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OD&M

OPEN DESIGN & MANUFACTURING

A Knowledge Alliance between HEIs, Makers and Manufacturers to boost Open Design & Manufacturing in Europe 2017-2020

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Contents

Introduction

The Open Design & Manufacture (OD&M) project has been funded by the European Commission under the Erasmus+ Programme: Knowledge Alliances Strand.
The three-year project commenced in 2017 and brings together the following organisations to share knowledge and create teaching and training programmes within the OD&M paradigm:

- University of the Arts, London
- University of Florence – DIDA
- University of Dabrowa – Gornicza
- University of Deusto – Faculty of Engineering
- University of Tongji – Furniture and Furnishing Centre, Tecnalia
- Fablab Lodz
- Fablab London
- P2P Foundation
- LAMA Agency

The project also brought together a number of Universities, SMEs, Foundations, Local Innovation communities and networks across Europe as associate partners.

OD&M is a Knowledge Alliance with a focus on the creation, support and scaling up of transnational communities of practices around the Open Design & Manufacturing paradigm. The Alliance aims to utilise openness, sharing and collaboration to create new value systems of innovation in design and manufacturing which are orientated towards social good.

The Alliance has facilitated openness through the active involvement of Universities, manufacturing businesses and communities of digital-savvy makers across Europe and China in order to co-create an ecosystem that encourages open design and manufacture. This in turn leads to a more innovative, socially and environmentally focused sustainable manufacturing system.

Through the creation of new means and methods to strategically connect Universities, maker communities, enterprises and stakeholders, the OD&M Alliance works to shape meaningful routes of knowledge exchange, which are able to generate new research and experimentation with products and processes informed by OD&M approaches and principles.

The OD&M project had three key objectives that spanned the Alliance:

1. The **advancement of awareness and knowledge** on the OD&M arena, in order to increase its recognition and understanding within society
2. **Innovation within Higher Education** through new content across curricula which includes innovative teaching and learning methods that are based on multi-disciplinary, open collaboration, peer and project based learning
3. **Building new capacities and skills** that facilitate the usage of OD&M approaches and principles among manufacturing enterprises and therefore foster innovation in the sector.

Research Methodology

Throughout March to August 2017, the four main partner countries of the OD&M project (Italy, Spain, the United Kingdom and Poland) carried out action-research with the core aim of analysing how and to what extent:

- Universities, maker communities and enterprises (the OD&M Knowledge Triangle) are currently engaging with the OD&M paradigm
- this 'knowledge triangle' is working together towards the creation of effective and meaningful value chains of innovation as well as understanding the elements that enable or limit this.

The action-research was structured into four key stages:

1. The analysis of the key skills and competences that are present within the current 'maker profile' in order to understand how and in which context these are developed, as well as identifying in which particular teaching and learning processes (formal, informal, non-formal) these are cultivated.

2. The analysis of existing making-related initiatives promoted or partnered with Universities, and the development of an understanding via discussion with Higher Education staff about the drivers, barriers and possible scenarios connected to the introduction of making education within formal learning.

3. An exploration of how making-related values, skills and competencies are contributing to inform and shape businesses (both professional makers and OD&M enterprises) i.e. businesses that are integrating open source ICTs and open-driven approaches within their own business models, production processes and/or products.

4. The investigation of the perceptions and opinions of traditional companies (i.e. those that are not engaged in OD&M and are unaware of this paradigm and the opportunities for

innovation within it) in relation to these topics and the potential risks and benefits that may arise for them within the OD&M paradigm.

The overarching goal of this action-research was to identify gaps and opportunities that could strengthen connections and collaborations within the OD&M 'knowledge triangle' and equipping Higher Education Institutions with new assets and capacities in order to take a more substantial role in this arena.

The action-research employed a broad range of data collection and analysis tools in order to investigate the key stages and included:

- Desk research in order to understand; the main features and key trends of the global maker movement, current formal teaching methods (inc. the integration of making principles, approaches and tools) in HEI systems and relevant business case studies/success stories that have applied OD&M principles in each country involved.
- Surveys that were targeted to 50 makers in each country aimed at investigating key values and principles, skills and competencies and the contexts (formal, non-formal and informal) as well as the processes that enable the development of these competences.
- Semi-structured interviews with varying stakeholders in order to build knowledge of the additional perspectives on the maker movement and bolster the understanding of the 'maker's profile'.
- Focus groups (3 in total) were carried out in each country with participants from a range of makerspaces (e.g. those linked to HEI's or community-based).
- Qualitative participant observations of the processes and dynamics occurring within the context of workshops, events and maker gatherings.

