 for advice.

3.5. Dissemination action planned/realised

The follow-up of the actions realised will be done by EMC2 as WP leader. A questionnaire will be sent to all partners every 6 months to update the following table.

Date	Name of the event	Location of the event ("city, country" or "online")	Type of action (article published, speech at conference, booth at fair, etc)	Partners involved	Type of audience (research, business, policy-makers) Domain of the audience (materials, welding, manufacturing)	Audience quantity (nb of readers, number of companies present)

4. Exploitation

4.1. Approach

4.1.1. Strategy

The targeted impact is a breakthrough in the development of WAAM for high throughput (up to 10 kg/h) multimaterial deposition, leading to graded products of superior quality with minimum use of expensive materials (TRL 4-6). As next steps (TRL 6-9), the technology will be optimised from a cost perspective and WAAM modular equipment will enter the market by 2026.

All the value chain to deliver innovation is represented in the consortium of Grade2XL. The **end-users** (MAN ES, EDF, Villeroy&Boch, GKN, Arrk, Gorenje, Kuźnia Jawor) will directly implement the technology to the products used as demonstrators. The scientific innovations stemming from related projects (such as AiM2XL) will be exploited by all project partners. **Research institutes and universities** (CEA, TU Delft, UGent, PWr, M2i) will exploit their IP through further research, on optimising grading strategies or exploring new materials combinations for WAAM. **Service providers** (RAMLAB, Naval Group) will be able to cater to a wider market, based on the experience built up with the challenging selection of Grade2XL application cases. **Equipment and software vendors** (Valk Welding, Air Products, RAMLAB) will directly implement the innovations in new, customised WAAM hardware and software – to enter the market within two years of the project's end. **Materials producers** (vaBWG, LSW) will optimise the WAAM wire materials (currently under development) and liaise with BV to prequalify these wires for the entire range of Grade2XL applications – thus accelerating their market entry.

4.1.2. Exploitt Methodology

Grade2XL implements the EXPLOITT methodology for industrial exploitation and take-up designed for H2020 project. It was created under the H2020-FoF-Focus project.

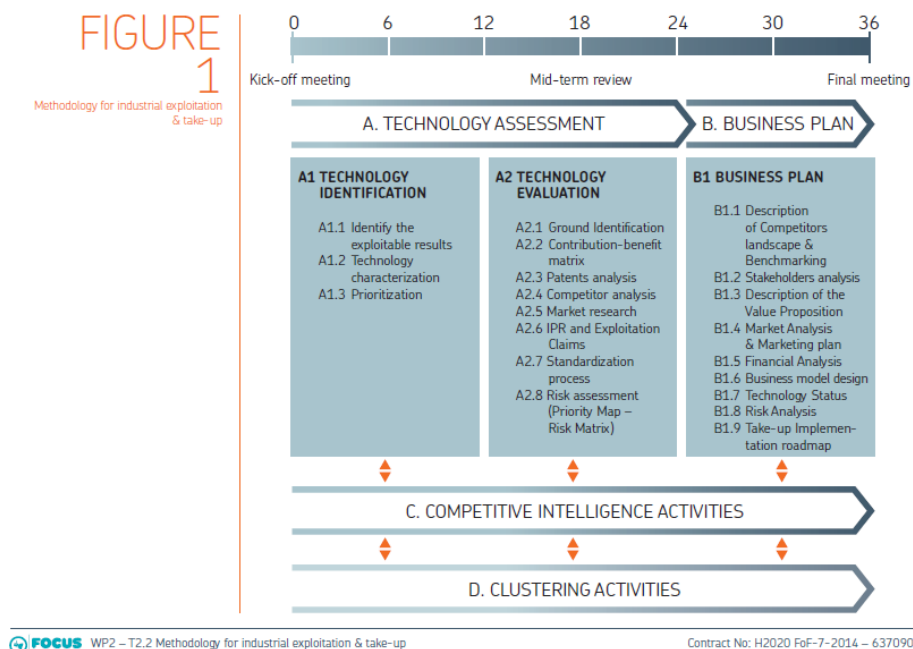



Figure 7. Exploitt Methodology



The first step is the technology identification. The exploitable results and potential products are already identified on M3. The business cases without confidential information are detailed in this document.

4.2. IP strategy

Given the type of action (IA) requiring freedom to explore the market opportunities, the consortium strives to ensure an optimum management of the ownership and access to key knowledge (data, IP). The strategy and actions are presented below.

