WP9 – Dissemination, Exploitation and Communication

D9.4 – Dissemination and Communication Plan (final)

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Summary

This deliverable is the final version of the plan describing the Dissemination and Communication activities to be carried out within Work Package 9 of the MERGING project. Submitted at M48, this document consists of the final version of the plan. It includes a full report on the Dissemination and Communication results, and the planned actions to sustain dissemination and knowledge sharing beyond up to four years after the end of the project, as per article 29 of the Grant Agreement and per the DG Jean-Eric Paquet letter to all H2020 project on 15 April 2021.

Executive summary

The deliverable D9.4 focusses on the Communication and Dissemination activities of the MERGING project, within the dedicated work package (WP9). It covers two major areas: Dissemination, focussed on the disclosure of project results to specific target groups, and Communication, aimed to promote the project and its impacts to wider – although still well-defined audiences. For each activity area, it describes: the goals, the targeted audience, and the activities carried out within the project. Finally, it includes a section on collaborative activities with other H2020 projects, and a section on the evaluation criteria that are used for assessing the plan.

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1. Introduction

1.1. Scope

The present document is the updated version of the Dissemination and Communication Plan for the MERGING project. It focusses specifically on:

- Expanding and refining the plan described in the initial and revised versions, deliverables D9.2 and D9.3.
- Reporting on the actions carried out so far since the beginning of the project.

For both Communication and Dissemination, this document details the objectives, the key messages, the target audiences, the tools and actions already used and foreseen (website, social, leaflet, videos, press releases, journal publications, conference presentations, etc.) and a timeline of how they are used to reach the desired goals.
A specific section is devoted to collaboration on communication and dissemination with the other projects funded under the same call as our project, i.e. H2020-NMBP-TR-IND-2018-2020 (Transforming European industry), under the topic DT-FOF-12-2019 (but also another similar project funded under another programme). During the last project period, these collaborative efforts presented significant growth, with beneficial synergies influencing not only the communication and dissemination impact of this project, but of the whole H2020 research topic.
In the last section, evaluation criteria (KPIs) for determining the success of the dissemination and communication actions are discussed.

1.2. Definitions

In this plan, the terms “Dissemination” and “Communication” are used according to the prevalent definitions used by the European Commission with respect to Research and Innovation projects[1]. A brief reminder of the scope of the two terms follows.

Dissemination is defined as *the public disclosure of the results by any appropriate means, including by scientific publications in any medium.* It is focussed on **project results only**; it is addressed to audiences that may use the results in their own work e.g., peers (scientific or the project's own community), industry and other commercial actors, professional organisations, policymakers, etc., and it aims to *enable use and uptake of results.*
Its overall goals are:

- transferring of knowledge and results to the ones that can best make use of it;
- maximizing the impact of research, enabling the value of results to be potentially wider than the original focus;
- ensure Open Access to publications (an underlying principle in H2020)

Communication is instead defined as the set of activities that focus on both the project itself and the results, that are addressed to multiple audiences beyond the project's own community (including the media and the public) and that aims to inform and reach out to society to show the benefits of research.

[1] https://ec.europa.eu/easme/sites/easme-site/files/h2020_energy_info_days_communication_dissemination_and_exploitation_presentations_all.pdf

2. Communication

2.1. Objectives

The following Objectives for Communication were defined in the Project Proposal.

- (O1) to involve young minds into digitisation, namely in the development of digital manufacturing technologies and their importance and impact onto the economy and society
- (O2) to promote gender equality, integrate gender dimension in R&I activities, promote career opportunities in robotics and manufacturing
- (O3) to achieve societal endorsement linked to R&I on digital manufacturing
- (O4) to achieve support of industry potentially open to the adoption of **MERGING** technology and solutions for the project, and for future initiatives linked to robotic solutions for manufacturing
- (O5) to mobilise the European Research Area for the adoption of knowledge generated in the project for the development of new technologies and applications
- (O6) to raise awareness among EC, Public Authorities and Policy Makers to foster cooperation in spreading the benefits of robotics manufacturing and contributing to regulatory process.

The six objectives listed above can be turned into operative principles for preparing content and guide the selection of Key messages for communication (see following paragraph); this means that the MERGING communication actions and products must put particular emphasis on:

- countering the perception that automation is associated to job loss, by highlighting the human/robot collaborative potential of solutions for soft objects manipulation;
- presenting robotisation as a beneficial, and ultimately more ethical and sustainable, alternative to job displacement towards low-wages country, in particular in sectors such as the textile industry where the problem is relevant and affects the public perception;
- framing the project as part of an overall European strategy for competitive, resilient and sustainable manufacturing, made even more urgent by the impact of the COVID-19 pandemic;
- providing lay audiences with the necessary technical background to capture the importance and innovative content of this technological effort;
- informing timely about the project's results, and insert these information in the news cycle so that they can be picked up by the news media

2.2. Key messages

The first step for a communication strategy is to define key messages that have to be conveyed through various media, and that should stick with the audience after any encounter with the project's communication. This is fundamental in order to achieve consistency in the communication.

The preliminary plan included in the project proposal outlined some general messages regarding:
KEY MESSAGE 1:
The relevance of MERGING results in our daily life
KEY MESSAGE 2:
The relevance of MERGING project in jobs creation, energy efficiency, and life quality
KEY MESSAGE 3:
The MERGING project results and its impact beyond robotic industry
KEY MESSAGE 4:
The potential for collaborating with robots and contribution to job quality improvement
KEY MESSAGE 5:
Career opportunities for women in robotics and automation derived from MERGING results.

These general messages can now be declined more precisely, in the form of brief statements / content points that can be used as "building blocks" in communication materials, presentations, press releases etc., and in general guide the communication.

KEY MESSAGE 6 (technology focus):
MERGING will pioneer the use of robotics and Artificial Intelligence for manipulating flexible and fragile objects.
KEY MESSAGE 7 (areas of application):
The solutions will be tested in the textile, food and automotive industries, but will have potential for other industrial sectors.
KEY MESSAGE 8 (main expected outcome):
MERGING aims to design a versatile, low cost and easy-to-use robotic solution that manufacturers can apply to support or automate tasks involving the handling of flexible or fragile objects.
KEY MESSAGE 9 (technology building blocks):
The solution will consist of new robotic dexterous gripper that will also take advantage of an integrated adaptive electro-adhesive skin. Control will include dedicated perception and supervision functions to adapt the system's response to the environment and to the object's behaviour, and abilities to make the human-robot or multi-robot co-manipulation of the flexible object safer, using Artificial Intelligence like Machine Learning.
KEY MESSAGE 10 (consortium):
MERGING is a three-and-a-half years project coordinated by CEA (Commissariat a l'Energie Atomique et aux Energies Alternatives) in France, and involving academic and industrial partners from six countries.
KEY MESSAGE 11 (partners' role):
The specific role of each individual partner in the project (relevant at the national/local level) is clearly defined.

2.3. Target audiences

The preliminary plan outlined in the project proposal already defined the most relevant target audiences for MERGING, namely:

- **Young Minds** (i.e., students)
- **Stakeholders** (industrial clusters and associations)
  E.g.: EFFRA, EuRobotics, Euratex/ETP Fibres Textiles Clothing, Text4IM, ERTRAC, ACARE, International Federation of Robotics, EUROPEN, etc.
- **Workers** (i.e., in particular those in the sectors where soft manipulation is relevant)
- **Women** (i.e., in relation to the under-representation of women and gender imbalance in the engineering sector)
  European Platform of Women in Science (EPWS), European Association of Women in STEM (WITEC)
- **European Research Area** (i.e., the general scientific community in Europe, who should be made aware of the potential for research and innovation in this sector)
- **Public in general**

- **Media**

(i.e., journalists on print, online, TV and radio, in particular those specialising in technology, AI, robotics, business and industry).
Although the media can also be seen as a vector to reach targeted audience mentioned above, effectively engaging media professionals requires treating them as a separate audience with its own need and specificity.

2.4. Actions and tools

The MERGING communication plan leverages the following principal communication tools and actions:

- Public website
- Leaflet
- Presentations at public events promoted by industrial associations
- Presentations at public events promoted by research associations
- Publication of project information in EC platforms
- Publication of project information in national networks for research and innovation
- Press releases
- School visits to partners' facilities
- Joint initiatives with European associations for gender balance in science
- Short videos
- Project video
- Social network profiles and information publication

The following table presents an updated timeline of how these actions and tools have been deployed over the course of the project in order to convey the key messages listed in section 2.2 to the key audiences listed in 2.4.

Action/tool	Target Audience	Key Messages	Timing
Website	All	All	M01-M48
Leaflet	Stakeholders / European research area / public in general	2, 4, 6-10	M01-M48
Presentations at public events promoted by industrial and research associations	Stakeholders / European research area	All	M01-M42
Publication of project information in EC platforms	Stakeholders / European research area	All	M18 onwards
Publication of project information in national networks for research and innovations	Stakeholders, researchers, public in general	All	M18 onwards
Press releases	Media (and stakeholders / public in general via the media)	All	M01-M48
Short videos shared via YouTube/website/social networks	All	All	M30 onwards
Project final video	All	All	M48
Social media profiles (LinkedIn, twitter) and information publication	All	All	M6 onwards

A more detailed description of each tool/action is presented in the subsections below, including how they have been used over the course of the project (where applicable) and plans for future use.

2.4.1. Public website

The main objective of the MERGING Public Web Portal is to promote the MERGING project via Internet. The aim is to achieve worldwide dissemination of the knowledge of the project, to publish news and information and to enable the communication between the project coordinator and everyone who is interested in the project. It was primarily developed for any person who wants to be informed for the content and the achievements of the MERGING project.

The MERGING public web portal can be reached at the link: http://www.merging-project.eu/
This portal has been developed and is maintained by Merging partner n°2, i.e., the Laboratory for Manufacturing Systems and Automation (LMS) of University of Patras (Greece). It is based on the open-source WordPress. WordPress is a flexible Content management/Portal solution that is easy to install, use, extend and maintain. A complete description of the structure and technical aspects of Merging website is provided in deliverable D 9.1 – Public website. It has been launched online by the end of Month 2 (December 2019).
Over the course of the project, the website has been used to present:

- the project's overall concept.
- the composition of the consortium and the role of each partner in the project.
- the structure (title and main topic of each WP) as well as the status of the main technical WPs that are ongoing or already completed.
- an overall presentation of the project in the form of a news story/press release that serves as reference extended description.
- news items about events, in particular presentations at conferences and workshops;
- the project leaflet, that can be downloaded from the website.
- the project's results/.
- the partner's outlook on key topics in flexible material manipulation and how they addressed relevant issues.
- the enabling technologies and training material for their usage or exploitation.
- Public deliverables
- Training material
- Clustering projects and activities
- Demonstrator showcase with use case videos

An overview of the traffic analytics for the whole project duration is shown in the figure below (from Google analytics).

Table 1. Traffic analysis of the public website (period 01/03/2023 till 30/10/2023)

Month	March	April	May	June	July	August	September	October
Visitors	1050	1125	771	1401	862	613	1121	1024
Total	7965							

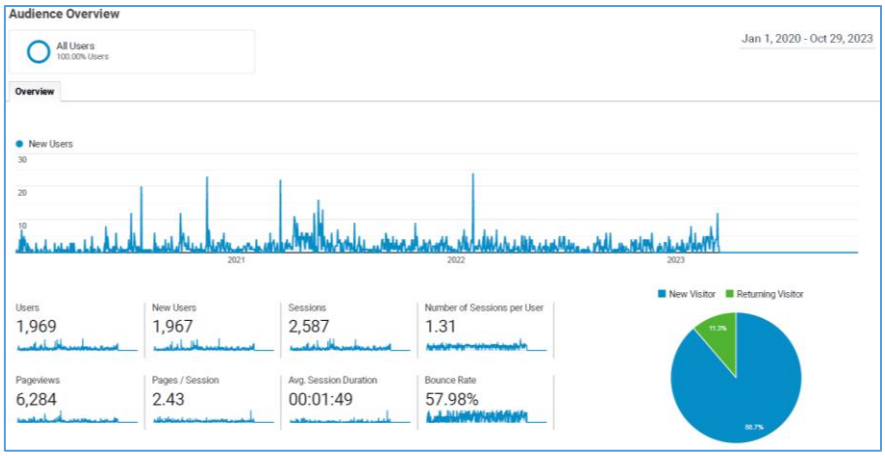


Figure 1. Traffic analytics of the public website (period 01/01/22 to 01/03/2023)

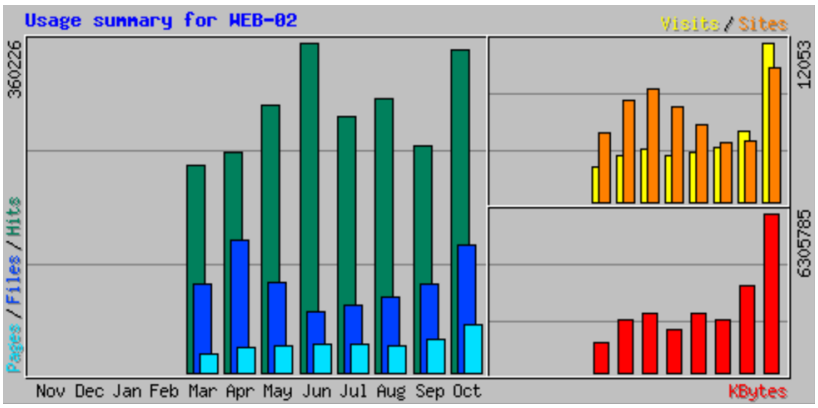


Figure 2. Traffic analytics of the public website (period 01/03/2023 to 30/10/2023)[2]

It appears there is an increase in traffic over the last months. This is mainly caused by the frequent release of blog posts that communicate project's results. Another aspect is the integration of the training material. The Webalizer tool was used to analyze website statistics derived from server logs for the second period. Figure 2 presents filtered values in order to remove traffic from crawlers, bots, and other automated agents to provide a clearer representation of genuine user interactions. Table 1 summarized the filtered traffic per month.

General presentation and reference to MERGING has been also included on the CEA-LIST public website (https://list.cea.fr/en/) :

- on "The news / Technological Advances" page :
  - https://list.cea.fr/en/july-24-2023-industrial-collaborative-robots-you-can-simply-teach-no-programming-required/ (in English) and https://list.cea.fr/fr/24-juillet-2023-la-programmation-intuitive-des-cobots-pour-lindustrie-pourquoi-comment/ (in French) (published on line the 24/07/2023)
  - in relation to parallel developments at CEA LIST, on https://list.cea.fr/fr/10-octobre-2023-une-robotique-de-manipulation-agile-au-service-du-recyclage-des-dechets-electroniques/) (in French) (with a link to the project public website https://www.merging-project.eu/) (published on line the 10/10/2023)

[2] Due to an update from google universal analytics to google analytics 4, google analytics stopped providing usefull insights. For this reason, filtered log data from the server are used for the remaining period.

