CULTURECYCLE
Crafting Future Skills

FAB LAB AND MAKERS SPACE
@
AUSTRALIA'S LEADING INNOVATION PRECINCT
UNIVERSITY OF MELBOURNE

Expression of Interest

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CONTENT

GLOSSARY

CPD **Continuing Professional Development**

CNC **Computer Numerically Controlled**

DMLS **Direct Metal Laser Sintering**

FDM **Fused Depositon Modeling (also called Fused Filament Winding)**

FFF **Fused Filament Winding**

HDR **Higher Degrees Research**

OEM **Original Equipment Manufacturer**

SME **Small and Medium Enterprises**

SLA **Stereo Lithography**

SLS **Selective Laser Sintering**

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1 EXECUTIVE SUMMARY

Over the past 10 years, we have witnessed an unprecedented rise in the use of digital fabrication techniques throughout the engineering and design process. Modern university workshops are now incapable of supporting the diverse engineering design and manufacturing applications required for contemporary academic and research priorities. The University of Melbourne has developed a plan for a Fab Lab and Maker Space that profiles and promotes leading engineering, design and technical innovations to attract partners, researchers and students, advance University of Melbourne's international standing, and serve as an innovation enabler to promote University of Melbourne research and practice globally.

1.1 Value Proposition

Undergraduate and post graduate curriculums, together with industry research projects, are increasingly reliant on digital fabrication from the concept through design and production phases. At the University of Melbourne (UoM) it is particularly important to connect this knowledge with state of the art resources so as to model future collaborative research environments for students, researchers and industry partners. Development of the Innovation Precinct and the Fab Lab and Maker Space (FLMS) will support relevant undergraduate, postgraduate and research activity. This key, central resource will provide unparalleled opportunities for multiple pathways into practice and research.

The UoM FLMS key value proposition is that it will enhance the University's ability to demonstrate connections between diverse disciplines in the undergraduate and postgraduate cohort (both locally and internationally) while providing a prototyping facility for the research community and industry wishing to explore and expand beyond the boundaries of bespoke manufacturing and test new processes for advanced additive manufacturing.

Figure 1 Example of a Digital Fabrication Laboratory. Source: http://fablabasia.net/what-is-fablab/

Figure 2 Fabricate CEO, Dr Antonino Nielfi delivering 3D printing workshop. Frankston Foundry, Jan 2017

1.2 Vision

The UoM Fab Lab and Maker Space (FLMS) , in conjunction with the Superfloor will deliver an innovative overlay to UoM higher education and industry partnerships by

1. presenting research, teaching and business development opportunities using digital fabrication
2. supporting graduates and small businesses to develop new types of products using digital fabrication technologies,
3. providing skills and small business development opportunity pathways to support to those considering further post graduate study and/or creative partnerships

FLMS will provide students, graduates and alumni access to the latest digital fabrication technologies and access to learning from Engineering, wider STEM and Design experts. FLMS is a catalyst for innovation offering distinct products and services of high-value across a growing digital fabrication capability ecosystem. Superfloor models next generation collaboration to embed this innovation more broadly.

1.3 Capabilities

FLMS offers capacity building and support which is targeted for specific disciplines, thereby contributing to the development of an entrepreneurship and innovation culture.

FLMS business products include:

1. infrastructure capability survey of regional capacity in the areas of jobs and growth, city-revitalisation initiatives (and STEM/STEAM initiatives which target small and micro enterprises which are built on creative/cultural industries.
2. Centralised infrastructure capability database that ensures infrastructure is recognised, searchable and locatable across the regions.
3. Access to a digital fabrication laboratory. This facility has been scoped to provide access to the highest quality mid-scale digital fabrication facilities which enable small manufacturers, micro enterprises, students and community members to test and prototype new products and services.

There are four distinct target audiences for which FLMS will deliver differentiated products and services

1. small manufacturing businesses and start ups
2. researchers, students, alumni and industry partners
3. creative and cultural industries (in particular Science Gallery)
4. microenterprises and local craft-based businesses and partners with regional NBN initiatives to deliver effective products and services that connect sectors to each other and to the world.