It is important to note that whilst this methodological approach aimed to provide an in-depth understanding to the maker movement, participants numbers and the contextual specificity of each country has meant that the analysis presented should not be considered exhaustive but rather an initial picture of the maker movement and its prevalence within Higher Education and businesses, in the context of the UK[1]. The findings from this research stage have since informed the development of a training program for staff within the Higher Education context.

[1] For more detailed information of the UK research findings see OD&M Report with China, Annex 1 OD&M Country report, UK available here: https://odmplatform.eu/wp-content/uploads/2017/05/Report-ODM-Shanghai-Mobility.pdf

Research Findings

In 2017 there were over 200 makerspaces throughout the UK, with nearly every city having at least one makerspace. Funding streams and research implemented at both a national and international level have facilitated the creation of an active making environment in the UK which has had an impact upon educational, social and business arenas.

Despite plurality between the values, motivations, competency levels and practices between makers in the UK community and communities of practice there are key principles that permeate through the movement.

Across almost all tiers of education, institutions are exploring meaningful connections with the making community which can be attributed to renewed political interest and a focus and investment in STEM (Science, Technology, Engineering and Maths) education.

The rise of incubators and accelerators within the business sector has created an environment where disruptive business models are being developed within startups and companies. Large corporations also help to sustain the development of the maker movement through Corporate Social Responsibility (CSR) budgets.

A key aspect to the UK maker movement is its strong connection with Social Innovation. Makerspaces often operate as collective experimentation sites for socially driven projects and are particularly focused on urban regeneration, unemployment and social inclusion of marginalised groups.

In relation to practices undertaken within makerspaces, new thematic areas within design and making take on an ever exploratory focus, which can be exemplified in green and bio design spaces, that are equipped with specialist equipment required for growing and designing in biological contexts.

The key principles of the UK maker movement:

- *Prosumption* – this is specifically evidenced through the use of 'prosumer tools' and the 'collaborative consumption' of tools used in the execution of projects. Prosumer tools can be defined as tools with self-fabrication capabilities, where the maker both consumes, and produces media as an output of the creative act (this is typified by 3D printing and it's associated practices). These tools are used in the contexts of learning, enterprise and socialisation[2].
- *Collaborative working* – projects are often undertaken with this ethos at their centre with co-working, time-banking and bartering being commonplace whereby the network of makers and members of maker communities offer time, resource and expertise as currency in exchange for access to space, use of facilities and services.
- *Active engagement with technology* – most importantly makers aim to develop their skills set and competencies within tool based creativity by establishing communities of interest and, by extension, communities of practice through peer-to-per proximate learning where skills and shared and developed collegially.

The key values of the UK maker movement:

- *Self-production* – which is commonplace within enterprising individuals whose motivations may be commercial or situated within a broader understanding of self-actualisation
- *Positive social impact*
- *Accessibility* – which are promoted through openness, collaboration, sharing and democracy.

UK Maker Profiles:

A result of the research was the development of a range of 'maker profiles' that aimed to personify the plurality that exists within the movement (in age ranges, gender, ethnicity or demographic). 14 emergent maker profiles were proposed:

1. **Agonist:** who looks for, and embraces, plurality in their design/making education with their programme of study being holistic and fluid. They hold a solid skills set in making and tool-based creativity, which affords them the ability to move from problem context to problem context effectively.

2. **Autonomous student maker**: is typified by the student maker who engages with the makerspace culture in order to augment and complement their university provision often through self-initiated projects that are credit bearing.

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[2] This is informed and supported by the findings of the Royal Society of Arts Report by Dellot,B. (2015) *Ours to Master: How makerspaces can help us master technology for a more human end*. Royal Society of Arts, Action Research Centre.

3. **DIYer:** from all walks of life and experiences with a history or tinkering, building and crafting. These tend to typically be a hobbyist, enthusiast with making as a personal passion.

4. **Educator:** skilled communicators and knowledgeable in a range of making contexts with a desire to support the development of others.

5. **Entrepreneur:** is adept at picking up industry trends and utilising those insights to inform the things they make, all with a focus on maximising the bottom line.