- on “Research programs in Smart robotics” page : https://list.cea.fr/en/page/smart-robotics/ (in English) and https://list.cea.fr/fr/page/robotique-intelligente/ (in French) (with a link to the project public website https://www.merging-project.eu/) (website updated in 04/2022)
- on the “Agenda” and “The News” page :
  - https://list.cea.fr/fr/event/erf-2022/ (in French)
  - https://list.cea.fr/en/event/erf-2022-2/ (in English) (June 2022)
  - https://list.cea.fr/en/event/ro-man/ (published on line the 11/08/2022)

2.4.2. Leaflet and banner

Originally, a six-page leaflet was developed by EPFL, with collaboration from all partners. The leaflet presented the overall concept and fields of application, the technology building blocks, the use cases and the composition of the consortium. Texts and images were extensively discussed in several WP9 meetings.

On the same basis, the leaflet has been updated by LMS two times. The first update involved mainly aesthetic and layouting modifications. The final version introduced new graphics and content deriving from the implemented demonstrators. Both versions were also motivated by the updates in terms of the project’s consortium, with OMNIGRASP joining the project for replacing SHADOW.

The leaflets can be downloaded from the website, by visiting the “Dissemination material ” tab, and can also be retrieved in Annex C. Nevertheless, the latest version is presented hereunder:

Figure 3. Latest project leaflet

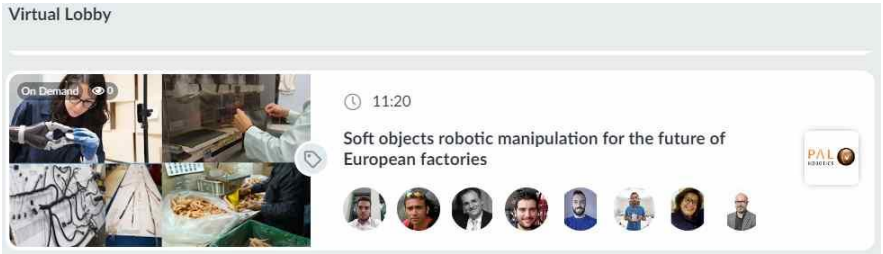
Apart from the leaflets, the project also has a roll-up banner that was used at public events frequently. Similar to the flyers, but in more plain manner, the banners present the project’s concept. The latest banner is presented hereunder, whereas previous versions can be retrieved in ANNEX C.

Figure 4. Project roll up banner - final version

2.4.3. Presentations at public events promoted by industrial or research associations

The main associations to be targeted by this action line include EFFRA, EuRobotics, Euratex/ETP Fibres Textiles Clothing, Text4IM, ERTRAC, ACARE, International Federation of Robotics, EUROPEN, etc.

This action line covers both Communication (focussed on the project itself) and Dissemination (focussed on result, see section 3). The most major participations in public events or workshops are enlisted hereunder:

ERF 2021	**Type**	Organization of a **workshop** and participation with a **presentation**
	Organizing Association	EuRobotics
	Venue	Virtual
	Timing	13 to 15 April 2021
	Description	MERGING together with APRIL, REMODEL and SOFTMANBOT co-organized a joint workshop entitled "Soft robotic manipulation for the future of European factories". The objective was to a) projects get familiar with parallel research activities under the same funding topic, b) communicate and exchange together with the European robotic community fundamental needs in robotic developments and challenges, and c) identify possible technical topics where projects could have synergies. The workshop endured for 90 minutes where 20-minute presentations per project triggered a joint discussion for approximately 10 minutes. Our project was represented by Dionisis Andronas, from LMS, with a presentation entitled "Robotic Manipulation for the Textile Industry: the MERGING project" which was inspired by the challenges, needs and enabling technologies of the SHELMARK use case. One of the outcomes of this initiative was the establishment of the cluster and the announcement that more joint activities were underway. Refer to appendix for more details about the workshop and its organization timeline. 
	Audience	over 800 registrations
	Communication actions	• news item on the CORDIS website • posts on MERGING Twitter and LinkedIn profiles • posts by CEA LIST and Shadow Robot profiles

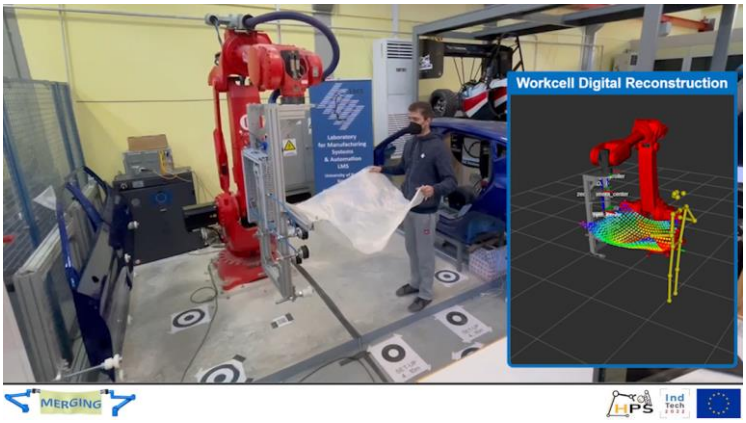
ERF 2022	**Type**	Participation in **workshop** with a **presentation**
	Organizing Association	EuRobotics
	Venue	Rotterdam, Netherlands
	Timing	28 to 30 June 2022
	Description	Continuing the clustering activities with the "sister projects" funded under the same topic, MERGING together with the projects SOFTMANBOT, APRIL and REMODEL shared a sub session of the "9th Hybrid production systems workshop". The workshop is organized by LMS, since 2014, and consists of an activity of the "Hybrid Production Systems" cluster. For this year, the four projects also invited DRAPEBOT project, that despite not being funded under the same topic, shares similar challenges, and can contribute to the cluster.

		This participation also signals the inclusion of the projects to the HPS cluster as well; meaning that synergies are also possible on additional thematic areas, such as human robot collaboration, reconfigurable manufacturing systems, etc. The sub-session consisted of the 10-minute project presentations that mobilized a 10-minute joint discussion. Our project was represented by Christos Gkournelos, from LMS, with a presentation entitled "Model-based human robot co-manipulation: a composites industry paradigm" which was inspired by the challenges of the VDL use case and highlighted the project's advances in model-based control. Refer to appendix for more details about the workshop. 
	Audience	over 1000 registrations
	Communication actions	• posts on social media platforms • mails on cluster participants mail lists

ERF 2023	**Type**	Organization of a **session**, and participation with **two presentations**
	Organizing Association	EuRobotics
	Venue	Odense, Denmark
	Timing	14 to 16 March 2023
	Description	• Continuing the clustering activities, MERGING together with the projects SOFTMANBOT, APRIL and REMODEL in addition to DRAPEBOT, shared a sub-session of the "10th Hybrid production systems workshop". The workshop is organized by LMS, since 2014, and consists of an activity of the "Hybrid Production Systems" cluster. MERGING mobilized the organization of the workshop named "Handling systems for flexible materials" by inviting the other 4 projects. The session suggests a continuation of the last year's workshop with a more focused sub-session focusing explicitly on flexible material handling. The session consisted of 10-minute project presentations that prepared the audience for an interactive panel discussion of 20 minutes. • Our project was represented by Dionisis Andronas, from LMS, with a presentation entitled "MERGING: Manipulation Enhancement through Robotic Guidance and Intelligent Novel Grippers". The presentation showcased the project's enabling technologies with an application example from the VDL's lab demonstrator at LMS facilities.

		 • Continuing the clustering activities, MERGING was represented in the workshop "human robot collaboration and AI in challenging industrial applications", where were represented the following projects: AI PRISM, FELICE, RaRe2, RESPECT, FEROX, AGILE-HAND and Zer0P. Baptiste Gradoussoff, from CEA, made an oral presentation entitled "Intuitive programming using skills and teaching by demonstration". The presentation of skill-based intuitive programming framework, which goal is to provide the operator with a set of robotic skills, which can be easily setup, and automatically optimized and run on the robot for semi-automatic assistance or for small process automation. These developments xere illustrated by Merging industrial use-cases. Refer to appendix D for more details about the workshops.
	Audience	over 1000 registrations
	Communication actions	• posts on social media platforms

Indtech 2022	**Type**	Participation with a **booth** for promotion of **dissemination material**
	Organizing Association	French Government, European Commission, CEA, AMIRES
	Venue	Grenoble, France
	Timing	27 to 29 June 2022
	Description	The IndTech Conference is the European Commission's biannual conference on industrial technologies held in the country holding the Council of the European Union's presidency. In 2022, the conference took place in Grenoble, France and addressed key themes such as Green and digital transition, circularity and sustainability, among others. MERGING participated in the event by having a booth at the EFFRA village. The booth contributed to the communication and dissemination of the project through promotional videos, leaflet presentation, and a roll up banner. Dionisis Andronas, from LMS, as well personnel from CEA, which was also the coordinator of the whole event, represented the project through joint discussions with stakeholders or other project representatives.

		 
	Audience	over 620 registrations
	Communication actions	• posts on social media platforms

Manufacturing Partnership Day 2023	**Type**	**Participation** with a booth and a presentation
	Organizing Association	EFFRA
	Venue	Brussels, Belgium
	Timing	26 September 2023
	Description	A project-centred event organized by the European Factories of the Future Research Association. With over 50 projects being registered as participants, MERGING had the chance to communicate and disseminate its results through: a) a booth where promotional material (i.e., leaflets and banner) was showcased, and b) a presentation. Dionisis Andronas, from LMS, together with Pisupati Anurag, from IPC, and Dilecki Volkan, from VDL, registered as exhibitors and had the chance to share experiences with stakeholders and promote recent MERGING results. Dionisis Andronas, from LMS, also had a presentation with the title “Recent advances and outlook in non-rigid product manufacturing, the MERGING approach”. The presentation outlined the enabling technologies of the project, and also communicated the results from the composites manufacturing use case demonstrator.

		 
	Audience	over 400 participants
	Communication actions	• posts on social media platforms

Other participations of project partners in public events include:

Event type	Timing	Audience	Partner involved
Swiss Robotics Day 2021 Presentation on soft gripping technologies by prof. Herb Shea (https://swissroboticsday.ch/previous-editions/previous-srd2021/)	2021	Swiss robotic industry, scientific community, general public : Almost 500 participants	EPFL
Oral presentation at the French national research group event (GDR Robotics - Workgroup : Multiscale manipulation): "Dernières avancées en préhension et manipulation dextre à l'échelle nationale"	2022	French robotics researchers (scientific, customers)	CEA
Organization (and presentation) of the Workshop "Soft grippers: from the labs to the market"	2023	Scientific community and stakeholders for soft grippers	OMNIGRASP
Poster presentation at the "Cognitive Modelling in Robot Learning for adaptive Human Robot interactions" workshop at ICRA 2023	2023	Scientific community and stakeholders for soft grippers	AIMEN
Oral presentation at the French national research group event (GDR Robotics - Workgroup : Multiscale manipulation): "Soft robotics – conception et commande des préhenseurs robotiques souple"	2023	French robotics researchers (scientific, customers)	CEA
Organization of the workshop "Soft grippers from the labs to the market" at IEEE RoboSoft2023	2023	Scientific community and stakeholders for soft grippers	OMNIGRASP

Invited talk at 2023 Transducers conference	2023	Industrial and scientific communities	OMNIGRASP

2.4.3.1. Planned actions

The following organisation of workshops/parallel events at conferences and industry forums are currently foreseen. The list is partial and will be updated depending on communication opportunities that might appear. Organisation of parallel events will continue for up to four years after the end of the project.

Event type	Timing	Audience	Partner involved
Participation to national research group events (GDR Robotics - Workgroup : Multiscale manipulation)	yearly	French robotics researchers (scientific, customers)	CEA
Participation at "Hybrid Production Systems workshop" at ERF	yearly (2024, 2025?)	Industrial and scientific communities	To be defined

2.4.4. Publication of project information in EC platforms

The CORDIS website of the European Commission includes a news section that publishes summary of project results as well as important updated on H2020 projects and allows projects to post updates through the WIRE service, where articles can be submitted, are vetted by CORDIS's editorial team and then published.

By the moment of writing this report, the following items where published:

- announcement of workshop participations
- communication of the reached milestones through public reports
- details for conference proceedings publications
- details for peer review article publications
- software repositories though OpenAIRE

whereas further publications will be used to highlight the results of the integrated industrial demonstrators. Feedback from VDL, SELMARK AND THIMONNIER will be considered in order to ensure that no confidential information is disclosed.

2.4.5. Publication of project information in national networks for research and innovations

CEA has already used and will continue to leverage the communication network of Réseau C.U.R.I.E., that in France federates the professionals active in innovation, valorisation and technology transfer related to publicly-funded research. It gathers 190 institutions including universities, hospitals, research institutes, exploitation entities of the public research, INPI, IP practice, SMEs and large industries, and its communication network reaches several thousands people.

Action	Timing	Target audience
Information on MERGING-related events in Réseau C.U.R.I.E. Newsletters and social networks	from 2022, in parallel to communication through social media	more than 190 French research institutional members (French research universities, institutes, exploitation entities of the public research, INPI, IP practice, SMEs and large industries)

Press releases - Members of Réseau C.U.R.I.E.	from 2022, in parallel to direct institute press release	French public, medias, industrial, stake holders, investors, customers
Innovation news - Réseau CURIE on Twitter, Linkedin and Facebook	depending on results	professional and public audience
Innovation news - Réseau CURIE's large public website	depending on results	French public
Innovation news - Réseau CURIE's professional website	depending on results	French industrials

During the project's final phase, MERGING consortium was contacted by the scientific publisher "Techniques de l'ingénier". The publisher is interested in having a paper about MERGING with the objective of presenting its technological and scientific advances to a professional scientific audience, mostly composed of engineers. At the moment of writing this report, LMS and CEA, as dissemination leading and project coordinator partners, are in direct communication with the publisher for the preparation of the paper. The paper will showcase the project's use cases, and the project's technical objectives towards the introduction of robots in non-rigid product manufacturing.
On the same basis, LMS and CEA are in communication with EFFRA for preparing an article for the Science&Business journal. The article will prioritize business perspectives and will discuss: a) the economic potential for businesses that haven't introduced robotics (due to sophistication of non-rigid workpiece handling), b) the challenges that recent developments are trying to address, and c) remarks for the future directions of the European academic and industrial communities. The article will also include an outlook on these topics based on our experiences and the evaluation of MERGING solution.