4.1.2.1. A. *Strategy for IP management and protection*

The objectives of Grade2XL are fully compliant with the innovation strategies of the involved organisations. The project tasks are integrated in their business strategies, ensuring an effective use of the project results in their respective business and research activities. The strategy for knowledge management and protection includes the following elements:

Background (pre-existing knowledge needed for the project): background is made available on transfer conditions to the partner(s) who need it for the execution of their task in the project. Full, royalty-free access to the background knowledge as required by the project tasks is made available to the project partners during the project and as reasonably necessary after the project for the appropriate implementation of exploitation measures. The providing partner will give access to their background based on non-disclosure agreements signed with the receiving partner(s). The partners are making an exhaustive overview of the background related to the project provided in the annexes of the Consortium Agreement. A preliminary assessment revealed the following relevant background, which will be shared with the relevant partners for the duration of the project:

- **Super-Active Wire Feed Process (S-AWP)** is applied in Grade2XL to achieve high throughput WAAM deposition. S-AWP was invented by Panasonic and further developed by Valk Welding for arc welding processes (under a licensing agreement with Panasonic).
- **Prototype WAAM wires** developed by the materials companies vaBWG and LSW are tested in the project. New wires may need to be developed to meet the requirements for WAAM grading.
- **A “clamping device”**, i.e. a flexible system to clamp round parts, has been designed by Valk Welding (Dutch patent pending, application number N2021374) – for arc welding applications. This device will be manufactured and integrated in the WAAM production line and enable a controlled manipulation of cylindrical parts.
- **Monitoring and control software:** it was developed by RAMLAB to control the deposit rate, temperature. The control system (including sensor technology, logging and feed forward control) is protected by copyright. The software is further developed in Grade2XL to handle multimaterial deposition and allow detection of defects by laser ultrasonic scan.
- **Monitoring and NDT:** CEA has developed advanced ultrasonic testing for the control of complex components through UT phased array technologies and on-line X-ray fluorescence (XRF) analysis systems for production controls. CEA has also been developing laser ultrasonic testing compatible with *in situ*, real time monitoring in the framework of the project I-AM-SURE (2016-2019). These technologies are evaluated in Grade2XL. Advanced data analysis with the CIVA software developed by CEA will also be used for complex multi-parameters correlation analysis.



Foreground (results generated by the project): the partner who generated the results shall own the foreground. Each partner is responsible for taking appropriate measures to secure the intellectual property resulted from the project (e.g. filing of patent applications). Each partner owning a specific result shall be free to exploit it. In case of joint ownership of results (where two or more partners have contributed to a specific result), the owners shall conclude dedicated agreements covering the allocation and the exploitation of their joint ownership. The partners concerned must inform the Coordinator and the European Commission with regard to patent applications for the IP generated during the project. Several innovations are expected to be generated by the project and exploited by the industrial partners through direct application and/or commercialisation:

- **Hardware innovations:** multi-wire deposition (simultaneous and sequential); smart shielding device; new S-AWP torches; special wires – will be covered by patents and commercialised;
- **Software innovations:** monitoring and control software for multimaterial WAAM processes – will be commercialised by RAMLAB;
- **New product designs:** a new, more efficient propeller blade design (MAN ES) and the injection moulding die with conformal cooling (Arrk Shapers) – will make the subject of patent applications.

Access rights to Background and Foreground shall be free of charge for the partners of the consortium, for research and development purposes within the scope and the duration of the project. Beyond the project, access rights to results owned by one or more of the partners shall be granted on fair and reasonable conditions and to the extent necessary to enable these partners to exploit their own results. For this purpose, the involved partners may decide to conclude special agreements.

Access to data: All data resulting from the project will be owned by the partner(s) who generated it. The data will be shared among the consortium free-of-charge using the project workspace (Plaza) as sharing platform. The partners will not be authorised to share the data outside the consortium, unless an explicit authorisation is sought and granted by the relevant partners. Open access to the data will not be provided to the public, due to the need to protect novel findings leading to ground-breaking innovations.

Third party rights: The results of a preliminary patent search confirmed freedom to operate for the Grade2XL consortium, extended patent search is to be carried out as described below.

Publication of non-confidential results will be carried out via high impact scientific journals, conference proceedings, project website, etc. If there is no intention to patent, the results are to be exploited through publication in open access journals, preferably using the gold model (immediate access). Publishing will allow the involved institutes to publish their scientific advances and gain a top position in the scientific community. The consortium will follow strictly an internal publication procedure: concept texts of publications must be submitted to all partners together with a request for permission to publish. If no objection is raised within a period of one month of the request, tacit approval is assumed. In case of objections, the involved partners shall discuss how to overcome the justified grounds for the objection, on a timely basis. An objecting partner shall not unreasonably continue the opposition if appropriate actions are performed following the discussion.

The **Innovation Committee** led by the Exploitation manager will discuss patentable results and agree whether patenting is the most suitable strategy. The participating research institutes may use knowledge or results from the project that have either been published or classified as publishable –



only for research and teaching purposes. The project website will also include an overview of all published information.

4.1.2.2. B. Consortium Agreement

The partners had concluded a Consortium Agreement based on the DESCA Horizon 2020 model Consortium Agreement addressing the following aspects:

- a) background;
- b) foreground and (joint) ownership and transfer of results;
- c) access rights;
- d) publications and procedures for the dissemination of results.