6. **Extracurricular student maker:** are students enrolled on a course but who work on collaborative projects that are initiated or facilitated by the university. In this context projects are often collaborative and open to students from across a HEI and non-accredited.

7. **Inspired co-worker:** is inspired by the maker culture, primarily using the makerspace as a co-working base. Their practice may not focus directly on making, but the environment and interaction with users fosters creativity.

8. **Pro-maker:** has developed competent making skills and openly embraces emerging technologies as it emboldens their ability to add scale and efficiency to the process.

9. **Self-learner:** who learns through principles of effectuation and via watching how-to videos and swapping tips through online forums.

10. **Shift-surfer:** is restless and agile. Experimentation and networking are key as the sites for learning are distributed across the city. Skills are developed through practice in real world contexts.

11. **Socialiser**: maker spaces are often used to socialise and this maker learns through processes of engagement and socialisation.

12. **Strategist:** these are the coordinators of staff who play a strategic role in the development of the space, culture and programming.

13. **Student maker:** are student enrolled in Higher Education and are working on taught projects set by university courses.

14. **Thinkerer:** is focused on self-actualisation. These users utilise the space to retrain and develop skills. These users are typically time rich.

Makers in the UK: skills, competencies and learning contexts

Formal learning

In the UK, formal design and making education (curricula that takes place in a structured environment, specifically dedicated to learning and typically leading towards a qualification) is delivered primarily through the Higher Education university system and specifically through Art and Design courses.

Higher education courses that have a focus on OD&M are typically in the 3D design subject area and is evident in courses such as Industrial Design, Product Design, Three-Dimensional Design, Design Maker courses, 3D Design and Craft, Decorative Art, Innovation Design Engineering, Design Products, Model Making, Ceramic Design and Design and Innovation. Digital manufacturing is also explored in Computer Aided Design courses and physical computing and digital manufacturing in Interaction Design programmes. This research has also shown that open maker/fabrication/digital practice is practiced across many different art disciplines (arts, performance and fashion).

Through research it was identified that to date there are no UK courses at undergraduate level that solely focus on OD&M. Whilst there are no dedicated courses, there are dedicated initiatives found within universities that facilitate making culture and training through extracurricular or elective modules. Examples of these are:

- The Institute of Making at University College London: is a multidisciplinary research club for students and staff with a mission to provide all makers with a creative home in which to innovate, contemplate and understand all aspects of materials.
- The Shed at Kent's School of Computing: is a stand-alone open access workshop established to provide space for students to work on practical projects. Students and staff use the Shed to build physical devices within taught modules (such IoT) but also to support and develop their own personal projects.
- The Digital Maker Collective at UAL: is an open group of UAL students, staff and alumni who share common goals of exploring digital & emerging technologies in the context of arts, education, society and the creative industries[3].

These initiatives share the characteristic of open and distributed learning. Whilst sometimes non-accredited, these initiatives exist within the regulated HE sector and will often align with the strategic aims of the institution and feed directly into student experience and the university culture.

[3] See: Higher education Academy HEA starter tools Learning resource: https://www.heacademy.ac.uk/enhancement/starter-tools/maker-culture#snapshot-logo

Outreach is another value that is promoted within maker culture especially within the HE context with activities being facilitated through makerspaces and collectives. Examples of these initiatives that were identified through research include:

- Fab Lab Plymouth at Plymouth College of Art: resources are utilised by students across a range of study programmes (including both undergraduate and postgraduate students), pre-degree (Extended Diplomas, Foundation Diploma) and importantly arts clubs that engage students from ages 9-16 in Saturday and after school clubs. Fab Lab Plymouth also opens up to local businesses and members of the public each week therefore acting as a site of proximate learning.
- The Invention Rooms at Imperial College London: is an initiative funded to work with students from 5 locally identified Widening Participation (WP) schools with the initial intake being one hundred 14-18 year olds over the course of a year in groups of 20. Over the course of 14 contact days students will develop skills in specific areas and also develop a self directed project in order to embed these skills.
- Fab Lab Blackhorse Workshop, Tate Exchange and UAL: is working with local schools and collaborating with UAL on a widening participation project 'Design Untitled'. Students from Crafts College, Stratford are also referred to the Fab Lab.