2.4.6. Press releases

MERGING communicates its advances and results to the different communities through press releases that can be correlated with significant project milestones. Throughout the project period, the following press releases have been prepared:

Title	Period	Description
A robotic platform to manipulate soft materials in industrial environments	2021Q2	Communication of the project's composition, objectives, and industrial sectors.
How a new generation of robots can change the textile industry	2021Q4	State, needs, and challenges of the textile industry and how MERGING can have impact.
The MERGING solution, for enhanced flexible material handling, tested at lab environment	2023Q3	Communication of the project's results after the completion of the laboratory demonstrators.
From lab to factory: MERGING's innovative flexible material handling solutions successfully integrated and tested in industrial settings	2023Q3	Communication of the project's results after completion of the industrial integration activities
MERGING's hybrid cell: a benchmark for composites manufacturing industry	2023Q3	Communication of the MERGING solution for composites manufacturing.
MERGING's cell for the textile industry: product quality through dexterous handling	2023Q3	Communication of the MERGING solution for the textiles industry.

Description of the press releases can be found in ANNEX B.

Similar to the last two press releases, one additional is press release is under preparation for highlighting the advances of MERGING in the food packaging industry. It will be inspired by the results of industrial demonstrator at THIMONNIER.

The press releases have occasionally been translated into different languages for covering a broad range of audiences. Representative examples include the translation of press releases in Spanish, by AIMEN and SELMARK, as well as French, by CEA.

Further articles at the national/regional level highlighting the role of individual partners include:

Topic	Publication	Timing
General article about Robots flexibility enhancement and Future Robotics in France, thanks to large institutional funding, mentioning the CEA coordination of the H2020 Merging project	L'Usine Nouvelle https://www.usinenouvelle.com/editorial/comment-la-robotique-industrielle-se-reinvente-pour-gagner-en-flexibilite.N1123439	15 sept. 2021 (revised version on 25 October 2021)

A mailing list has been prepared for distributing the press releases, with over 30 selected contacts (not included here for privacy reasons) from publications including:

- AgriTrade news
- Digital Labels & Packaging magazine
- Manufacturing & Engineering Magazine
- New Electronics
- Food & Drink Technology
- Food Navigator
- Advanced Manufacturing – The Engineer
- The Manufacturer
- Industrie & Technologies
- Science & Vie Junior
- L'Esprit Sorcier
- Reseau c.u.r.i.e
- SwissInfo
- IEEE Magazine
- Wired
- the Economist
- AgriTrade news
- Digital Labels & Packaging magazine
- Manufacturing & Engineering Magazine
- New Electronics
- Food & Drink Technology
- Food Navigator
- Advanced Manufacturing – The Engineer

2.4.7. Joint initiatives with European associations for gender balance in science

MERGING has established a contact with the European Platform of Women Scientists (https://epws.org/). In a meeting with its President, Lucia Martinelli, we agreed to develop joint initiatives on women in robotics, including :

- Profiles of women scientists/engineers working on the MERGING research topic to be published on the EPWS website ("Latest Interviews" page). We have started gathering candidate women among Merging partners for these interviews.
- Organisation of a seminar on gender balance in robotics during 2023

During original contacts, there were two considerations for our project, namely Adriana Costas Lopez from AIMEN and Julie Dumora from CEA. Both candidates, as senior female researchers, had significant contributions to key project enabling modules. However, the communications were delayed as Adriana, which was the first in the line option of the consortium, departed from AIMEN. Subsequently, the consortium proposed Julie Dumora, but also the project's coordinator, namely Christine Rotinat. Due to dense agendas from all involved entities, the activities for the profile creation are expected to progress further in the upcoming period.

2.4.8. School visits to partners' facilities

These activities have been affected significantly due to the restrictions linked to the COVID-19 pandemic during the first months of the project. Throughout the project, the objective was for each

partner to contact schools in its area (targeting students ages 14-19 y.o.) aiming to organise at least one visit to its premises during the school year, providing students with a general presentation and "invitation" to the topic of robotics and AI, and a technology demo focussed on the MERGING technologies.
From LMS side, the project, and the benefits it brings for non-rigid product manufacturing, and packaging have been presented three times. Two times, students from the university of Patras were involved, whereas within the third one, high-school students visited the facilities during a department tour. Due to the transferring of the composites manufacturing demonstrator to VDL's premises, for the last group, the project was presented in video presentation format.

2.4.9. Short videos

Short interviews were recorded with the consortium members highlighting specific aspects of the project (from accessible explanations of its technical aspects to its potential impact, as well as the societal and ethical aspects related to research on robotics and automation).
Considering logistics, budget limitations, and prioritization of resources towards the integration of MERGING technologies, the consortium decided to have all professional video recordings at the end-user facilities. The interviews took place among with the recording of use case demonstrators with interviewees that had key impact on the development and integration activities of the project. All short interviews among with the demonstrator clips are rendered into three videos, one per use industrial use case.
The resulted videos can be accessed at the project's public website as well as its YouTube channel.

2.4.10. Project Video

A project video is released towards the end of the project. The video merges the highlights from the demonstration recordings and the short video interviews, described in Section 2.4.9. The video is approximately 5 minutes long, and presents the concept, building blocks, use cases and potential impact.
The resulted video can be accessed at the project's public website as well as its YouTube channel.

2.4.11. Social network profiles

The MERGING Twitter profile is active at the link: https://twitter.com/MergingProject
The MERGING LinkedIn profile is active at the link: https://www.linkedin.com/company/merging-project
These profiles currently have 172 combined followers (in comparison with the previous report where they were 90 in total). They are both used to communicate quickly upcoming events, the publication of new content on the website, to signal important activities from individual partners (participation to conferences, publications, involvement in other projects that have some thematic links with MERGING contents, etc.).
The following partners are also individually active on social media:

Partner	Active on	Combined number of followers
CEA LIST	LinkedIn/Twitter	about 9,300
EPFL School of Engineering	LinkedIn/Facebook	about 6,500
CASP	LinkedIn/Twitter	about 90
VDL group	LinkedIn/Twitter/Facebook	over 54,000
Omingrasp	LinkedIn/Twitter	over 380
Aimen	LinkedIn/Twitter/Facebook	over 23,500
Selmark	LinkedIn/Twitter/Facebook	over 110,000

LMS	LinkedIn/Twitter	about 1,300
Opteamum	LinkedIn/Twitter	about 500

It has been noticed that LinkedIn is a more popular platform with more active audience than Twitter. At the moment of preparing this report, the MERGING project profile has published the following posts:

Post	Period	Reactions	Reposts
1st press release	2020	2	1
Communication of new robotic grippers	2020	1	-
Shadow winning award	2020	2	-
Communication of demonstration stream by SHADOW	2021	2	-
Communication of ERF2021 participation	2021	-	-
Communication of ERF2021 participation	2021	1	1
Participation of MERGING to ERF2021	2021	-	-
Communication of 1st Review meeting	2021	6	1
Communication of MERGING participation to IROS2021 ROMADORA workshop	2021	3	1
Communication of MERGING participation to IROS2021 ROMADORA workshop	2021	1	-
CIRP annals publication by LMS	2022	3	1
WP5 Public deliverable on MERGING site	2022	4	-
Communication of MERGING participation to ERF2023	2023	7	1
Presentation of MERGING at ERF2023	2023	13	1
VDL visits LMS	2023	41	5
IEEE RoboSoft 2023 publication by OMNIGRASP	2023	8	1
LMS-CEA workshop at LMS facilities	2023	22	2
Workcell Controller post by LMS	2023	24	2
Human detection and gesture recognition post by AIMEN	2023	14	3
Modelling post by LMS	2023	16	2
Hardware installation at VDL by LMS and OPTEAMUM	2023	68	7
Foam co-manipulation by CEA module repost	2023	40	7
MERGING public event save the date post	2023	9	6
AIMEN paper presentation and respective post repost	2023	14	3
Calibration of modelling parameters module by LMS	2023	17	3
SMEJMS publication by LMS for calibration module	2023	27	1
MERGING public event agenda	2023	21	11
Wrinkle removal module by AIMEN post	2023	9	-
Skill teaching module by CEA post	2023	5	1
MERGING post-lab integration press release	2023	16	-
MERGING booth at EFFRA Manufacturing Partnership day	2023	16	-
MERGING presentation at EFFRA Manufacturing Partnership day	2023	24	1
MERGING public event registration repost	2023	21	11
MERGING public event registration repost	2023	9	
Multi-tool end-effector for composites by LMS post	2023	21	2
Model-based co-manipulation planner by LMS post	2023	41	3
MERGING public event remote registration post	2023	10	3
Human System Interfaces by LMS post	2023	20	1
MERGING industrial integration press release	2023	19	-
Communication that MERGING public training material in online	2023	1	-
Communication that MERGING public event is online	2023	1	-
MERGING public event value chain and modules sessions are online	2023	1	-
MERGING public event round table discussion is online	2023	1	-

MERGING public event training sessions are online	2023	1	-
MERGING VDL-use case related press release	2023	1	-

Apart from the MERGING LinkedIn profile, partners' profiles have also communicated the project. The following list includes some indicative posts:

Post	Profile	Period	Reactions	Reposts
Communication of MERGING by CEA in English	CEA [LinkedIn]	2021	12	2
Communication of MERGING by CEA in French	CEA [LinkedIn]	2021	4	2
Communication of MERGING by CEA in French	CEA [Twitter]	2021	4	2
Communication of MERGING by CEA in English	CEA [Twitter]	2021	2	3
CEA at RO-MAN	CEA [LinkedIn]	2023	16	2
CEA at RO-Man	CEA [Twitter]	2023	2	2
CEA at ERF2023	CEA personnel [LinkedIn]	2023	17	2
CEA activities in MERGING	CEA [LinkedIn]	2023	40	7
CEA solutions for flexible material handling and programming	CEA [Twitter]	2023	3	3
MERGING public event	IPC [LinkedIn]	2023	24	4

Monitoring the project's account on LinkedIn, for the last year (October 2022 to October 2023) the following remarks can be discussed:

- Impressions from less than 100, surpassed an average of 1500, with two months peaking at 3000 and 4000 impressions.
- Reactions from less than 5 per month, managed to maintain numbers above 50 for 5 months.
- Visitors were augmented by 10 times, with engagement rates of more than 100 per month.
- Followers were doubled with 80 new followers (153 in total)

The increased traffic and publicity are the results of the more frequent public website posts that encourage the audience to follow our project for further updates.

3. Dissemination

3.1. Objectives

The following Objectives for Dissemination were defined in the Project Proposal:

- **(O1)** to raise awareness and interest of potential users on the project results.
- **(O2)** to potentiate interaction with stakeholders and potential users to obtain key feedback to enhance exploitation opportunities of the MERGING results.
- **(O3)** transfer of knowledge among the partners,
- **(O4)** effective acquisition of new skills by users,
- **(O5)** to ensure a broad applicability of the project results taking into consideration regulations and standards,
- **(O6)** to foster MERGING technology acceptance by users.

3.2. Target audiences

The key audiences identified by the MERGING Dissemination plan include:

- Project partners
- Industry (hardware and software integrators, as well as robot manufacturers)
- Scientific Community
- Stakeholders
- Standardization Organisation

- High-level education (HLE)
- European robotics researchers and engineers, in general and in particular those working on Haptics, Robotics and Ergonomics
- Investors in robotics
- Customers

3.3. Tools and actions

In order to disseminate the project's *results*, the MERGING dissemination plan leverages the following principal tools and actions:

- Presentations at Scientific Conferences
- Publications in scientific and technical journals
- Organisation of events during scientific conferences, industrial forums and events promoted by Industrial Associations
- Workshop & Webcast
- Online training
- Participation to Trade Fairs
- Project website & Social Media

The following table presents an updated timeline of how these actions and tools are deployed over the course of the project in order to convey the key messages listed in section 2.2 to the key audiences listed in 2.3.

Action/tool	Target Audience	Key Messages	Timing
Presentations at Scientific Conferences	Industry/Scientific Community	Results, feature and performances of the MERGING solutions	M18 onwards
Publications in scientific and technical journals	Scientific Community	Project results	M18 onwards
Organisation of parallel events during scientific conferences , industrial forums, and events promoted by Industrial Associations	Industry, Scientific Community	Results, feature and performances of the MERGING solutions	M18 onwards
Project workshop & Webcast	Industry, scientific community, stakeholders	Results, feature and performances of the MERGING solutions	M48
Online training	Industry, high-level education	Results, feature and performances of the MERGING solutions	M42 onwards
Participation to Trade Fairs	Industry	Performance of MERGING solution in targeted applications	M36 onwards
Project website & Social Media	All	Project results (in addition to concept and goals, see "Communication" section)	M2 onwards

Within the frame of the Quality Management task of the project (WP1 – Management), an **internal review process** has been formalized for all partners to gain approval from the consortium before submitting journal publications or conference publications.

It is instructed that publications follow the Open Access guidelines that are part of H2020. In addition to the publications in journals, Open Research Europe (https://open-research-europe.ec.europa.eu/)

will also be considered for publications, in particular for papers at the end of the project describing the three use cases.

3.3.1. Presentations of article publications at Scientific Conferences

During the project, several presentations at scientific conferences were carried out:

Title	Author Affiliation	Conference	Timing
On Modelling and Handling of Flexible Materials: A Review on Digital Twins and Planning Systems	LMS	8th Conference on Assembly Technology and Systems	29 September to 1 October 2020
Model-Based Robot Control for Human-Robot Flexible Material Co-Manipulation	LMS	26th International Conference on Emerging Technologies and Factory Automation	7-10 September 2021
RoMaDO-RA (Robotic Manipulation of Deformable Objects: Challenges in Perception, Planning and Control for Real-World Applications) workshop	LMS, AIMEN	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)	27 September to October 1 2021
Dexterous textile manipulation using electroadhesive fingers	EPFL	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)	27 September to October 1 2021
A variable stiffness soft gripper with integrated ion-drag pump	EPFL	SPIE Smart Structures + Nondestructive Evaluation, 2022	6-9 March 2022
Real-time Gesture Recognition in Industry	AIMEN	Workshop on Cognitive Modelling in Robot Learning for adaptive Human Robot interactions @ ICRA 2023	29 May to 2 June 2023
On deformable object handling: Model-based motion planning for human-robot co-manipulation	LMS	CIRP General Assembly 2022	21-27 August 2022
Slip Anticipation for Grasping Deformable Objects Using a Soft Force Sensor	EPFL	2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	23-27 October 2022
Controller design of a robotic assistant for the transport of large and fragile objects	CEA	2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	23-27 October 2022
Use of a human-centered manual interaction patterns analysis methodology for the specification of dexterous robotic grippers	CEA	2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)	29 August 2022 - 02 September 2022
An Intelligent Robotics Modular Architecture for Easy Adaptation to Novel Tasks and Applications	CEA	2023 IEEE 19th International Conference on Automation Science and Engineering (CASE)	26-30 August 2023
Automated assembly of non-rigid objects	LMS	CIRP General Assembly 2022	20-26 August 2023

Further information about these conference publications can be found in ANNEX A.