4.3. Prior Right Search

An Extended Patent Search will be performed in order to ensure the freedom-to-operate. The exploitation manager will conduct the extended patent search every six months (in Task 7.2) that will be carried out by a contracted professional.

If conflicts do arise and competing technology evolves, we will act fast and negotiate licensing with the party holding the relevant IP.

The fields of search for the first search will be set at the Steering committee, on the 2nd of June 2020.

4.4. Business-cases

AM technology based on powder deposition is reaching saturation in terms of applications, whereas WAAM has the biggest growth potential, especially for large engineering structures, ubiquitous in our built environment. With Grade2XL, we will harness the powers of WAAM to produce multi-material, superior quality products at low cost and deliver a unique and complete offering to the European markets:

1. **WAAM-as-a-service** – offered by RAMLAB and Naval Group during and after the project to any end-user and more than 1.000 European SMEs;
2. **WAAM equipment** – including WAAM (multimaterial) robotic deposition equipment offered by Valk Welding and cryogenic cooling equipment, marketed by Air Products;
3. **WAAM wire materials** – offered by vaBWG and LSW, as well as by Valk Welding;
4. **WAAM graded products (demonstrators)** – followed by technology roll-out within the companies of the involved end-users (MAN ES, EDF, Villeroy&Boch, GKN, Arrk Shapers, Gorenje, Kuźnia Jawor) to unlock massive financial and material savings.

These developments will give the industrial partners in the consortium an immense competitive edge over the competitors, which will translate into a market leadership position for at least a decade to come.

4.1.3. WAAM-as-a-service.

4.1.3.1. The offering and target market:

The market can be split in two macro areas: manufacturing of new products (including spare parts) and repair of existing ones. Both of them are enormously relevant to Grade2XL and almost unbounded.

WAAM print-on-demand of new products (including spare parts): New designs are achievable WAAM graded structures, because WAAM opens new ways of manufacturing versus conventional processes. Furthermore, a better material quality can be achieved with WAAM, with fewer defects than in cast parts.

The business of making, storing, and shipping spare parts has long been a source of time-consuming and costly difficulties for suppliers of spare parts as well as for their customers. Maintaining inventories

of infrequently ordered parts is so expensive that suppliers often simply stop offering them. At the same time, sourcing spare parts have become extremely expensive and complicated for the customers. In this respect, additive manufacturing has made a radical difference, for at least three reasons: firstly, it improves the short-term availability of spare parts; second, small-lot sizes of spare parts can be produced economically; third, it facilitates the overall logistics of the spare parts business. A simple yet impactful example is the one of Oil & Gas: extraction often happens in remote places and shipping spare part can be expensive and time consuming. Setting up additive manufacturing infrastructures nearby the production/processing sites allows parts to be replaced (and at times even redesigned) more quickly and directly on site. The market of 3D printed metal parts has already surpassed 1 Bn€ per year².

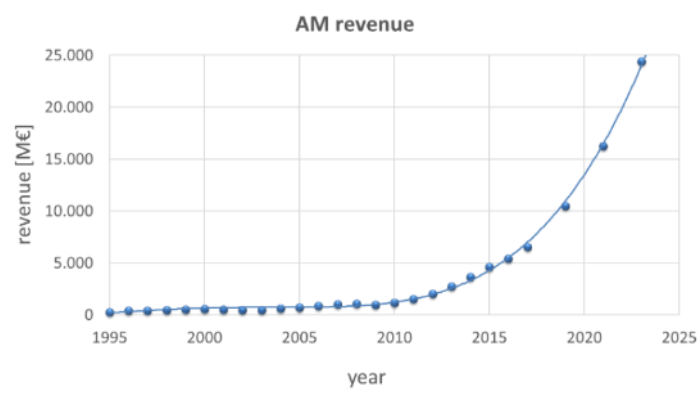
Repair: The repair of moulds and dies is a **100+ billion dollar market**³, largely untapped. In some domains assets that are undergoing reparation cause enormous losses to the companies owning them. SMEs are at the core of the commercial offer for WAAM services offered by RAMLAB, whereas Naval Group is mainly focused on large marine and energy contractors. RAMLAB will become a hub for technology transfer, printing WAAM products on demand for any interested end-user in Europe (and later worldwide).

WAAM prototyping and coaching service offered during the WAAM Experience Days at the locations of RAMLAB (NL), Valk Welding (NL, DK, CZ, FR) and Naval Group (FR) – as well as during the WAAM Roadshow. This service will be offered within the scope of the project, during its second half. Small companies will use it for small-scale productions and prototyping purposes; larger companies can use it to get acquainted with the technology in order to decide whether to purchase directly a Grade2XL WAAM machine from 2027 onwards (supplied by Valk Welding). The service will breaking even operatively and will be used to introduce WAAM to potential users.

WAAM print-on-demand and WAAM repair service offered by RAMLAB and Naval Group (after the project) to companies who do not want to buy or use a machine.