Learning methods:

Through analysis of the survey, interviews with academics and observations of learning and teaching, six categories of learning methods have been proposed within the OD&M context:

1. **Learning to learn:** where students are openly positioned as active participants in their learning.
2. **Learning through doing**: where teaching and strategy has evolved through a clear commitment to 'learning through doing'.
3. **Collaboration:** whereby collaborative and entrepreneurial learning are encouraged and taught as a core competency of maker culture.
4. **Distributed learning and signposting:** learning occurs across the city and its distributed resources where signposting and directing the learner to relevant resources is key.
5. **Online learning resources:** occurring in both formal and non-formal contexts, this method is important for personal development and as a site for knowledge exchange. Within HE, virtual learning spaces act as a site for communication, a file repository and for information dissemination.
6. **Problem posing:** is a common teaching method in the formal learning context, using briefs formulated from situated 'live' problem contexts and with structured making and design processes as part of the curriculum.

Non-formal learning

Non-formal learning typically takes place through planned activities (in relation to learning objectives and learning time) whereby some form of the learning support is present e.g. student-teacher relationships. Non-formal learning can cover programmes that impart work skills, adult literacy and basic education for early school leavers.

Common examples of this include in-house company training, whereby companies aim to update and improve skills of their staff such at ICT skills, structured online learning (through the use of open educational resources) and courses gained by civil society organisations for their members, their target group or the general public.

Makerspaces in the UK take on the function as an experimental facility for research, innovation and learning through the provision of space that encourages a close proximity between users, producers, technologies and materials with the maker profile being those who are first and foremost, curious. Learning occurs through innovation in the space.

In the UK, close to 70 percent of makerspaces offer classes to users and over 60 percent have their own school programmes. Sessions include introductions 3D printing, boot camps for Arduino, master classes in clay throwing to 'mind hacking[4].

Our survey of makers and coordinators indicates that knowledge, skills and competencies learned within the maker culture focus on:

- 3D printing and machine training
- 3D scanning
- CNC machining
- CNC milling
- CNC production and machine training
- CNC routing
- Computer Aided Design (CAD)
- Creative coding and physical computing
- Design for CNC
- Fundraising
- Fused Deposition Modelling
- Laser processes and training: Laser cutting; Laser engraving
- Robotics
- Vinyl cutting
- Woodwork, metalwork and assembly.

[4] see: Sleigh, A., Stewart, H., & Stokes., K. (2015) Open Dataset of UK Makerspaces. Nesta.

A number of attributions within the maker culture were developed through research activities and these include:

- **Agility**: the ability to embrace rapid change and retain an open mind
- **Effectuation**: the way of thinking that serves entrepreneurs in the processes of opportunity identification and new venture creation
- **Enterprise**: the mind-set that takes measured risks that perceives and creates opportunities, as well as the resourcefulness to pursue these in a ethical and sustainable manner
- **Resilience**: the willingness to adapt and remain motivated, overcome obstacles and deal with ambiguity, uncertainty and rejection
- **Collaboration**: the understanding and working with the collective skillset of yourself and others.

Technical operational skills are introduced through specific training programmes, courses and hands on demonstrations. The courses are as varied as the spaces and the makers who use them.

Innovative Manufacturers

An open innovation agenda seeks to insert makerspace creativity into global manufacturing systems. The movement is seen as somewhat disruptive in relation to a design paradigm as it challenges conventional notions of production and consumption and new entrepreneurs are emerging from this movement. Semi structured interviews were conducted with the following enterprises:

- Opendesk
- SAM Labs
- Bare Conductive
- Gravity Sketch
- Raspberry Pi Foundations

Knowledge and skills in demand within the UK OD&M context

Through research it has been identified that companies within the OD&M context focus on agility, resilience and collaborative approaches to working within their teams. They expect:

- Digital Literacy
- Good listening skills
- Elements of resilience and the ability to operate in an entrepreneurial setting where turnaround time can be quick from idea to implementation
- The ability to set clear goals that are actionable
- There is a need to organise tasks that seem nebulas
- The ability to set and manage goals to manageable levels
- Communication with the team to understand whether goals are set with the teams' goals. Continual open conversation with the team to understand parameters.

Enterprises operating within the OD&M context are looking for:

- The ability to collaborate is valued as the most important attribute by enterprises but this is also the perception of makers surveyed in this research
- Communication with the team to understand whether goals align with team goals. Continual open conversation with the team to understand parameters
- Digital Literacy
- Elements of resilience and the ability to operate in an entrepreneurial setting where turnaround time can be quick from idea to implementation
- Good listening skills
- Holistic understanding of the team and their capabilities as well as their needs/requirements in order to meet collectively set/facilitated/curated goals
- Prototyping abilities: many enterprises interviewed who operate at the high-tech/industrial level see making in OD&M contexts as essential to their research and development process, before outsourcing the mass production of their products
- The ability to manage complex demands. There is a need to organise tasks that seem nebulas
- The ability to set and manage goals to manageable levels
- The ability to set clear goals that are actionable.