At the moment of writing this report, the consortium foresees the following conference publications that are expected to be reviewed and provisionally published after the project's conclusion.

Title	Author Affiliation	Conference	Timing
A Skill Programming Environment for Industrial Robots	CEA	ICRA/ IROS/ CASE	2024

3.3.2. Publications in scientific and technical journals

A number of articles related to the results of the project have been published in peer-reviewed journals (see below). In cases where the journals required the oral presentation of results within conferences or general assemblies, these activities have been also recorded in Section 3.3.1.

Title	Author Affiliation	Journal	Timing
On deformable object handling: Model-based motion planning for human-robot co-manipulation	LMS	CIRP Annals Volume 71, Issue 1, 2022	2022
How to compete with robots by assessing job automation risks and resilient alternatives	EPFL	SCIENCE ROBOTICS Vol 7, Issue 65	2022
Shielded soft force sensors	EPFL	Nature Communications 13	2022
Cyber-physical systems in non-rigid assemblies: A methodology for the calibration of deformable object reconstruction models	LMS	Journal of Manufacturing Systems, Volume 70	2023
On deformable object handling: multi-tool end-effector for robotized manipulation and layup of fabrics and composites	LMS	The International Journal of Advanced Manufacturing Technology	2023
Automated assembly of non-rigid objects	LMS	CIRP Annals Volume 72, Issue 2, 2023,	2023

At the moment of writing this report, the following articles (see details in Annex A) have been submitted to journals for publication. The list involves articles that are accepted, yet they are in production, or articles that are under peer review. Publications will continue for up to four years the end of the project.

Title	Author Affiliation	Journal	Timing
Artificial Intelligence in Manufacturing. Reinforcement Learning based approaches in manufacturing environments	AIMEN	Springer OA books	2023/2024 (in production)

A service-oriented orchestration and planning tool for plug and produce manufacturing: a deformable object handling supervision paradigm	LMS	International Journal of Computer Integrated Manufacturing	2023/2024 (under peer review)
Human Robot Interaction in Co-Manipulation of Deformable Objects *(book chapter)*	LMS	Springer Nature	2023/2024 (under peer review)

At the moment of writing this report, the consortium foresees the following journal publications that are expected to be reviewed and provisionally published after the project's conclusion.

Title	**Author Affiliation**	**Journal**	**Timing**
Hybrid cell for composites manufacturing	LMS, VDL	CIRP RCIM	2024/ 2025
Model-based co-manipulation of soft materials	LMS	CIRP SMEJMS	2024/ 2025
Extended reality interfaces for operator support	LMS	IJAMT	2024/ 2025

3.3.3. Project workshop & Webcast

A final seminar, the "MERGING Workshop" was organized at the final month of the project. The workshop took place in hybrid format, with the physical venue to be at the CEA-LIST facilities. Stakeholders, who could not physically participate, could join the workshop through video stream and be informed about the project's enabling technologies and technological results. A dedicated deliverable report (D9.10), led by IPC, documents all activities behind the organization, communication, execution and aftermath of this event. More details about the Project's workshop can be found in ANNEX D.

Figure 5. Group photo of the consortium at the end of the workshop

Figure 6. Interactive session involving the project's integration and industrial partners

3.3.4. Online training

In the context of "WP9 – Dissemination, Exploitation and Communication", the consortium, led by IPC, aims the preparation of materials for training and technology transferring towards effective technology acceptance. The plan of this knowledge transferring is documented within D9.8, whereas the transferring activities are reported within D9.9 as well as D9.10.

During the project period, internal sessions have been performed where technology experts showcased the designed and implemented modules to the rest of the consortium towards: a) efficient joint integration of the MERGING solution, and b) easy usage of the MERGING solutions by the end-users. These sessions had either physical, hybrid or teleconference formats depending on the ongoing project activities or events.

Apart from internal sessions, training material was also publicly available for engaging stakeholders that are either interested in the technological advances (and how these can be adopted and/or engineered) or interested on how these solutions can address their challenges.

In overall, the training material was organized in respect to the technical work packages and usually correspond to the project's Key Exploitable Results. For public training, the project's Website was used by forming a specialized thematic area, named "Tutorials". In that area, the training material was organized in pages where users can navigate and have access on manuals or video tutorials.

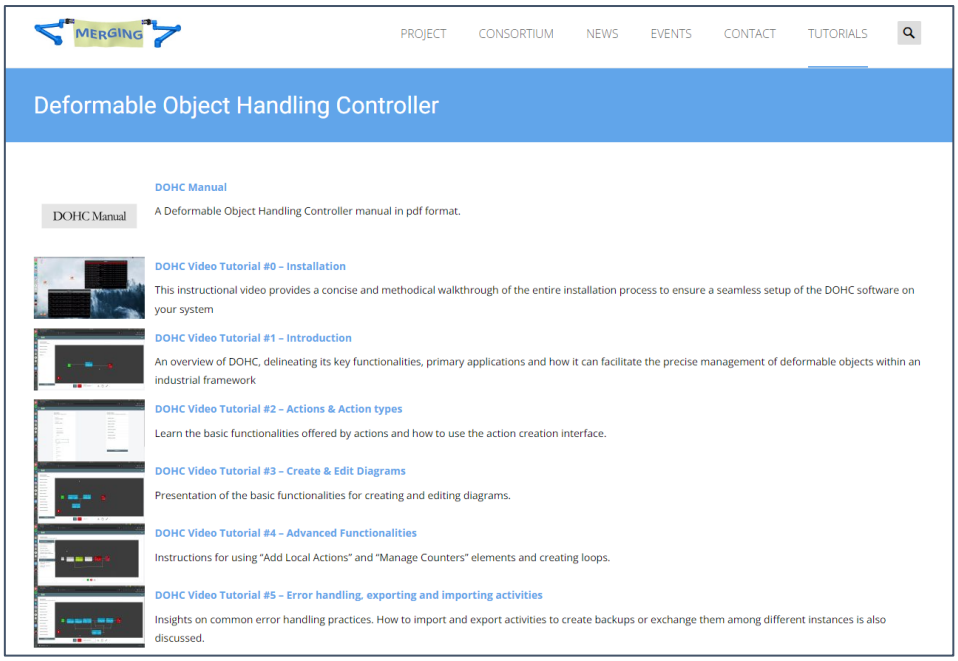


Figure 7. Indicative training material sessions for the Deformable Object Handling Controller by LMS

It is worth noting, that for public training material, any confidential information related to pending IP protection or non-disclosable information from the industrial partners, will be adapted into a light public version of the training plan.

3.3.5. Participation to Trade Fairs

Within the project, and after its ending, the project results will be presented at trade fairs and industry-related events, with a focus on the performance of MERGING solution in targeted applications. A list of potential participations is given in the table below. The list evolves and is updated depending on the foreseen opportunities (i.e., trade fair calendars) and stakeholder interest (i.e., European economy, market trends, etc.) for the project's technologies.

Industry field	Event
Manufacturing	World manufacturing Forum
	Smart Manufacturing Summit
	Global Industrie 2022 (France)
Robotics	LogiMat
	Global Robot Expo
	Production & Logistics Forum
	Hannover Messe
	Automatica
	Vision
	Robotics & Motion
	Sindex
Composites	JEC
Textile & clothing	ITMA
	Texworld
	Interfilier
	Lingerie Pro
Transport	Busworld
Packaging	All4pack
	Interpack
	Packinnove Machine

4. Clustering and collaboration with other projects

On the occasion of the preparatory meetings for the workshop at the European Robotics Forum 2021, a fruitful collaboration with the H2020 projects APRIL, REMODEL and SOFTMANBOT has started. MERGING's initiative in organizing the common workshop was key in promoting this collaboration.
Additional clustering activities straightened this collaboration, like the participations in the ERF2022 or ROMADORA workshops. Key contribution to these synergies had the inclusion of the projects in the "Hybrid Production Systems" cluster, that was founded by LMS almost a decade ago.
The four projects, including also DRAPEBOT that shares similar challenges, consist of a thematic group of the cluster that focuses on flexible material handling. Through the cluster, the projects can disseminate their results as well as communicate their outlook on key topics related automated non-rigid product manufacturing.
The latest clustering activity involved the organization of a special session under the "Hybrid Production Systems workshop" at ERF2023. LMS as project's dissemination leader, besides founding entity of the HPS cluster, mobilized the discussions for materializing this workshop. CEA has also reinforced the contact with DRAPEBOT, during the preparation of ERF2023, in the specific context of Artificial Intelligence and Human-Robot Collaboration. For more information regarding the workshop itself, refer to section 2.4.3 and appendix D. For the upcoming years, the cluster will contribute on further promoting the results of the MERGING project by its inclusion on public events or conferences. The audience can be informed about the cluster through the MERGING's public website under a specialized tab.

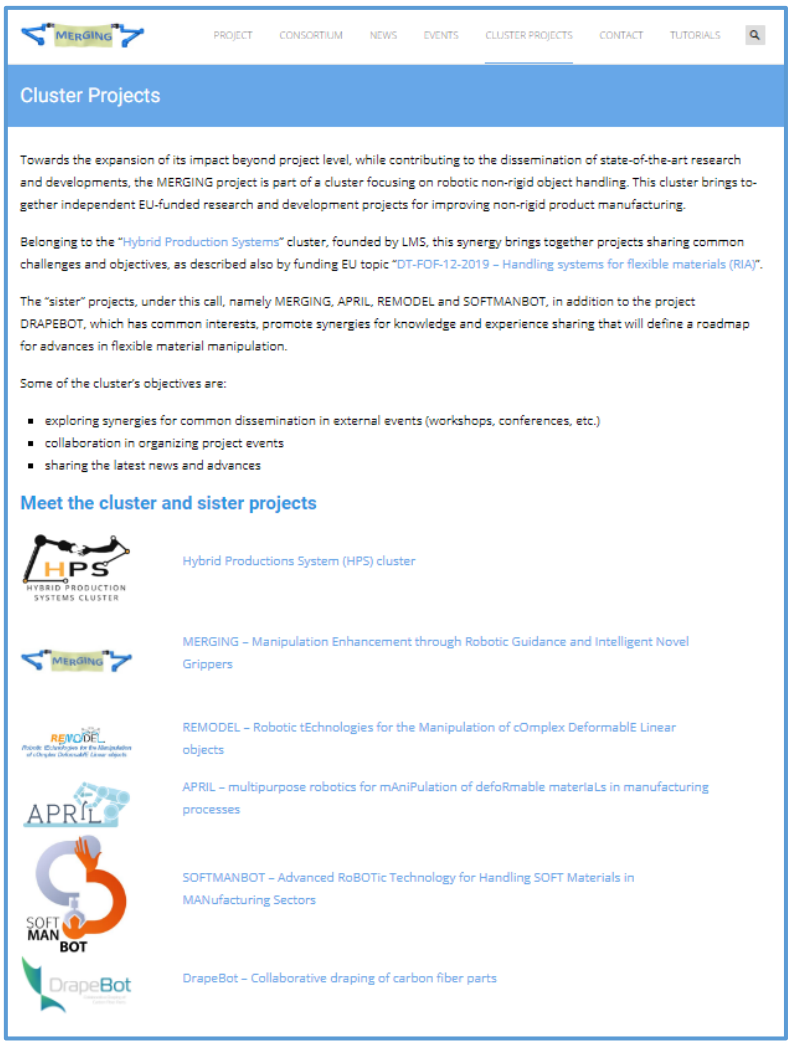


Figure 8. MERGING website page that informs about the cluster.

5. Assessment / evaluation criteria

The success of each action proposed in this plan is measured by tracking over time (starting after the official launch of the website), the monthly evolution of the following indicators:

Indicator	Target	Result (M48)
Traffic on the website	>10,000 pageviews	14249
Number of followers on social networks	>200 followers	>170
Number of project mentions on general media (TV, magazines, daily newspapers, online-only media portals...) and type (mentions, dedicated articles, interviews to Project members...)	>2 dedicated articles >20 mentions >5 interviews	• 1 dedicated article published • 2 articles in preparation • Interviews from 7 partners with multiple persons • 1 interview in preparation
Number of papers accepted by scientific journals	>7 articles	• 6 published • 3 under review/ production
Number of accepted papers/presentations at conferences and similar events	>7 papers >20 presentations	• 12 papers • 1 presentation
Number of participants to online training	>100	approx.. 110 and increasing
Number of attendees to final MERGING workshop/webcast	>100	62
Number of parallel project events organised	>3 events	4
Number of stories/events organized with European platforms for women in science/stem	>2	2 ongoing

ANNEX A – Details on patents, articles in conferences and peer reviewed journals

Patents

Despite not being a direct dissemination or communication activity, MERGING has submitted the following patents, which are associated with the project:

Patent name	Patent type	Date of publication	Reference
CEA - Process of part comanipulation by an operator assisted by a robotic partner	FR	20 May 2022	FR2204873
CEA - Process of part hybrid-comanipulation by an operator assisted by a robotic partner	FR	9 August 2022	FR2208213
CEA - Gripper, system and process of object insertion into a rail, and robot equipped with such gripper	FR	23 December 2022	FR2214458
OMNIGRASP - Electro-adhesive gripping system and method for gripping an object	US and WO (PCT[3] phase)	January 2023	EP21193935.0
CEA - Process and control system for a robotic system	FR	24 January 2023	FR2300637

Submitted and published articles on conferences

Title	On Modelling and Handling of Flexible Materials: A Review on Digital Twins and Planning Systems	
Authors	Dionisis Andronas, George Kokotinis, Sotiris Makris	**Abstract:** In this paper, a series of studies dealing with flexible material manipulation in aspects of manipulation, modelling and scheduling are discussed. The main purpose of this work is to provide an overview of the existing technologies and their capabilities both in manufacturing and academia, that can be elaborated in autonomous flexible material handling using robotics. The particularities of flexible material handling require advanced control systems for simulating, monitoring and managing the deformation of plies. A simulation model for predicting and defining the status of manipulated fabrics is proposed. Digital representation of the production system, in the basis of Digital Twin, is intended for achieving real-time adaptation. A pioneer control and planning system, interconnected to the digital model, is proposed for orchestrating the manipulation process. Current limitations of the existing technologies in flexible material handling and modelling are outlined and discussed, towards the implementation of a Workcell controller for flexible material manipulation robotic cell.
Affiliation	LMS	
Conference	8th Conference on Assembly Technology and Systems	
State	Published	

Title	Model-Based Robot Control for Human-Robot Flexible Material Co-Manipulation	
Authors	Dionisis Andronas, Emmanouil Kampourakis, Katerina Bakopoulou,	**Abstract:** Despite market importance and growth, manufacturing systems involving flexible materials, textiles and composites remain manual. Challenges related to flexible material deformation highlight limitations of robot cognition during fabric handling. This manuscript presents a model-based closed-loop control framework for seamless

[3] PCT: Patent Cooperation Treaty. By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in a large number of countries.