4.1.3.2. Market overview: size and trends, competition

The market for AM is highly dynamic. According to the Wohlers report (see figure below), the value of the total AM industries (products and services) is currently valued at 6,27 Billion euros (2017) and is estimated to increase at a CAGR of 45% by 2023 to go beyond 23,32 Billion euro by 2023 (before the end of the Grade2XL project). Whereas the market for powder-based AM is saturating, WAAM still has a tremendous potential, due to its unparalleled capability to produce large structures in record times by transferring key concepts from welding, a well-known technology. Nowadays only companies producing WAAM machines also offer WAAM services, but limited to proof of concept for prospective



² <https://www.strategyand.pwc.com/report/future-spare-parts-3d>

³ https://www.researchgate.net/publication/257298410_Causes_of_Failure_and_Repairing_Options_for_Dies_and_Molds_A_Review

clients in order to convince them to purchase the service. This is the strategy chosen by Gefertec or WAAM3D, for instance. Other companies offer WAAM services for very specific purposes and with significant technical limitations: an example is DG Weld (Italy), which is specialised in the repair of dies and has non-autonomous welding systems that are limited in yield and require the constant presence of humans.

Figure 8. Expected growth rate of the total Additive Manufacturing market (source: Wohlers report, 2018)

4.1.3.3. Business model and estimated revenues

The business model for “WAAM as a service” is relatively simple: the customers provide companies like RAMLAB or Naval Group with technical specifications and drawings of the parts that need to be manufactured, and they use their facilities and personnel to produce them. Unlike RAMLAB, who caters to a wide spectrum of customers, Naval Group is focused on acquiring a smaller number of large contracts with naval shipyards and energy operators for a complete, long-term WAAM offering, including repair and manufacture of spare parts on demand.

We have calculated the prices and lead times for five use cases related to the application domains considered in the Grade2XL project (Maritime & Energy and Industrial machinery). Then, we have compared them with the conventional processes used nowadays in each of those domains (casting or machining from blocks), in terms of costs and lead times. The calculations backing the table have been done in the most accurate way, considering a full breakdown of costs provided directly by the involved end-users. The prices have been calculated to give to RAMLAB a 20% gross margin, with an uptime of the workshop of 57% throughout the whole year. In principle, these prices will not vary across users, but discounts can be negotiated for big orders and early customers – especially for the end-users involved in the Grade2XL consortium, with whom special agreements will be concluded.

Even in the three cases when WAAM is not the most convenient in terms of price, it is much more convenient in terms of lead times, at times even by orders of magnitude. With WAAM, the lead time increases only in the case of Arrk Shapers new injection mould with conformal cooling. However, such a tool will be disruptive in terms of quality – as it reduces the cooling cycles at the final user to enable 30% increase in production speed, which will ultimately justify a higher price point for the injection mould.

4.1.3.4. Market entry and roll out


RAMLAB and Naval Group plan to roll-out its services in two steps:

Step 1: Serving pilot customers and co-developing with Valk Welding (from end Grade2XL to end of 2026)

During this phase, RAMLAB and Naval Group will purchase Grade2XL WAAM machines from Valk Welding and will offer services to pilot customers, such as the seven end users involved in the project. These machines will not yet be finalized, since at the end of the Grade2XL project (mid 2024) the technology will have reached TRL 6 only (technology demonstrated in relevant environment). Yet, this will be sufficient to serve the growing demand of customers and in the meanwhile allow RAMLAB, Valk



Welding and Naval Group to finalise the technology development. The ambition of RAMLAB and Naval Group is to produce each 250.000 kg of WAAM-manufactured products in 2026; the minimum envisioned for the same year is 75.000 kg. Each Grade2XL WAAM cell will be able to produce 5 kg/h, resulting in 25.000 kg/year (considering a 57% uptime). These means that depending on the orders, RAMLAB and Naval Group may host each between 3 and 10 WAAM cells (pessimistic and optimistic scenario, respectively) by the end of 2026. The first WAAM



cell will be purchased at cost from Valk Welding within the first six months of the end of the project; the others will be purchased at commercial price.

Figure 9. Component printed at RAMLAB with the Valk Welding dual robotic deposition set-up made available by Autodesk.

Step 2: Autonomous integrated WAAM-based “flexible manufacturing system” (FMS) to scale up operations (from 2027 onwards)