Key considerations from this research were developed to inform the development of the training program for Higher Education staff. These being:

- Technical training is present in Industry, HEI and maker spaces. However, the development of IoT proprietary teaching and digital skills, structured curriculum around CoDesign and crowd sourcing presents an opportunity in all contexts according to survey responses.

- Considering the plurality of interests and themes, challenge based projects are perhaps the most applicable form of delivery. Content will always be contextually specific.
- Softer skill sets in communication, resilience, collaboration, effectuation, should be considered in a training programme. The social function of the movement and culture is emphasised in all data: openness, collaborative, sharing, empathy are recurring concepts.
- How do we define Open?
- There is a need for a recognition framework that recognises skill and attributes developed in through learning in the open context. How do we validate a distributed model of education where proximate learning in OD&M culture?
- Citizen Centred Innovation is of thematic interest to the UK context.

Training Prototypes

Throughout the 15th – 17th January 2018, University of the Arts London hosted a co-design workshop with the aim of utilising initial research findings to develop Training Prototypes to pilot learning and knowledge exchange in the OD&M context.

The workshop was structured through 4 co-design sessions over the 3 days with a focus on building a common lexicon, understanding the prominence of an OD&M curriculum, the definition of learning attributes and learning gain with the intention to apply this within the OD&M paradigm.

Participants of the workshop were taken through the following co-design sessions:

Session 1: Building a common lexicon, which included 'endorsement and learning recognition', and 'profiling learners and stakeholders'.

Session 2: OD&M vision and backcasting, which aimed at defining a common vision for the anticipated learning gains from OD&M curriculum.

Session 3: The development of pilot trainings whereby the backcasting moved towards addressing territorial challenges and developing speculative curriculum for pilot training sessions. 4 challenges were presented and developed:

- Addressing environmental barriers to mobility through co-design
- Co-designing publics, participation and inclusive community growth through citizen centred innovation
- Designing catalyst agents and new productivity in arts and crafts
- Exploring smart cities through event based learning (hackathons).

Session 4: Utilising learning arches to develop specific modules and incorporate key elements that were identified during the backcasting session. The outcome of this was the development of 4 training modules that each had a length of 10 weeks.

The final outputs from the workshops were 4 briefing documents containing specific training programmes. The modules considered how the learning experience and collaboration through each challenge should be utilised and were tested in the 4 main geographic contexts of the Alliance throughout September 2018 to April 2019.

Implementation

A series of open sessions were developed and held in London to establish a community of practice and establish thematic challenges to act as vehicles through which to deliver the UK training programme, these were:

- Make Camden (3-7 July 2018, Lethaby Gallery, Central Saint Martins: UAL – attendance circa 1,000).
- Public Briefing: Furnishing the Public Living Room (24 October 2018, The St Pancras & Somers Town Living Centre)
- Re-Designing Products for a Circular Economy (7 November 2018, Camberwell College of Art: UAL)
- Introduction to Green Lab (21 November 2018, Green Lab)
- Public Showcase of work in progress (28-29 November 2018, Central Saint Martins: UAL);
- Lecture on Open Design and Manufacture to 90 BA Product Design students at Central Saint Martins.

Through these events, the following socially responsive themes in the context of Industry 4.0 were developed with the aim to deliver challenge-based learning through open design principles:

1. Open Design for Inclusive Neighbourhood Development in collaboration with the London Borough of Camden.
2. Open Design for Future Sustainable Living: focused on bio material innovations in algae material for healthier urban environments in collaboration with Green Lab
3. How Can We Design Locally, Make Globally? Aligned to principles of the Fabcity. The program of training involves working with local authorities, industries and makerspaces to establish and develop the thematic context for each challenge.

Learning Institutions were able to disseminate challenges via the OD&M digital platform, where students could enrol as well as be issued with open learning badges (a total of 50 badges were defined and developed in the co-design workshop) that recognised soft skills and maker competences to students that completed the challenges.