	Christos Gkournelos, Panagiotis Angelakis, Sotiris Makris	human-robot or multi-robot fabric co-manipulation. A mass-spring model is used for simulating ply distortion and generating optimal grasping points' spatial localization. The model is enhanced with real-time operator's handling actions, as captured from the implemented perception system. The proposed sensor and model-based controlling framework incorporates robot motion planners either for operator support, through non-rigid object co-manipulation, or synchronization of cooperative robots within fully automated tasks. An experimental setup is used for validating system's handling cognition during collaborative manipulation.
Affiliation	LMS	
Conference	26th International Conference on Emerging Technologies and Factory Automation	

Title	Dexterous textile manipulation using electroadhesive fingers	
Authors	Krishna Manaswi Digumarti, Vito Cacucciolo and Herbert Shea	**Abstract:** Handling of fabric is a crucial step in the manufacturing of garments. This task is typically performed by trained workers who manipulate one sheet at a time, thus introducing a bottleneck in the automation of the textile industry. This paper seeks to address the challenge of picking fabric up by proposing a new method of achieving ply-separation. Our approach relies on a finger-tip sized (2 cm 2) electroadhesive skin to lift fabric up. A pinch-type grasp is then used to securely hold the separated sheet of fabric, enabling easy manipulation thereafter. The ability to successfully pick up and manipulate a variety of commercial fabrics with diverse materials, shapes, sizes and textures is demonstrated. The ability to handle fabrics 100s of times larger than the electroadhesive skin is unique to our approach. Additionally, we demonstrate the manipulation of non-flat fabrics, a challenge that has not been previously addressed by electroadhesive approaches. We believe that this method introduces a smarter way of handling flexible and limp materials, showing great potential towards automation of garment manufacturing.
Affiliation	EPFL	
Conference	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)	

Title	A variable stiffness soft gripper with integrated ion-drag pump	
Authors	Krishna Manaswi Digumarti, Michael Smith and Herbert R. Shea	**Abstract:** We present a compact prehensile soft gripper capable of rapidly varying its stiffness on demand. It can grasp and also manipulate objects that have complex shapes. For instance, it can grab a mug by the handle or around the body of the mug, providing a high level of versatility. The gripper consists of fluidic chambers within a silicone structure, with two compliant electrostatic clutches bonded to opposite external surfaces. Bending actuation is achieved by pressurizing the chambers using an integrated electrohydrodynamic 'ion-drag' pump, while simultaneously blocking one of the clutches. Once the object is grasped, the second clutch is blocked, greatly increasing the stiffness of the structure, and allowing the object to be manipulated. The use of the integrated ion-drag pump means the gripper has the advantages of pneumatic actuations, but without the need for an external compressor. The integrated electrostatic clutches allow for bi-directional bending, and for very low energy consumption to hold a position. We will demonstrate the gripper picking up a range of objects.
Affiliation	EPFL	
Conference	SPIE Smart Structures & Non Destructive Evaluation Conference 2022	

Title	Slip Anticipation for Grasping Deformable Objects Using a Soft Force Sensor	
Authors	Judd, E., Aksoy, B., Digumarti, K. M., Shea, H., Floreano, D	**Abstract:** Robots using classical control have revolutionised assembly lines where the environment and manipulated objects are restricted and predictable. However, they have proven less effective when the manipulated objects are deformable due to their complex and

Affiliation	EPFL	unpredictable behaviour. The use of tactile sensors and continuous monitoring of tactile feedback is there-fore particularly important for pick-and-place tasks using these materials. This is in part due to the need to use multiple points of contact for the manipulation of deformable objects which can result in slippage with inadequate coordination between manipulators. In this paper, continuous monitoring of tactile feedback, using a liquid metal soft force sensor, for grasping deformable objects is presented. The trained data-driven model distinguishes between successful grasps, slippage and failure during a manipulation task for multiple deformable objects. Slippage could be anticipated before failure occurred using data acquired over a 30 ms period with a greater than 95% accuracy using a random forest classifier. The results were achieved using a single sensor that can be mounted on the fingertips of existing grippers and contributes to the development of an automated pick-and-place process for deformable objects
Conference	2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	

Title	Controller design of a robotic assistant for the transport of large and fragile objects	
Authors	Julie Dumora, Julien Nicolas, Franck Geffard	**Abstract:** This paper deals with the design of a robotic assistant for the transport of large and fragile objects. We propose a new collaborative robotic controller that fulfills the main requirements of co-transportation tasks of large and fragile objects: to execute any trajectory in a collaborative mode while minimizing the stress applied on the object by both partners in order to avoid damaging it. This controller prevents the robot from applying torques on the object while maintaining a desired orientation of the object along the transport trajectory in order to follow the operator. An original feature of our approach is to care about torques applied by both partners (not only by operator) during any co-manipulation trajectory execution. It leads to a novel outcome: the minimization of stress applied by both partners on a large and fragile object during its transport on any trajectory. We demonstrate the effectiveness of this approach in a collaborative transportation task.
Affiliation	CEA	
Conference	2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	

Title	Use of a human-centered manual interaction patterns analysis methodology for the specification of dexterous robotic grippers	
Authors	Thomas Mokadim; Florian Gosselin	**Abstract:** The advent of robots in our daily life depends on their ability to navigate and intervene efficiently in our environment. Whether considering household or industrial applications, one of the most important functions they should have is the ability to grasp and manipulate a large amount of objects, tools and machines that can vary in form, size and weight, but share the fact that they were designed for humans and have functional elements, e.g. buttons or handles, fitted to the human hand. The development of biologically inspired anthropomorphic robotic hands thus appears as a natural research path to allow robots replicating these activities. Such devices however prove to be complex to design and control, and they remain in practice limited to date to laboratory experiments. They hardly reach a sufficient simplicity, robustness and cost allowing for their widespread adoption in our houses or factories and industrial robots still make use of simple bi-digital grippers or dedicated tools which in turn suffer a poor versatility. To overcome this situation, novel dexterous grippers are required, that are sufficiently versatile to adapt to various situations and objects yet simple enough and cost effective. This compromise is however difficult to achieve and the specification of such grippers is still an open issue. This paper introduces a human-centered manual
Affiliation	CEA	
Conference	2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)	

		interaction patterns analysis methodology that intends to contribute to fill this gap. After a presentation of our approach, we apply it in different contexts and show how it can be used to orient a robotic gripper design that will fit given use-case requirements.

Title	Real-time Gesture Recognition in Industry	
Authors	A.M. Pertusa Llopis, A. Costas Lopez, J. Masood	**Abstract:** Computer vision-based gesture recognition and cognitive modeling connectivity can play a key role in developing efficient algorithms and understanding the neural mechanism behind multiple human communication. It leverages to detect, track, and interpret human body movements in intuitive ways so that we can control and interact with robots in a safe manner. In this paper, we present our experience of deploying real-time gesture recognition based on the multiple industrial camera system. A new strategy is presented based on YOLO and OpenPose to reach 13 fps with robustness to detect, track, and decompose movements of multiple humans wearing different clothing. YOLO was used to detect and track the person and the background was eliminated to focus only on the area in the image that represents humans. OpenPose was used to detect the 15 key point information from each human bounding box. This precise key point information was then used to construct the human 2D skeleton for gesture recognition. The approach yields robust and stable results with limitations pertaining to human crossing and human cloth-to-background color matching. Index Terms—gesture recognition, low-cost sensors, non-verbal cues, human detection, human tracking.
Affiliation	AIMEN	
Conference	Workshop on Cognitive Modelling in Robot Learning for adaptive Human Robot interactions @ ICRA 2023	

Title	An Intelligent Robotics Modular Architecture for Easy Adaptation to Novel Tasks and Applications	
Authors	F. Gosselin, G. Acher, B. Gradoussoff, et all.,	**Abstract:** Industrial robots significantly contributed to the increase of quality and productivity in the industry. Still, their deployment and use remain complex and expensive, limiting their main market to mass production in large factories. This article introduces an intelligent robotics framework intended to solve this issue. It relies on a four-layer modular architecture associating a components-agnostic orchestrator coordinating software modules accessed through a standard middleware, and different hardware running the required functions. This architecture is implemented for performing various tasks in autonomy or in collaboration with a human operator, the different components being turned on and adapted on-demand according to the use-case requirements. We illustrate the proposed concept on four robotic sequences: the assembly of a representative gear unit with one arm, the same application with two robots, the Robothon® Grand Challenge and the insertion of deformable objects in a rail.
Affiliation	CEA	
Conference	2023 IEEE 19th International Conference on Automation Science and Engineering (CASE)	

Submitted and published articles in peer reviewed journals

Title	On deformable object handling: Model-based motion planning for human-robot co-manipulation	
Authors	Makris, S., Kampourakis, E., Andronas, D.	**Abstract:** Despite extensive automation in multiple industrial sectors, manufacturing operations involving deformable objects are mostly performed manually. Challenges originating from flexible objects' dynamic distortion underline handicaps in robot cognition and dexterity. This paper presents a model-based motion planner for deformable object co-manipulation. The developed closed-loop
Affiliation	LMS	
Journal	CIRP Annals	

	Volume 71, Issue 1, 2022	controlling framework interprets manipulation inputs into appropriate handling actions by simulating fabric's distortion through a mass-spring model. The planner incorporates tools for rapid system commissioning and reconfiguration, grasping point planning, and monitoring of human actions. Inspired by automotive composite industry, two experimental setups are used for validating the system's performance during translational and rotational co-manipulation.

Title	How to compete with robots by assessing job automation risks and resilient alternatives	
Authors	Paolillo, A., Colella, F., Nosengo, N., Schiano, F., Stewart, W., et al.	**Abstract:** The effects of robotics and artificial intelligence (AI) on the job market are matters of great social concern. Economists and technology experts are debating at what rate, and to what extent, technology could be used to replace humans in occupations, and what actions could mitigate the unemployment that would result. To this end, it is important to predict which jobs could be automated in the future and what workers could do to move to occupations at lower risk of automation. Here, we calculate the automation risk of almost 1000 existing occupations by quantitatively assessing to what extent robotics and AI abilities can replace human abilities required for those jobs. Furthermore, we introduce a method to find, for any occupation, alternatives that maximize the reduction in automation risk while minimizing the retraining effort. We apply the method to the U.S. workforce composition and show that it could substantially reduce the workers' automation risk, while the associated retraining effort would be moderate. Governments could use the proposed method to evaluate the unemployment risk of their populations and to adjust educational policies. Robotics companies could use it as a tool to better understand market needs, and members of the public could use it to identify the easiest route to reposition themselves on the job market.
Affiliation	LMS	
Journal	SCIENCE ROBOTICS, Vol 7, Issue 65	

Title	Shielded soft force sensors	
Authors	Bekir Aksoy, Yufei Hao, Giulio Grasso, Krishna Manaswi Digumarti, Vito Cacucciolo & Herbert Shea	**Abstract:** Force and strain sensors made of soft materials enable robots to interact intelligently with their surroundings. Capacitive sensing is widely adopted thanks to its low power consumption, fast response, and facile fabrication. Capacitive sensors are, however, susceptible to electromagnetic interference and proximity effects and thus require electrical shielding. Shielding has not been previously implemented in soft capacitive sensors due to the parasitic capacitance between the shield and sensing electrodes, which changes when the sensor is deformed. We address this crucial challenge by patterning the central sensing elastomer layer to control its compressibility. One design uses an ultrasoft silicone foam, and the other includes microchannels filled with liquid metal and air. The force resolution is sub-mN both in normal and shear directions, yet the sensor withstands large forces (>20 N), demonstrating a wide dynamic range. Performance is unaffected by nearby high DC and AC electric fields and even electric sparks.
Affiliation	EPFL	
Journal	Nature Communications volume 13	

Title	Cyber-physical systems in non-rigid assemblies: A methodology for the calibration of deformable object reconstruction models	
Authors	Nikolaos Theodoropoulos, Emmanouil Kampourakis, Dionisis Andronas, Sotiris Makris	**Abstract:** Despite the advances in robot agent cognition and systems' decision-making, under the prism of cyber-physical systems and industrial metaverse, the manufacturing processes involving the handling of non-rigid product assemblies present a delay in the adoption of smart automation. Model-based planning and control can address the particularities of deformable object manipulation;

Affiliation	LMS	however, their competence is heavily dependent on the models' accuracy and reconstruction frequencies. Despite the many breakthroughs that have been achieved in real-time modelling and behavior prediction of deformable objects, the calibration of such models and the measurement of their accuracy remain a significant challenge. In this paper, a method for the definition of the physics parameters of flexible material reconstruction models is presented. The proposed systematic approach, employing a number of optimization algorithms, fine-tunes the model's parameters for the real-world deformable object, as captured by the perception system, to be aligned with its digital twin. A mass-spring model for the reconstruction of two-dimensional fabric objects is used as an application paradigm. An experimental setup in an industrially relevant environment validates the applicability of the proposed approach and is used for assessing alternative sensing practices and optimization algorithms.
Journal	Journal of Manufacturing Systems. Volume 70	

Title	On deformable object handling: multi-tool end-effector for robotized manipulation and layup of fabrics and composites	
Authors	Giorgos Papadopoulos, Dionisis Andronas, Emmanouil Kampourakis, Nikolaos Theodoropoulos, Panagiotis Stylianos Kotsaris & Sotiris Makris	**Abstract:** Despite the advances in robot agent cognition and systems' decision-making, under the prism of cyber-physical systems and industrial metaverse, the manufacturing processes involving the handling of non-rigid product assemblies present a delay in the adoption of smart automation. Model-based planning and control can address the particularities of deformable object manipulation; however, their competence is heavily dependent on the models' accuracy and reconstruction frequencies. Despite the many breakthroughs that have been achieved in real-time modelling and behavior prediction of deformable objects, the calibration of such models and the measurement of their accuracy remain a significant challenge. In this paper, a method for the definition of the physics parameters of flexible material reconstruction models is presented. The proposed systematic approach, employing a number of optimization algorithms, fine-tunes the model's parameters for the real-world deformable object, as captured by the perception system, to be aligned with its digital twin. A mass-spring model for the reconstruction of two-dimensional fabric objects is used as an application paradigm. An experimental setup in an industrially relevant environment validates the applicability of the proposed approach and is used for assessing alternative sensing practices and optimization algorithms.
Affiliation	LMS	
Journal	The International Journal of Advanced Manufacturing Technology, Volume 128	

Title	Automated assembly of non-rigid objects	
Authors	Sotiris Makris, Franz Dietrich, Karel Kellens, S.Jack Hu	**Abstract:** Many assembled products contain parts that are not rigid, and there is a large variety of such parts, which might be as different as cables, sheet metals, plastic covers, or foams. The assembly processes of such products may also involve non-rigidity in the tools used. Non-rigidity in the parts and tools adds additional degrees of freedom to the assembly processes and systems, which, on the one hand, adds engineering complexity, and on the other hand, may be the key for superior solutions. This paper reviews recent developments in models, methods, handling techniques, and control of such parts at the assembly station and systems levels with a main focus on applications related to the manufacturing industry. The core areas of knowledge addressed by this paper cover advanced models for non-rigid objects, process and system planning, new tooling, and new control concepts based on perception and human-robot interaction. More research work is expected in the field of modelling and perception due to the
Affiliation	LMS	
Journal	CIRP Annals Volume 72, Issue 2, 2023	

		development of computer vision, robotics, and artificial intelligence. New advances on the processing and assembly hardware can also be expected due to the highly active research field of soft material robotics and high-payload-gripping with soft material versatility.