At the beginning of 2027, the Grade2XL WAAM system will have reached TRL 9, i.e. a fully autonomous flexible manufacturing system (FMS) embedding a WAAM cell, a warehouse, a CNC milling machine and ancillary equipment (cooling, NDT inspection, oven etc.). The Grade2XL FMS will be able to operate 24/7 and carry out very complex tasks, also thanks to the advanced software that will schedule and control the operations, currently being developed at RAMLAB – to be adapted to account for multimaterial deposition and optimised towards commercial deployment after the project. Thanks to this system, RAMLAB and Naval Group will be able to scale up their operations not only in terms of yield of the single WAAM cell (expected to reach 85% uptime annually, hence about 37.000 kg of material) but also in terms of overall operations, since a single technician could run (supervise) the entire system at once. Once the FMS is operative, RAMLAB will quickly ramp up its customer base, reaching beyond the pilot customers and partners of the Grade2XL project, and service customers – especially SMEs – throughout Europe. The ambition of RAMLAB and Naval Group is to reach **370.000 kg of welded material each by 2030** – which requires 10 fully operative FMS. In terms of further capital requirement to scale up production **beyond 2027**, each FMS will cost about 1,5 Million euro (including installation costs). Besides the WAAM system (purchased from Valk Welding for 300.000 euro), each company will require an investment of 1,1 Million euros, to cover: *i) the overall infrastructure* including the robotic arm and the warehouse (costs estimated at 700.000 euros, including installation and training); *ii) CNC milling machine* (costs estimated at 300.000 euros); *iii) inspection devices* and oven for heat treatment (100.000 euros each).

4.1.4. WAAM equipment

4.1.4.1. The offering and target market:

The offering of Valk Welding will consist in **high throughput WAAM robotic deposition equipment**, based on the super-active wire process (S-AWP)^{Erreur ! Signet non défini.}. The market of WAAM systems is still embryonic and there are no available figures for it. However, we can use as a proxy the one of arc welding systems, which serves similar customers: this market has grown by 20% between 2017 and 2018, reaching a volume of 4.930 in Europe⁴. Assuming a similar growth, the number of WAAM systems deployed worldwide will more than double by the end of Grade2XL.

Directly related to the growth in additive manufacturing applications is the **market for weld process gases and WAAM cooling equipment**. This is an emerging and brand-new market hence no current market analysis for gas usage in additive manufacturing is available. The Air Products cooling system was initially developed and built for rapid cooling during high heat input applications such as thermal spray coating, where peak temperatures range from 2000°C to >10.000°C. The system is very flexible in its use and has been proven in the thermal spray coating industry, coating very hard metals such as tungsten carbides but also ceramics. The current system will be optimised for cooling using liquid nitrogen, which would be suitable for additively manufacturing steel parts.

4.1.4.2. Market overview: size and trends, competition

Very few players worldwide offer WAAM systems somewhat comparable to those manufactured by Valk Welding nowadays. Yet, none of them offers multimaterial WAAM. As a matter of fact, only seven

⁴ Annual Report of the Industrial Federation of Robotics (IFR), 2018.

companies worldwide – four in Europe, two in Asia, and one in the USA – sell WAAM systems. Their main features are summarized in **the following table**⁵:

Table 3. Overview of the main market players selling WAAM robotic equipment

Name and country of origin	Brief description
ProdWays (France)	This company is a global supplier of several kinds of additive manufacturing techniques, and they have recently expanded to WAAM too. They focus specifically on the aerospace domain and work with titanium, which is not relevant for the Grade2XL project (our aerospace applications are limited to the manufacturing of moulds, not of products).
Gefertec (Germany)	Mature technology, and one of the first companies offering WAAM cells on commercial basis. At this moment, their technology does not address multimaterial.
Waam3D (UK)	Spin-off company of Cranfield University, with a very limited commercial footprint. The company runs pilot projects with customers from Aerospace (Airbus, Lockheed Martin, and Thales Alenia Space) however most of its projects have an academic impact only.
Addilan (Spain)	Born as partnership between two companies (Ona Electroerosión and Maher Holding), and currently collaborating with the Research Center Tecnalia. They have not yet penetrated the market.
Lincoln Electric (USA)	One of the biggest wire suppliers worldwide, a Grade2XL consortium partner. It has recently acquired a company that makes WAAM systems.
Mazak (Japan)	Solid technology, but they focus on much smaller parts than those produced with the Grade2XL WAAM cells. They sell WAAM systems as part of their vast portfolio in metal additive manufacturing, but WAAM does not seem to be their main focus.
Raycham (China)	The information publicly available in English is not abundant, but sufficient to understand that they commercialize WAAM machines though limited in scope (no multimaterial solutions and relatively small parts). It seems mainly, or fully, focused on the Chinese market.

Concerning the **gas supply systems**, offering specific to additive manufacturing are rare for gas companies, with a few exceptions such as Linde's oxygen gas management system (ADDvance O2 precision) – which is specific to powder based additive manufacturing processes. The main competitors of Air Products would be Air Liquide, Linde PLC and Messer Griesheim. To the best of our knowledge, there are no similar offerings to the liquid nitrogen temperature control system for WAAM.

4.1.4.3. Business model and estimated revenues

Thanks to the activities of the Grade2XL project, Valk Welding will significantly increase its commercial activities and turnover. Currently (figure for 2018), the company has a turnover of 56,5 Million euros and it sells over 200 welding cells, out of which 20 are WAAM based. According to the commercialisation strategy and sales projections, within 10 years from today Valk Welding will already have sold more than 80 Grade2XL systems. The sales of each system will be paired by sales of the monitoring and control software for multiwire deposition, developed at RAMLAB. RAMLAB estimates revenues in the range of 16 Million euros by 2030 from licensing their software.