The programmes took place over 15 weeks and were followed by 5 weeks of training which focussed on dissemination and engagement activities related to the outcomes developed. A total of 36 learners subscribed to the three challenges.

Also during the 5th to 10th March 2019, the UAL Digital Maker Collective, OD&M project affiliates, industry and community partners were in residence at the Tate Exchange for the launch of Beta Society[5]. The event was structured around participatory workshops, round-table

[5] For more detailed information on the Beta Society and OD&M at the Tate Exchange, please see report 'Open Design & Manufacturing Project at Tate Exchange 2019, which can be found here: https://odmplatform.eu/wp-content/uploads/2017/05/odm-x-tate-19_report.pdf

discussions and debates on the following themes:

- Citizen-centered innovation
- Socially engaged practice
- Community perspectives and community/organisation led provocations
- Open design and open practice
- Building a sustainable open education infrastructure
- Equality of opportunities

The intention was to develop a new network of organisations, academia, industry and public to explore and reimagine a speculative society of equal opportunities. The ‘Beta Society’ network is an evolving concept and the event at Tate was the beginning of the journey.

Conclusion

The research undertaken by the Alliance identified a triple gap in the relationship between universities, the maker world and traditional enterprises these being:

1. A knowledge gap regarding the open design and manufacturing features and potentials for innovation, evident both within educational and business domains;
2. An awareness gap about the mutual benefits that may stem from unedited alliance between the maker movement, the education domain and the world of business;
3. A connection gap between these actors.
4. The co-development of the training programmes aimed to address this gap and build capacity and skills between these actors.

In order to measure the impact of the training programmes a series of tools were developed to understand the experiences of those who took part:

- Focus groups with students who participated
- Interviews with HEI representatives who participated
- Focus groups with representatives of innovative communities
- Interviews with traditional organisations (SMEs, Local Authorities etc.)
- Focus groups discussion with HEI representatives at the end of the project implantation.

As the OD&M project brought together a range of traditional organisations (local authorities, NGOs, public institutions, schools, informal groups etc.) it became difficult to assess and create a general understanding of the results of these stakeholders engagement. However, a key conclusion emerged that contact with the project team and OD&M paradigm was an opportunity to gain new knowledge and experience and ultimately, deepen the experience related to OD&M. These stakeholders were positive about the contact and opportunities for collaboration with students, Fablabs, innovative communities and makers[6].

A key conclusion for HEIs were that a new approach to teaching and learning had been developed and tested through the OD&M project, resulting in innovative opportunities and challenge-based learning. This had a positive impact in the HEI approach to nurturing the next generation of designers and manufactures. HEIs found that they could easily implement OD&M training programmes within existing curricular structures either as regular elective training

[6] For more detailed information on the OD&M projects impact, please see report 5.3 Impact Final report, section 4, OD&M Impact Summary, which can found here: https://odmplatform.eu/wp-content/uploads/2017/05/5.3-impact-final-report-final.pdf

exercises for all students or as more mandatory exercise for those students wishing to develop their careers within the innovative communities, fablabs or as makers[7].

Students that participated in the training programme found that they had an increased knowledge regarding the terms ‘OD&M’ and ‘makers’ as well as an increase in knowledge about business models, production processes and techniques found in the OD&M paradigm.

Most students highlighted that their technical and soft skills (e.g. skills gained in rapid prototyping with software, machines and materials) had improved due to engagement with the training programmes as well as their skills in group dynamics and management, organisation, teamwork, communication, presentation, stress-management and time management.

A key advantage for those students who participated was a holistic approach to combining theory and practice, which was achieved through working in hybrid teams. According to students’ opinions, a key competency that was achieved by the project was the ability to see the design process more holistically, to be more aware of the design environment in both an academic and commercial perspective[8].

It is hoped that development and testing of the pilot training programme highlighted the opportunity for HEIs to include OD&M challenges within pedagogy that can facilitate the development of skills and knowledge building/sharing and capacity within students, HEI personnel and the wider maker movement.

[7] For more detailed information on the OD&M projects impact, please see report 5.3 Impact Final report, section 4.3, OD&M Impact Summary, which can found here: https://odmplatform.eu/wp-content/uploads/2017/05/5.3-impact-final-report-final.pdf

[8] For more detailed information on the OD&M projects impact, please see report 5.3 Impact Final report, section 4.4, OD&M Impact Summary, which can found here: https://odmplatform.eu/wp-content/uploads/2017/05/5.3-impact-final-report-final.pdf