Under peer-review or production articles submitted in journals

Hereafter, the project's articles that are under peer review process or they have been accepted, but yet are in production, are enlisted:

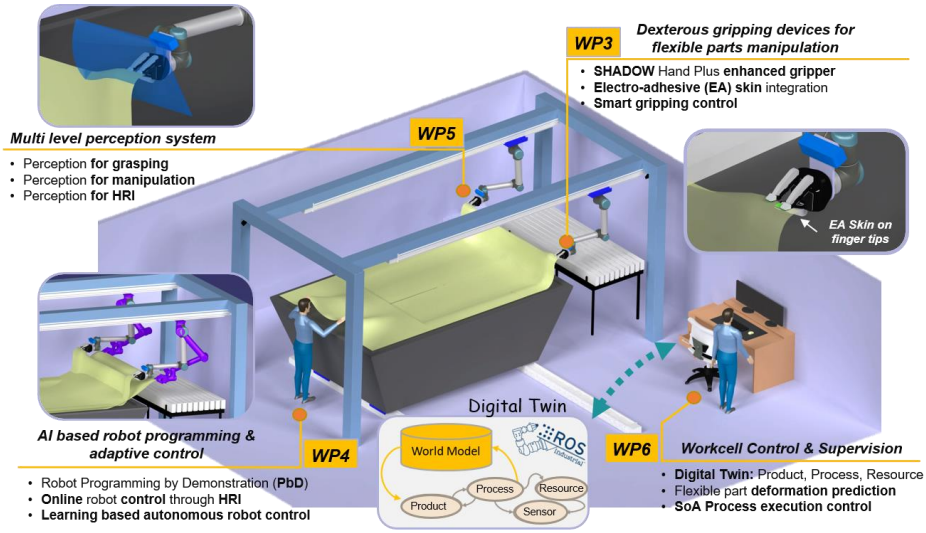
Title	Artificial Intelligence in Manufacturing. Reinforcement Learning based approaches in manufacturing environments ***(production)***	
Authors	A. F. Martínez, C. González-Val, D. Gordo Martín, A. Botana López, J. A. Segura Muros, A. M. Petrusa Llopis, J. Masood and S. Muiños-Landin	**Abstract:**
Affiliation	AIMEN	
Journal	Springer OA Books	

Title	A service-oriented orchestration and planning tool for plug and produce manufacturing: a deformable object handling supervision paradigm ***(peer review)***	
Authors	Konstantinos Kavvathas, Emmanouil Kampourakis, Dionisis Andronas, Nikos Fousekis, Sotiris Makris	**Abstract:** Recurrent production changes due to shortened product lifecycles besides the increased complexity, that the industry 4.0 paradigm brings, highlight the need for tools that are able to seamlessly orchestrate intelligent resource agents and guarantee rapid commissioning times. This paper presents a complete package for the creation, debugging, editing, management and execution of complex work schedules of robotic systems, named Workcell Controller. The controller is capable of simultaneously orchestrating multiple resources and modules or managing errors based on the real time shopfloor's state. For greater applicability and compatibility, it is completely integrated with the ROS framework, meaning that standard ROS interfaces, functionalities and practices can be deployed. An intuitive web-based graphical user interface is designed for offering high usability even for novice users during programming and execution phases. The proposed package has been deployed and tested in two use cases inspired from the composites industry, demonstrating the controller's applicability, usability and short ramp up times.
Affiliation	LMS	
Journal	International Journal of Computer Integrated Manufacturing	

Title	Human Robot Interaction in Co-Manipulation of Deformable Objects ***(peer review)***	
Authors	Dionisis Andronas, Nikolaos Theodoropoulos, Konstantinos Kavvathas, Emmanouil Kampourakis, Panagiotis Stylianos Kotsaris & Sotiris Makris*	**Abstract:** Recurrent production changes due to shortened product lifecycles besides the increased complexity, that the industry 4.0 paradigm brings, highlight the need for tools that are able to seamlessly orchestrate intelligent resource agents and guarantee rapid commissioning times. This paper presents a complete package for the creation, debugging, editing, management and execution of complex work schedules of robotic systems, named Workcell Controller. The controller is capable of simultaneously orchestrating multiple resources and modules or managing errors based on the real time shopfloor's state. For greater applicability and compatibility, it is completely integrated with the ROS framework, meaning that standard ROS interfaces, functionalities and practices can be deployed. An intuitive web-based graphical user interface is designed for offering high usability even for novice users during programming and execution phases. The proposed package has been deployed and tested in two use cases inspired from the composites industry, demonstrating the controller's applicability, usability and short ramp up times.
Affiliation	LMS	
Journal	Springer Nature	

ANNEX B – Press releases

Press release 1	A robotic platform to manipulate soft materials in industrial environments



The MERGING collaborative project, involving twelve partners from academia and the industry, will pioneer the use of robotics and Artificial Intelligence for manipulating flexible and fragile objects. The resulting technologies are to be applied to the textile, food and transport industries

A newly-launched European research project will develop and test new technologies to give robots one of the key abilities they still miss: the ability to manipulate soft, flexible and fragile objects.

Current robots are mostly used for industrial applications, where their tasks typically consist -of handling rigid objects such as car parts or electronic components, interacting with them in repetitive operations. On the other hand, a big part of the European and global industry is comprised of sectors where soft and flexible items are manipulated. For example the textile industry, with the fabrication of garments, shoes or lingerie; the food supply chain, that encompasses a wide range of difficult tasks like the processing of meat, canning, packaging or manipulation of food, liquids, fruits, vegetables, and all sort of tasks in retail; the transport sector, involving the manipulation of glass fibre, carbon fibre or other materials for the manufacturing of composite parts for building structures of vehicles. All these materials do not behave in an entirely predictable way, due to their high flexibility, and can be easily damaged. Grasping and manipulating them requires a gentle grasp, fine and adaptive control of movements that is beyond the current state of the art in robotics.

The European project MERGING (Manipulation Enhancement through Robotic Guidance and Intelligent Novel Grippers), that launched in November 2019, aims to design a versatile, low cost and easy-to-use robotic solution that manufacturers can apply to support or automate tasks involving the handling of flexible or fragile objects. It will consist of a new robotic dexterous gripper taking advantage of an integrated adaptive electro-adhesive skin. This skin will induce electrostatic attraction between the gripping surface and the object, thanks to an electric field produced by skin-enclosed electrodes. The skin will also have the ability to conform to the objects to handle to raise the contact surface. Thanks to this skin, the new gripper will show enhanced gripping performances, while reducing the gripping forces, thus avoiding damaging the soft objects. The control of the complete robotic system will include, firstly, perception and supervision functions to adapt the system's response to the execution conditions and to high variability of the flexible object's behaviour; secondly, control abilities to make the human-robot or multi-robot co-manipulation of the flexible object safer, using Artificial Intelligence and Machine Learning. Thus, the robot will be able to learn how to handle soft objects without damaging them, as well as how to safely work side by side with humans.

The Merging technology will be tested in three different applications and sectors. The first one is lingerie manufacturing, with the manipulation of fine textile parts during a critical step of the process, the thermoforming process. The second one is food packaging, more specifically the handling of soft plastic pouches. The third one is the transport industry, where robots and humans will collaborate in handling glass-fibre textiles and foam to manufacture composite panels.

MERGING is a three-and-a-half years project coordinated by CEA (Commissariat a l'Energie Atomique et aux Energies Alternatives) in France, and involving academic and industrial partners from five countries: LMS (Greece), EPFL (Switzerland), AIMEN (Spain), SELMARK (Spain), VDL (Netherlands), Thimonnier (France), Shadow Robot (UK and Spain), IPC (France), CASP (Greece), Opteamum (France).

Press release 2	**How a new generation of robots can change the textile industry**

Robots have transformed many areas of manufacturing, to the point that whole industries –from automotive to electronics and chemical – would now be unthinkable without them. But other sectors are far more resistant to automation, and yet could equally benefit from it.

The textile industry is a good example. Textile and clothing are essential pillar in the European economy, involving around 160,000 companies employing over 1.5 million workers, with a turnover of 162 billion euros. Here, manufacturing processes are mostly manual, and in an effort to contain costs, businesses often end up outsourcing them to low-cost labor countries. As a result, Europe exports € 61bn worth of textile products, but imports € 109 bn – a trend that automation could help reverse.

For the European clothing sector, innovating through automation could be a way to increase competitiveness and reduce outsourcing, but there are huge scientific and technical challenges to overcome for automating the manipulation of textile materials. That is the reason why MERGING, a European research project on soft objects robotic manipulation coordinated by CEA and involving 11 other partners from industry and academia, has chosen the textile industry as one of its key use cases. Within MERGING, researchers and engineers from several institutions are working with SELMARK, a leading manufacturer of lingerie based in Vigo (Spain), to develop a robotic system that can support human operators in the most repetitive and tiring tasks that happen before the stitching of the final product: in particular de-stacking textiles from storage, grasping, placing and unfolding them to avoid wrinkling, measuring parts for intermediate quality control before next steps of the process. These operations are impossible for traditional robotic manipulators designed for rigid objects, as they cannot easily adapt in real time to the unpredictable behavior of fabrics. Total or partial automation of these tasks can promote the allocation of personnel to tasks that have more added value, while reducing the global production costs.

The MERGING solution is to combine various building blocks. At the basis, there are two collaborative robot arms that can safely work close to humans. The arms are equipped with a dedicated gripper, enhanced with EPFL's electroadhesive skin, a technology that uses electric fields to make objects stick to the jaws. Stereo cameras provide perception and high precision tracking of textiles developed by AIMEN, that -together with computer models of fabric's behaviour– allow to adapt the robot's movements in real time. The robot arms can be easily programmed by unexperienced users, thanks e.g. to robot programming by demonstration or other control features developed by CEA. Thus, the operator can show the robot how to perform the required tasks, rather than programming every movement on a computer. All data are combined into LMS's "digital twin", a digital representation of the working environment that allows to simulate process before transmitting orders to the combined industrial work cell supervision system.

When all these technologies are combined, the robotic grippers can grasp a ply from the textile materials stack, carefully detaching it from the ones below. The ply is then placed on the thermoforming device, and if any wrinkle is detected by the perception system, the robot will use corrective actions to undo it. The robot then feeds the fabric to presses that give the material the desired 3D shape (e.g. a cup, in the case of lingerie production), and places it on a stack of modified parts ready for the next step of the process.

MERGING started in late 2019 and is now halfway through its work programme, perfecting the system's building blocks. In early 2022 it will start working on the integration phase before setting up the pilot demonstration at SELMARK premises, which will be overseen by AIMEN covered by IPC.

The textile industry is only one of the three use cases explored by this project, that will also apply similar robotic technologies to food packaging and to the manipulation of fabrics in the automotive industry.

Press release 3	The Merging Solution, for enhanced flexible material handling, tested at lab environment

The technological outcomes of MERGING have started to demonstrate their potential. Research partners, supported by the project's integrators, have collaborated on delivering the project's integrated robotic systems. Industrial integration and validation get underway for the food packaging, textiles and composites industries.

The consortium of the European project MERGING, coordinated by CEA, has tested its new intelligent robotic system for enhanced material handling through cost efficient robotized solutions.
The project has developed a series of technological modules for furnishing the robots with the abilities of perceiving flexible material deformations and managing their behaviour within autonomous or collaborative scenarios. Now, the system is able to orchestrate numerous software and hardware modules, despite the sophistication of infrastructure that can be required for non-rigid workpiece handling. The partners have aimed on delivering tools for easy system programming and commissioning, using intuitive interfaces or teleoperation schemes.
As for the handling, pioneer gripping solutions by OMNIGRASP, LMS and OPTEAMUM have excelled in the manipulation of flexible packaging, garments, fiberglass composites, and composite core materials. These empower the deployment of pioneer handling strategies, by LMS, CEA and AIMEN, involving single- or dual-arm robot manipulators. Depending on the industrial needs, the robotic solution can operate autonomously or collaborate with human operators by translating their handling intentions into supportive actions.

The results from the three pre-pilot demonstrators initiate the last project phase.

At this step, three integrated settings have been materialized in parallel, in three different countries.
The first one, located at AIMEN research facilities in Spain, focuses on the automation of lingerie manufacturing. The specifications deriving from the SELMARK industrial case drove the integration activities, involving dual arm manipulation through electroadhesive (EA-) grippers.
On the same basis, a demonstrator for the semi-automation of composites manufacturing has been established at LMS facilities, in Greece. LMS has conceptualized and materialized a pioneer system based on an overhead dual arm manipulator, sufficiently close to an industrial solution.
Finally, there is one additional experimental setting, supervised by CEA. Located at CEA LIST facilities, in France, the demonstrator deals with the one industrial case of the food packaging industry. It also provided useful outcomes regarding important MERGING building blocks, proving the applicability of our project's solutions on different application sectors.

The results have been obtained through joint activities between the technology developing partners. Collaborative workshops have delivered quality results and important insights for the upcoming activities. The partners are confident for the success of the next phase
In overall, the project's integration milestones and objectives are achieved and "we are ready to start industrial integration", says the project's steering committee.

MERGING is a four-year project coordinated by CEA (Commissariat a l'Energie Atomique et aux Energies Alternatives) in France and it is involving academic and industrial partners from six countries: LMS (Greece), EPFL (Switzerland), AIMEN (Spain), SELMARK (Spain), VDL (Netherlands), Thimonnier (France), OMNIGRASP (Italy), IPC (France), CASP (Greece), and Opteamum (France).

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Press release 4	**The Merging Solution, for enhanced flexible material handling, tested at lab environment**

Building on its prior success, MERGING's innovations have now been tested on the industrial floors. Together with the project's integrators, research teams have transitioned the robotic systems from the lab to real-world industrial setups. Comprehensive industrial testing and validation have been successfully completed, marking a milestone for the food packaging, textile, and composite sectors.