⁵ Note that prices are usually kept confidential, as well as market shares. We did our best to estimate quantitatively what they could be, also based on the technological approach and business domain.

4.1.4.4. *Market entry and roll out*

The commercial roll-out of Grade2XL WAAM cells will occur in three stages:

- **Stage 1 (end 2024):** within 6 months from the end of the Grade2XL project (hence, by the end of 2024), Valk Welding will sell its first WAAM cell to RAMLAB. This system will not yet be the final one (the project will prove TRL 6) and the two companies will work together to further advance the product and co-develop/refine features. Considering the immature version of the WAAM cell, this product will be sold at cost to RAMLAB.
- **Stage 2 (2025-2026):** RAMLAB and Naval Group will start offering their service to early adopters, starting from the eight end users involved in the Grade2XL project. Each Grade2XL WAAM cell will be able to product 5kg/h, which results into 25.000 kg/year considering a 57% uptime, which means that the production facilities of RAMLAB will need to be scaled up. In the most optimistic scenario, RAMLAB and Naval Group will each purchase **nine additional WAAM cells in two years** – hence, bringing capacity up to 500.000 kg/year. In the most pessimistic scenario, RAMLAB and Naval Group will buy each **just two additional cells** in the same period. During this period, Valk Welding, in collaboration with RAMLAB, will take the WAAM cell to full maturity, from the technical and commercial viewpoint (TRL 9 achieved).
- **Stage 3 (2027 onwards):** once that the development of the WAAM cell has reached TRL 9, the machine will be available to end users too. It is to be expected that many clients, especially SMEs, will continue using RAMLAB because their needs, in terms of volumes, do not justify the purchase of a whole WAAM cell. However, larger customers will be eager to have one on their premises, also to avoid potential risks related to the IP of their products. Sales will ramp up quickly: according to our projections, the first year the company will sell 20 systems and there will be at least a 20% increase on yearly basis.

4.1.5. WAAM wire materials

4.1.5.1. *The offering and target market:*

The main Grade2XL players are the wire consumables producers vaBWG and LSW. The sale of wires may be a potentially interesting business for Valk Welding, too, as a reseller from the manufacturing companies (with whom Valk Welding has concluded favourable agreements). In Grade2XL, vaBWG and LSW will develop tailor made wires for wire arc additive manufacturing (WAAM). The companies will supply specific wires for WAAM to the project to produce the entire range of graded specimens and demonstrators and get essential input to optimise them – considering the heat and cooling times are so much different from standard welding applications.

The market for WAAM wires is completely new, which means it creates an additional revenue to the existing worldwide market of GMAW wires, which is estimated to be as big as 2.335.700 tons in 2015⁶. To be prepared for the new market, vaBWG has invested in an own WAAM machine to be able to produce test specimens and evaluate their mechanical properties, optimize wires and produce prototype parts as showcases. Directly related to the projected growth of the WAAM market is the market for weld process gases and cooling equipment. Air Products is the only gas equipment manufacturer in our consortium. The added value of cryogenic cooling technologies for multimaterial WAAM deposition will be demonstrated in the project and integrated as a modular feature in the WAAM FMS (addressed in the previous section).

4.1.5.2. *Market overview: size and trends, competition*

The size and further growth is difficult to predict. The reason is that the weight share of welding consumables in a standard manufactured part is estimated between 1-3 % in average. If a WAAM part is manufactured, the weight share is estimated between 105-110 %. Therefore, as soon as a company

⁶ The Japan Welding News for the World, Autumn Issue 2016 [Vol.20, No.77]

decides to manufacture parts with WAAM, the impact on the wire manufacturer is 2 orders of magnitude higher compared to the standard manufacturing.

4.1.5.3. *Business model and estimated revenues*

The potential additional revenue for the participating material producers was estimated based on a conservative scenario, considering roll-out only for the Grade2XL application cases. Even so, a considerable revenue from selling special WAAM wires can be expected for vaBWG and LSW (5,56 M€ in 2024), ramping up at a conservative rate of 15% yearly. Customers often purchase wires directly from the welding cell manufacturer (in this case Valk Welding) rather than from wholesale providers. This would then generate a third revenue stream for Valk Welding, minor overall but still significant if we assume the sales of WAAM wires follows the same trend for the sales of WAAM equipment.

4.1.5.4. *Market entry and roll out*

Through the demonstrators planned in the project, special WAAM wire materials will be introduced and validated across sample applications. The results should attract other customers and reduce their reservations. Moreover, the testing of WAAM prototype wires planned in WP 1 and 4 will deliver the data needed to initiate the technical reviews for a dedicated standard on WAAM.