The MERGING consortium has successfully transitioned its robotic systems from the lab to the demanding environment of industrial shop floors. The developed robotic solutions, designed to enhance automation in flexible material handling, seamlessly integrate a collection of software and hardware modules that equip robots with advanced capabilities, allowing them to perceive and adapt to deformations in flexible materials and manage their interactions in both autonomous and collaborative settings.

The creation of user-friendly tools for system programming and orchestrating is also considered as an important aspect of the developed technologies. Through intuitive interfaces, activities are directed towards simplifying the integration and use of the developed system in industrial setups.

Key to the project's success are novel gripping solutions developed by OMNIGRASP, LMS and OPTEAMUM. These tools excel in the handling of a diverse range of materials, from flexible packaging and garments to fiberglass fabrics and composite core materials. In collaboration with LMS, CEA and AIMEN, these solutions pave the way to innovative handling strategies using single or dual-arm robot manipulators. Designed to meet the requirements of industrial tasks, the MERGING solution can either operate in a fully automatic way or collaboratively with human operators, translating their handling intentions into robotic movements.

The outcomes from industrial integration signal the project's final milestone.

Following the laboratory testing phases, the three setups underwent practical testing in real-world industrial settings, resulting in all consortium partners' building blocks integration across diverse facilities.

The intermediate setup developed at AIMEN research facilities in Spain, dedicated to the automation of lingerie manufacturing, has been integrated into SELMARK facilities. The design and development activities by the partners were based on specifications from the SELMARK industrial case, and the final solution involves dual-arm manipulation using new electro-adhesive (EA) grippers.

Similarly, a system for the semi-automation of composites manufacturing, initially designed and implemented at LMS facilities in Greece, has been successfully integrated with the partners into the VDL Fibertech facilities. The innovative approach, centered on an overhead dual-arm manipulator, yielded results that reflect the efficiency and precision demanded by this challenging sector.

The robotic setup, originally developed at CEA LIST facilities in France, was successfully integrated with the partners into THIMONNIER facilities. This integration addressed challenges inherent to the flexible materials encountered in food packaging industry. The final solution involves two collaborating robots and the use of a new electro-adhesive (EA) gripper.

Beyond achieving their primary objectives, the demonstrators also provided valuable insights regarding essential MERGING components, highlighting the project's fundamental results adaptability across diverse sectors.

The observed achievements are results of the collective dedication and expertise of the technology developing partners. Through collaborative workshops, the consortium achieved significant outcomes, reinforcing the value and effectiveness of the project's innovations. The enhancement of handling capabilities of robots for soft objects manipulation revealed the potential of automation for improved quality and consistency. It will also improve the working conditions of operators. By shifting the technological baselines, the consortium is now motivated on further extending robot capabilities within future initiatives, widening also the domains of application.

The project has successfully realized its integration milestones, marking a notable advancement in the evolution of soft material handling solutions. The progress made by MERGING underscores its potential in shaping the future of industrial applications.

MERGING is a four-year project coordinated by CEA (Commissariat a l'Energie Atomique et aux Energies Alternatives) in France and is involving academic and industrial partners from six countries: LMS (Greece), EPFL (Switzerland), AIMEN (Spain), OMNIGRASP (Italy), IPC (France), CASP (Greece), Opteamum (France), SELMARK (Spain), VDL (Netherlands) and Thimonnier (France).

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869963

Press release 5	**A new era for textiles industry: the MERGING solution**

Many manufacturing sectors have been transformed by robots, which have become essential for industries such as automotive, assembly and others. However, some sectors are still reluctant to adopt automation, even though they could also benefit from it.

One of the selected use cases for MERGING, a European research project on soft robotics manipulation, coordinated by CEA and involving 11 partners from industry and academia, is the textile industry. It is a good example of a sector that could benefit from automation, but faces huge challenges in handling textile materials. For the European clothing sector, innovation through automation could be a way to boost competitiveness and reduce outsourcing, but most manufacturing processes are still manual and often outsourced to countries with low labor costs. This leads to a trade deficit for Europe, which exports € 61bn worth of textile products, but imports € 109 bn. Automation could help reverse this trend.

Textile and clothing are vital for the European economy, with around 160,000 companies employing over 1.5 million workers and generating a turnover of 162 billion euros.

A robotic system that can assist human operators in the most tedious and exhausting tasks before the final product is stitched has been developed by researchers and engineers from various institutions within MERGING, a European research project on soft robotics manipulation. They have been working with SELMARK, a leading lingerie manufacturer based in Vigo (Spain).

The robots are responsible of taking textiles from the storage, then grabbing, placing and measuring them while preventing them from wrinkling. These operations are not feasible for traditional robotic manipulators designed for rigid objects, as they cannot easily adjust in real time to the unpredictable behavior of fabric. By automating these tasks completely or partially, personnel can be assigned to tasks that have more value added.

The MERGING solution comprises a pair of collaborative robot arms designed to operate safely alongside human workers. These arms are equipped with grippers developed by OMNIGRASP that utilize electroadhesion technology, leveraging electric fields to make objects adhere to their end-effectors. This feature enhances their ability to handle objects effectively. Additionally, AIMEN provides stereo vision technology, enabling precise perception and real-time tracking of textiles, allowing the robot's movements

to be adjusted as needed. CEA's multi-modal programming by demonstration allows even inexperienced users to instruct the robot on task execution.
For high-level coordination, LMS's Workcell Controller is employed to ensure runtime synchronization and monitoring of the execution process. Within SELMARK's implemented robotic system, the robot arms carefully pick fabrics from a stack of textile materials, gently separating each layer from those below it. Subsequently, each ply is placed onto the thermoforming press, with the perception system promptly notifying if any wrinkles are detected. This integrated solution aims to enhance working conditions by assigning operators to less repetitive, more value-added tasks.
MERGING started in late 2019 and, within its four-year duration, it has worked on the implementation of innovative modules in the areas of handling, perception, cognition, and programming. Among others, the integrated demonstrator at SELMARK facilities consists of a benchmark not only for the robotics community but also for the textiles industry.
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869963

Press release 6	**MERGING's hybrid cell: a benchmark for composites manufacturing industry**

The automotive sector was the first major application of industrial robots, and is still the main adopter of automation technologies, accounting for almost 30 % of all industrial robots that are currently operative worldwide. Yet, even in the automotive industry there are parts of the manufacturing process that are still difficult to automate, as is the case of the manufacturing of composite parts.

That is why MERGING, a European research project on soft robotics manipulation coordinated by CEA and involving 11 partners from industry and academia, has chosen the fabrication process of fiber composites in the automotive sector as one of its key use cases.

When used in the automotive sector, composites can provide increased strength and stiffness while also reducing the weight of vehicles up to 70% compared to metallic alloys. The possibilities to shape them are also limitless. They already play an important role in the advanced transportation industry, in particular when it comes to reducing fuel consumption and CO2 emissions.

However, fiber composites are still more expensive than lightest metallic alloys, and before they become cost-effective, a decrease of up to 40% in production cost is required. One of the ways to achieve this objective is automation, but these materials pose several challenges to existing robotic solutions. Dry fibers are similar to conventional textiles and thus, highly flexible and highly deformable. Foam blocks are less flexible, but fragile. These individual component parts can be heavy and large, adding further challenges for manipulation.

Currently, manufacturing processes involve a series of manual handling operations of flexible Glass Fiber (GF) textiles in addition to reinforcement foam blocks. The complete workflow takes place on lay-up molds where all types of GF textiles and foams are positioned before resin infusion. The dimensions of the mold itself limit operator access to all areas, resulting in fluctuations in the performance in terms of production rate and quality, in addition to ergonomic issues that can affect workers.

Within MERGING, researchers and engineers from several institutions have worked with VDL Fibertech industries, a member of the VDL group and one of the Netherlands largest composite producers that operates in several markets. Together, they have developed a robotic system that can support human operators in the manufacturing of large composite panels by performing grasping, manipulation and placement of textiles and foam blocks.

The envisioned solution proposes a hybrid cell where humans and robots collaborate within a fenceless environment. LMS, as pilot driver, led the engineering of the system by designing a custom overhead dual arm manipulator. Together with the project's research partners, namely CEA and AIMEN, besides its integrators, CASP and OPTEAMUM, they have enhanced its dexterity, perception, cognition and interaction capabilities through state-of-the-art hardware and software modules.

Starting with dexterity, LMS designed a multi-tool end-effector that is able to handle all composite materials, or perform layup operations, without excessive and time costly tool changes. In terms of perception, LMS in collaboration with AIMEN, have deployed a number of perception modules for fabric localization and quality assurance, besides human tracking for safety and interaction purposes. Towards even greater cognition, LMS implemented a physical model that accurately simulates the fabric's deformation within co-manipulation, in real-time. An extension of this model empowers model-based co-manipulation of fabrics either in collaborative schemes or fully automated ones. CEA led the implementation of closed-loop controllers that allow the co-manipulation of fabrics or fragile objects without the need of external sensors, thanks to impedance control, or using sensor-enhanced gloves (allowing also intuitive tele-operation of distant robot arms). Rapid robot and system programming is enabled by the SPIRE framework of CEA, as well as by the Workcell Controller package, of LMS. The former package offers an intuitive environment for system orchestration and monitoring during runtime. For human-centricity, LMS implemented extended reality applications where operators can interact with the digital twin or receive support through intuitive content.

Successful integration and evaluation campaigns proved that the implemented system achieved the project's specifications and sets new boundaries for robotic automation in composites manufacturing.

The composite industry is only one of the three use cases explored by the project, which also applied similar technologies to food packaging and textiles for clothing industries. MERGING is a four-year project, coordinated by CEA (Commissariat a l'Energie Atomique et aux Energies Alternatives) in France, and it is involving academic and industrial partners from six countries: LMS (Greece), EPFL (Switzerland), AIMEN (Spain), SELMARK (Spain), VDL (Netherlands), Thimonnier (France), OMNIGRASP (Italy), IPC (France), CASP (Greece), and Opteamum (France)**For more information:**
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869963.

ANNEX C – Project leaflet and banner

Figure 9. Project leaflet – first version

Figure 10. Project leaflet - second version

Figure 11. Project leaflet - Third version

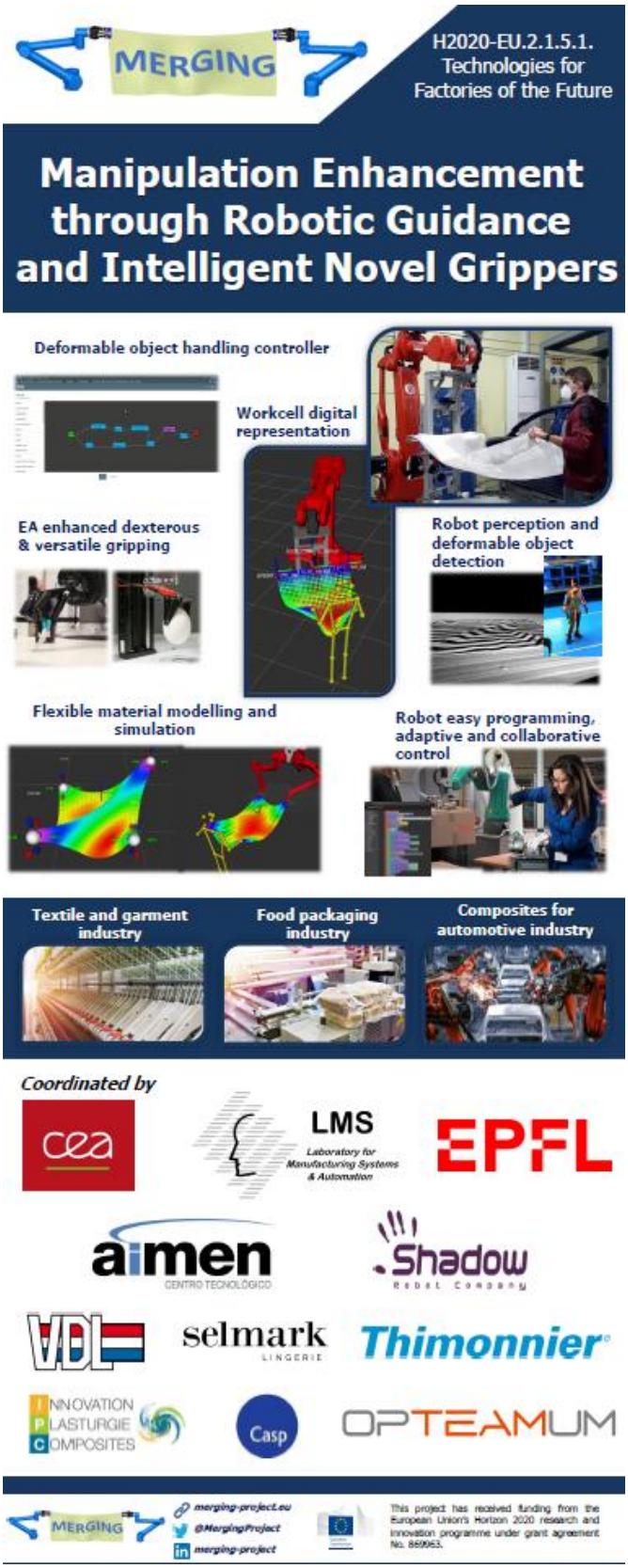


Figure 12. Project roll up banner - Initial version

Figure 13. Project roll up banner - final version

ANNEX D – Workshops details

➢ European Robotics Forum (ERF) 2021

For what concerns Communication the project, an opportunity to present the project was created and leveraged at the **European Robotics Forum 2021** organised by EuRobotics, which took place virtually from 13 to 15 April 2021, with over 800 registered participants.
Already in the 1st MERGING General Assembly meeting (in July 2020), following a suggestion from the Project Officer, the consortium started planning the organization of a **common workshop with the other 2 (later, 3) projects** funded under the same topic ("Handling of flexible materials"): APRIL, REMODEL and SOFTMANBOT. In November 2020, MERGING Consortium selected the European Robotics Forum 2021 as the most suitable venue. In parallel, from October 2020, SOFTMANBOT reached out to MERGING and to REMODEL to propose an internal discussion/have a round table discussing common topics, issues, solutions and way forward.
On our initiative, the four projects met online, agreed to combine the two ideas and collaborate in preparing a Workshop proposal for the European Robotics Forum, with the following outline:

- Joint workshop on "Soft robotic manipulation for the future of European factories" with the SoftManBot – Remodel – April projects, together with MERGING.
- Objectives: get to know each other, and have the opportunity to communicate and exchange, together and with the European robotic community, about fundamental needs in robotic developments and challenges, and eventually identify possible common technical work with our four projects.
- Format: Discussion style workshop / Presentation-oriented workshop
- Duration: 90 minutes (20' per project + 10' discussion)

The proposal was submitted to ERF by the 15 January 2021 deadline. It was accepted and the workshop was scheduled for 13 April, 11:20 CET (see the ERF programme at the following link : https://www.eu-robotics.net/robotics_forum/programme/programme/index.html). The final agenda and abstract is presented below:

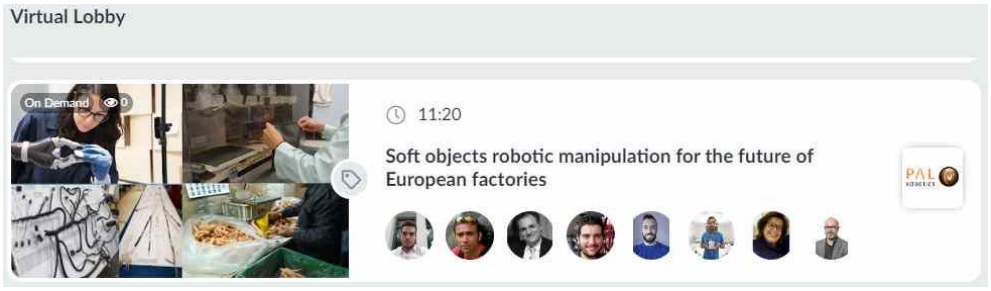
> **TITLE :** *Soft objects robotic manipulation for the future of European factories*
>
> **MOTIVATION, OBJECTIVES, EXPECTED OUTCOMES**
> The handling of soft materials with robots will play a significant role in the factories of the future. The European Commission launched a dedicated call, under which four projects have been funded between 2019 and 2020 and are now working on the robotic manipulation of soft objects, which presents many scientific and technological challenges. Use cases from the textile, electric, toy and food industries will be presented, describing current industrial situation, needs and specificity of a robotic cell, technological challenges and proposed approaches, and elements that can be applied to other cases. A final roundtable will discuss the changes in relative function and place of humans and robots in future European factories, and possibilities for standardization.
>
> **AGENDA :**
> **11:20 : The Factories of the Future**
> *Welcome and introduction from* José Carlos Caldeira, Honorary Board Member, *EFFRA - European Factories of the Future Research Association*
> **11:25 : Robotic manipulation for the textile industry: the MERGING project**
> Dionisis Andronas, project technical manager of MERGING
> *Current industrial situation - needs and specificity of a robotic cell in this use-case - technological challenges and proposed approach - elements that can be applied to other cases.*

11:40 : Robotic manipulation for the food industry: the APRIL project
Xenia Beltran, project coordinator of APRIL
Current industrial situation - needs and specificity of a robotic cell in this use-case - technological challenges and proposed approach - elements that can be applied to other cases.
11:55 : Robotic manipulation for the electric industry: the REMODEL project
Gianluca Palli, project coordinator of REMODEL
Current industrial situation - needs and specificity of a robotic cell in this use-case - technological challenges and proposed approach - elements that can be applied to other cases.
12:10 : Robotic manipulation for the toy industry: the SOFTMANBOT project Juan Antonio Corrales Ramón, project technical manager of SOFTMANBOT
Current industrial situation - needs and specificity of a robotic cell in this use-case - technological challenges and proposed approach - elements that can be applied to other cases.
12:25 : Final roundtable, questions and answers
Moderators: Marco Controzzi (Principal investigator, APRIL project), Leonard Engels (Dissemination manager, APRIL), Nicola Nosengo (Dissemination manager, MERGING project)
Synergies between the four projects; opportunities for standardisation; how the function and place of humans and robots will change in future European factories;

Information about the workshop was distributed through various communication channels, in order to maximise attendance:

- A news item was published on the CORDIS website, using the WIRE tool for contributions from H2020 projects (see also section 2.4.4) : https://cordis.europa.eu/event/id/148884-erf-2021-workshop-on-soft-objects-robotic-manipulation-for-the-future-of-european-factories
- The MERGING Twitter and LinkedIn profiles (see section 2.4.11) each published 2 posts about it, ahead of the event in addition to re-posting the information from the other 3 projects' profiles (a common presentation text had been agreed upon in advance). CEA LIST and Shadow Robot also posted information about the workshop from their own Twitter and LinkedIn profiles[4] and on the CEA LIST public website agenda page[5]. During the event, the MERGING Twitter profile was used for live-tweeting highlights from individual talks.

The workshop was attended by about 125 participants (speakers included), representing higher education institutions, large companies, SMEs, Research and Technology Organisations. A complete list of participants, including affiliation and contact information is available but cannot be included in this public deliverable for privacy reasons.
The workshop remains available for on-demand viewing (video record) on the event's platform at the workshop's page, for ERF 2021 registered participants only.



[4] https://www.linkedin.com/feed/update/urn:li:activity:6787770463738327040, https://twitter.com/CEA_List/status/1382004623599411203?s=20
[5] https://list.cea.fr/en/event/european-robotic-forum-erf-2021/ (in English) and https://list.cea.fr/fr/event/forum-robotique-europeen-erf-2021/ (in French)

➢ European Robotics Forum (ERF) 2022

MERGING participated in the **9th Hybrid production systems workshop** which will was held at the **European Robotics Forum** (ERF 2022), taking place from 28 to 30 June in Rotterdam.
Held regularly at all editions of the European Robotics Forum since 2014, the workshop usually includes presentations from the projects from the Factories-of-the-Future research cluster on Human-Robot-Interaction. Other research projects and interested parties were also invited to present at the workshop.
The table below shows the workshop's agenda and list of speakers. MERGING was presented by Christos Gkournelos, from LMS, and the workshop was introduced and moderated by Dr. George Michalos, also from LMS (MERGING partner).
The workshop featured a series of short presentations from various European organizations, including RTOs, Industries and Academics, on different aspects of Hybrid Production systems. The presentations covered: a) Preliminary results from new research projects. These were elevator pitches that explained the innovation idea, its benefit to potential users and a brief proof of concept, b) Technologies from more advanced projects. These focused on technologies that have been developed within the research project and are ready for wider adoption or commercialization.

- ➢ 8:30 – 8:39 Introduction of Workshop and recap of HPS activities (moderated by George Michalos)
- 8:39 – 8:48 The REMODEL project: Current challenges and novel approaches for automation in wiring industry (moderated by Roberto Meattini)
- 8:48 – 8:47 A user-centric programming environment based on Kinesthetic Teaching and Visual Programming (moderated by Itzel González)
- 8:57 – 9:06 The HR-Recycler project: Robotic solutions towards hybrid human robot collaborative WEEE recycling plants (moderated by Dimitrios Giakoumis)
- 9:06 – 9:15 Project Rossini: Robot enhanced SenSing, Intelligence and actuation to Improve job quality in manufacturing (moderated by Matteo ZANAROLI)
- 9:15 – 9:24 Open-Digital-Industrial and Networking pilot lines using modular components for scalable production – ODIN project approach (moderated by Panagiotis Karagiannis)
- 9:24 – 9:33 New control methods for human-robot collaboration. The use-cases of project CoLLaboratE (moderated by Fotis Dimeas)
- 9:33 – 9:42 Sharework: Implementation of Human-Robot Collaborative systems (moderated by Nestor Garcia)

- 9:42 – 9:50 Part 1 Panel discussion (moderated by George Michalos)
- 9:50 – 10:20 Break
- 10:20 – 10:29 DrapeBot – Collaborative Draping of Carbon Fiber Composite Parts (moderated by Christian Eitzinger)
- 10:29 – 10:38 Computer-Aided Risk Assessment (CARA) – Semi-automated Risk Assessment and Reduction for Human-Robot Collaboration (moderated by Mohamed El-Shamouty)
- 10:38 – 10:47 Seamless and safe human-centered HRC for novel collaborative workplaces – the SHERLOCK approach (moderated by Nikos Dimitropoulos)
- 10:47 – 10:56 MERGING: Model-based human robot comanipulation: a composites industry paradigm (moderated by Gkournelos Christos)
- 10:56 – 11:05 SoftManBot: Advanced robotic technology for handling soft materials in manufacturing sectors (moderated by Mohammad Alkhatib)
- 11:05 – 11:14 Human centered manufacturing task evaluation: application on collaborative assembly of large parts (moderated by George Michalos)
- 11:14 – 11:23 Transfer of robotic technologies to non-conventional road maintenance applications (moderated by Ander Ansuategi)
- 11:23 – 11:40 Part 2 panel discussion

9th Workshop on Hybrid Production Systems

Model-based human robot comanipulation: a composites industry paradigm

https://www.hybrid-production-systems.eu/

Presenter

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➢ European Robotics Forum (ERF) 2023

Extending its impact, the 10th workshop on the Hybrid Production Systems, consisted of a series of targeted sessions of approximately 40 minutes each. These sessions covered hot topics of the European robotics community focusing on a) intelligent workpiece handling, b) flexible material handling, and c) Artificial Intelligence for Human Robot Collaboration. Pioneer projects, members of the Hybrid Production Systems cluster, participated through stimulating presentations that were discussed by speakers, representing RTOs, Industries, and Academics.
As for the session, entitled "Handling systems for flexible materials", that was organized by MERGING, the speakers exchanged their views and insights on key technologies in robotics for flexible material handling, based on the presentations of each project. The panel discussion and the audience feedback revealed that there is still a lot of room for improvement in flexible material handling robotics. Although there have been significant efforts and diverse implementations in recent years, the solutions are not mature enough for industries to adopt them. The main challenges that need to be addressed are the enhancement of robot tools and sensor hardware, the development of dynamic motion

planners, modelling techniques and perception modules for handling non-rigid workpieces in a cognitive and proficient way. The speakers also discussed the industries that are still lacking automation and the reasons behind this gap and agreed that there is a need for standardization activities for industrial settings. Furthermore, the advantages and disadvantages of machine learning were highlighted, indicating a promising area for future project activities. The projects will continue to collaborate within the Hybrid Production Systems cluster and disseminate their results through public events or workshops. The projects have already shown their interest in participating in future HPS workshops and sharing their latest activities and outcomes.

Hereunder is the sub-session's agenda:

- 14:40 – 14:43 SOFTMANBOT (presented by Mohammad Alkhatib)
- 14:43 – 14:46 REMODEL (presented by Giovanni Berselli)
- 14:46 – 14:49 MERGING (presented by Dionisis Andronas)
- 14:49 – 14:52 APRIL (presented by Xenia Beltran)

- 14:52 – 14:55 DRAPEBOT (presented by Christian Eitzinger)

In parallel, MERGING was represented by Baptiste Gradoussoff, from CEA, with an oral presentation entitled "Horizon project MERGING – Manipulation Enhancement through Robotic Guidance and Intelligent Novel Grippers" at the "Human-Robot Collaboration & AI in challenging industrial applications" workshop.

The workshop is described as:

Collaborative robots (HRC) in many industries are underused, being regarded as expensive hi-tech tools with limited autonomy and intelligence that can only relieve workers of physical fatigue. To overcome these and other negative preconceptions, we must show how robots can learn to understand tasks at hand and how they are able to make joint decisions with fellow human-workers. In industrial scenarios which have tasks that are difficult to automate, and where speed and versatility are essential, competence and safety perception are fundamental. Another adoption barrier that impedes deployment is the skill requirement of workers to operate with robots. In this workshop, we will explore the HRC+AI topic via preliminary results, insights and challenges coming from 5 Horizon Europe projects that are trying to solve different industrial challenges and improve workers' capabilities.

Areas mainly addressed: Agile Production, Robotics and AI/Big Data Value, Autonomy, Collaborative Robots and cloud robotics.

• The workshop is divided into two parts, first part with 5-6 impulse talks and the second part is a panel discussion (Session total time: 48 minutes)

• e expect each speaker to prepare a presentation of 8 minutes (maximum) about the research question/s related to the workshop

• Each speaker will also take active part in the panel discussion (Session total time: 30 minutes). The goal is to discuss more about the three/four research questions and provide more insights/ problems faced/ successes related to them

Clustering projects : AI PRISM, FELICE, RaRe2, RESPECT, FEROX, AGILE-HAND, Zer0P and MERGING.

Hereunder is also the session's agenda:

00:00 – 00:03 Opening comments by the organizers
00:03 – 00:50 6 impulse talks

- Nacim Ramdani (male), University of Orleans (Academia) (Horizon project: RESPECT) – "Resilience task scheduling in HRC hybrid fleet management"
- Sharath Chandra Akkaladevi (male), Profactor GmbH (RTO) (Horizon Project: FELICE) - Flexible Assembly Manufacturing With Human-Robot Collaboration And Digital Twin Models
- Francisco Fraile (male), UPV, Spain (Academia) (Horizon projects:AI-PRISM) – AI Powered human-centred Robot Interactions for Smart Manufacturing
- Paul Chippendale (male), Fondazione Bruno Kessler, Italy (Research) (Horizon projects: FEROX, AGILE-HAND) – "Collaborative robots: An extra pair of hands, and eyes"
- **Baptiste Gradoussoff (Male), CEA, France (Horizon project MERGING) – "Intuitive programming using skills and teaching by demonstration"**
- Markus Ikeda (Male), Profactor GmbH, Austria (Zer0P – Zero Defect Manufacturing für die nachhaltige Produktion / Zero Defect Manufacturing for Sustainable Manufacturing)

00:50 – 01:15 Panel discussion (6 panelists; this will include the speakers) with parallel interaction with the audience (menti-meter/ polls)
01:15 – 01:20 Concluding remarks by the organizers

The presentation of Gradoussoff Baptiste, entitled "Intuitive programming using skills and teaching by demonstration." Is inspired by the teaching by demonstration and skill-based programming on the Selmark and Thimonnier use-cases.
Here under is the description of the presentation:

“Robotized automation is still limited to large batch and predictable processes. Other manufacturing activities – such as small batch production, bespoke or configurable products, repair and maintenance – are too unpredictable for conventional offline robotic programming, and often require expert operator knowledge to adapt and perform the task. To address such Factory of the future use-cases, CEA LIST currently work on a skill-based intuitive programming framework, which goal is to make the robot a tool for the operator, instead of an autonomous production line equipment. The goal is to provide the operator with a set of robotic skills, aka task-specific functions such as cutting, welding, screwing or insertion skills, which can be easily setup, and automatically optimized and run on the robot for semi-automatic assistance or for small process automation. To perform easily the required geometric information teaching (waypoints, trajectories, gestures), a multimodal teaching by demonstration module is coupled to the skills framework, which can integrate AI technics for similar cases adaptation and optimization. It allows for multiple teaching possibilities, using either hand-guiding, motion-capture, or teleoperation. These developments are supported by the H2020 MERGING European project, and applied to its industrial use-cases.”