4.1.6. **WAAM Graded Products (demonstrators)**

It is followed by technology roll-out within the companies of the involved end-users (MAN ES, EDF, Villeroy&Boch, GKN, Arrk Shapers, Gorenje, Kuznia Jawor) to unlock massive financial material savings.

4.1.6.1. *The offering and target market*

The offering for graded WAAM products is relevant to many markets. We selected two main domains (A. Maritime & Energy and B. Industrial Machinery) with several subsequent applications that have the potential to quickly penetrate and roll-out on fast growing markets in Europe, such as Aerospace and Automotive – see the following table.

Table 4. *Grade2XL products*

Offering	Business case owner	Target market
WAAM graded propeller with superior anticorrosion properties and <14% expensive material (and 0,1% efficiency increase).	MAN ES	Maritime
WAAM graded mobile rings for hydroelectric plants, with superior anticorrosion properties.	EDF	Energy
WAAM graded, cost effective mould for zero-defect sanitary ware production.	Villeroy&Boch	Home ware
WAAM graded, cost effective mould for composite part production with minimal thermal distortion.	GKN	Aerospace
WAAM graded injection mould with conformal cooling with 30% reduced cycle time at the final user and longer lifetime (to first repair).	Arrk Shapers	Automotive
WAAM graded metal forming tools with hard surface and double operational lifetime (to first repair).	Gorenje	Automotive
WAAM graded forming tools for stainless steel parts with hard surface, special friction properties and doubled operational lifetime.	Gorenje	White goods
Fast, cost effective WA:AM repair procedure for hot forging dies	Kuźnia Jawor	Heavy lifting

4.1.6.2. Market overview: size and trends, competition

Maritime: The main factors driving technology adoption by the **maritime industry** are:

- **Regulations:** They usually originate from national rules such as the Finnish-Swedish Ice Class Rules or North American Clean Water Act. These regulations are then interpreted and controlled by the classification societies. The regulations have increasing requirements on emissions. WAAM provides an opportunity to meet the regulatory demands by more efficient designs for the propeller blades.
- **Reliability:** The shipping industry is very competitive and unscheduled maintenance means downtime which could easily ruin the economy of a charter. It is therefore of utmost importance that each component runs smoothly until the next service especially if repairs require docking. Service or docking intervals for propeller equipment is usually five years. A ship typically has 6.000-7.000 hours of operations every year. If the equipment fails at a critical time, it could lead to life-threatening situations, environmental disasters or bankruptcy. WAAM doubles the operational time (between repairs) and offers the possibility of faster repair.
- **Delivery time:** For ships in service being able to deliver the parts with short notice is often more important than the price of the parts as the cost of having the ship docked and out-of-service far outweighs the price of the components. In this respect delivery times are essential for doing business. Some parts are therefore always on stock, this is of course not possible for every component, also not reasonably justified for parts designed to last the entire lifespan of the ship. In case of wreckage, the delivery time for such components could be several months – which can have severe consequences on the business viability.
- **Price:** For new designs, price is driving both the direct cost of the specific component and the cost of running the ship. Fuel consumption is especially important as it also has a significant impact on the environment.

Energy: The economic impact of WAAM in the hydroelectric energy generation can be evaluated by relying on the first lever or the reduction of supply lead times. The potential market is important because it can expand to European hydropower plants. From the available statistics, it is difficult to retrieve the exact number of mobile rings on the whole European park, but it could be assumed it is at least three times higher than the number of parts on the French fleet⁷. Moreover, the potential market (both French and European) can easily expand by considering other parts than the mobile ring, with equivalent or greater dimensions and equally important functions.

Industrial machinery: Toolmaking is a key element in manufacturing process for the following reasons:

i) *ubiquity*: tools are necessary to produce almost every component of a new product;

ii) *decisive influence on product quality and productivity*;

iii) *critical influence on the lead times* (for both existing and new products).

The **global metal forming machine tools market** is expected to increase to over **16 Billion dollars by 2020**, growing at a CAGR⁸ of 4% cent according to a report by the market analyst Technavio⁹. Within this market, the segment for **Automotive** tooling is very dynamic: parts produced from dies in the automotive sector are more complex from year to year. The demand for tooling in the **Aerospace** sector follows the trend of the growing Composites market. The global market for TP composites is expected to reach 38,8% by 2020¹⁰. Grade2XL will enable a significant enhancement (in quality,

⁷ 433 plants in 2016.

⁸ compound annual growth rate

⁹ <https://www.technavio.com/>

¹⁰ <https://www.marketsandmarkets.com/fibres-market-research-65.html>



efficiency and reliability) of the TP tooling capabilities at GKN, helping the company meet the increasing market demands.

There are multiple reports assessing the **aerospace market size for composites**, typically predicting growth to a size of **30-35 Billion dollars by 2025**. Stratview Research predicted the global tooling market for composites to grow at a CAGR of 7,1%, reaching **1,4 Billion euros in 2022**. The proposed AM process is typically targeting Invar tooling material that is most used for high-end aerospace composite applications. A rough estimate is that 25% of the total tooling market will be Invar.

4.1.6.3. Business model and estimated revenues

The Grade2XL end-users have all established and validated business models. WAAM in their case an enabling technology, allowing them to innovate and deliver products of superior quality and environmental performance, with a minimum CRM footprint. We have calculated the savings per company and sector for the entire lifecycle, comparing WAAM production and repair with the costs of the conventional production (casting, forging, machining) and welded repair.

4.1.6.4. Market entry and roll out

A cost assessment performed directly by the end-users in collaboration with RAMLAB and Naval Group, respectively, reveals that most of the products demonstrated in Grade2XL are already economically viable. Even when the calculation reveals a cost increase as opposed to conventional (small propeller, MAN ES), we find that extremely promising as WAAM is still in under development, and that is **without changing the current designs** to better match the higher strength of a graded material, such as a slimmer design, with further reductions in material use and improved fuel efficiency. Significant roll out is also expected beyond the markets currently addressed in the proposal. For example, the injection moulding tools have a widespread applicability not only in the Automotive sector, but also in Building and Construction, Agriculture and Leisure industry. Already towards the project end (2024), the end-users will **shift to WAAM produced components** differentiator for their offerings. In 2027, a significant growth can be expected once the market will become fully aware of the improved product quality offered by these companies. The Maritime end-user MAN ES also see in WAAM the opportunity of **new business lines**, as the case study further details.


5. Management

5.1. Industrial Advisory Board

An Industrial Advisory Group (“IAG”) will be appointed and steered by the Steering Committee. The IAG shall assist and facilitate the decisions made by the Steering Committee. Each partner proposed members for the IAG, and the decisions will be taken in the Steering Committee meeting, requiring unanimity when modifying the composition of the IAG, as well on the information to be disclosed to the IAG. Each partner has a veto right concerning the entrance of an Advisor in the IAG. When using his veto right, each partner shall motivate their veto. In case of a veto, partners shall find a solution to the satisfaction of all partners.

The IAG set up within the management structure will bring together interested companies from Europe, working at all levels of the supply chain. They will be informed on the progress of the technology development and on their turn, they will inform the consortium on important market drivers and potential bottlenecks from a business perspective. The IAG remains open to European companies and strategic international partners.

The Coordinator will ensure that a non-disclosure agreement is executed between all partners and each IAG member. Its terms shall be not less stringent than those stipulated in the Consortium Agreement and it shall be concluded no later than 30 calendar days after their approval in the Steering



Committee or before any confidential information will be exchanged, whichever date is earlier. The Coordinator shall write the minutes of the IAG meetings and prepare the implementation of the suggestions from the IAG. The IAG members shall be allowed to participate in dedicated sessions of the Steering Committee meetings upon invitation but have no voting rights.

The information to be provided to the IAG shall not include unpublished information or information that may make the object of a patent application. The information to be shared with the IAG will be decided in unanimity by the Steering Committee meeting, prior to the IAG meeting, which is normally organised in continuation of the Steering Committee meeting.

The IAG members may be revoked by the Steering Committee at the motivated request of a Steering Committee member, should there be any changes in their governance or business scope, unforeseen now of the Consortium Agreement.

The Industrial Advisory Board is part of the dissemination strategy. The members of this board will know the technology and project results and will be able to behave as prescribers in their own professional networks.

IAG methodology:

- Meeting once a year.
- Occurring at the second day of the SC meeting.
- Starting in 2021.
- Three IAG meetings in total during project lifespan.
- Duration: 4 hours.
- Structured per WP.
 - o IAG members send questions to the consortium before the meeting.
 - o Presentation by the consortium followed by key points and advice by the IAG members.
 - o Focus on the business cases (on both technical and economic aspects).
- Travel expenses are covered by the IAG member.
- Confidential information to be defined in detail the day before, at SC meeting.

5.2. Innovation committee

The **Innovation Committee** led by the Exploitation manager will discuss patentable results and agree whether patenting is the most suitable strategy. The participating research institutes may use knowledge or results from the project that have either been published or classified as publishable – only for research and teaching purposes. The project website will also include an overview of all published information. It aims at safeguarding the interest of both industrials (protecting IP) and academia (publishing research results). It participates in the Steering Committee. It is embodied by the Exploitation Manager. It is to be considered as a place for debating.

This is an internal committee that involves the people attending the steering committee and some more people that can be invited to discuss specific topics. The members of the IAG do not participate in the internal committee. RAMLAB as exploitation manager will bring contents to be discussed.

5.3. Who's Who

Exploitation Manager: M. Vincent WEGENER (RAMLAB)

WP7 leader: M. Maxime EZEQUEL (EMC2)

Communication: Mrs. Anniek ENSERINK (M2i) & Marion PONCET (EMC2)



6. Appendix

6.1. Acronyms

AM: Additive Manufacturing

IIW : International Institute of Welding

EWf: European Welding Federation

NDT: Non Destructive Testing.