Figure 3 3D printed brass bells. Professor Stephen Barrass, 2017

2 BACKGROUND

In the last 10 years, advances in digital design and fabrication technologies, (such as 3D printing), have radically changed the way design and prototyping are conducted. As a result, leading tertiary institutions have transformed their programs to embed broader ecosystems for innovation. UoM has recognised the value of engineering/ design pathways and has established an entirely new Innovation Precinct to model next generation innovation and collaboration.

2.1 Context

Multiple tertiary institutions have recognised that digital fabrication laboratories not only require new types of equipment but extensive professional networks and partnerships in order to meet the needs of future education and research. Therefore, the FLMS facility will need to be conceptualised and planned as an integrated system which invites stakeholder engagement and interaction into the pedagogic process.

Key Trend #1: Digital Fabrication co-existing alongside traditional workshop facilities
There has been a proliferation of digital fabrication facilities among tertiary institutions nationally and internationally. They have aimed at providing significantly more relevant educational experiences for today's graduates. In the most successful examples, these facilities augment traditional workshop equipment to provide an end-to-end prototyping innovation environment.

Figure 4: Traditional workshop

Figure 5: Augmented workshop equipment

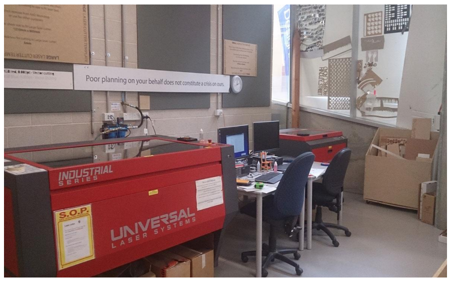

Figure 6: Scaled Digital fabrication

(all images with kind permission of UniSA). Photos: Angelina Russo

An increasing industry practice which depends almost entirely on digital design and prototyping processes enables faster and lower cost iteration and experimentation. In this instance, the provision of appropriately scaled facilities enables the greatest flexibility in both curriculum and industry engagement.

Key trend #2 : Recognition that STEM facilities must incorporate humanities and creative arts knowledge
Advanced manufacturing is often associated with niche products such as bio-pharmaceuticals or Defence technology but according to CEDA, "*Economies that have had the most success in advanced manufacturing are those that recognise it is not just about products – **Advanced Manufacturing includes the full suite of activities from the concept, research and development and design stages all the way through to post sales services. It is about adding value to the production line,** and it is very much about securing a place in the global value chain (GVL)*. (CEDA, 2014, p4)

A notable example is **The University College of London Institute of Making**, which integrates research, undergraduate teaching, industry engagement, postdoctoral fellows, community engagement and outreach to produce cross disciplinary innovations driven by the engineering disciplines.

Figure 7: The University College of London's Institute of Making Creates Cross-Disciplinary Innovations

Key Trend #3: Increased industry engagement with humanities & creative arts researchers & practitioners

Humanities and creative arts researchers and practitioners often work in vernacular and non-industrial-scaled domains and are constrained in their access to infrastructure. They rely on small-scale, in-situ laboratories not least because the bulk of creative work undertaken across Australia is represented by micro-enterprises. However, these enterprises feed larger STEM entrepreneurship agendas; given an environment where genuine collaboration was enabled, they would be better positioned to initiate new paradigms for innovation. To achieve this it is vital that access is provided to digital fabrication facilities that build engagement & collaboration between researchers and communities. Therefore, these facilities must include provision for the development of networks, partnerships, traditional and emergent forms of display and the promotion of outcomes.

2.1 Proposal

Key to meeting the objectives is an understanding of the functional requirements that each user group has for the DFL. These are summarized in **Table 1 below**.

Table 1: The Functional Needs of Each User Group for the FLMS Have Been Identified

Group	DFL Functional Needs		
	Prototyping Capability	**Availability & Access**	**Training & Safety**
Undergraduate	FDM, SLA, and SLS 3D printing, CNC machining, open source and OEM 3D design software	Direct access to equipment in line with undergraduate course schedule with anticipated peaks near end of term	Training for direct access
Graduate	FDM, SLA, and SLS 3D printing, CNC machining, test & evaluation tools, OEM 3D design software	Direct access to equipment in line with graduate schedule with frequent iteration, indirect access to external facilities not available at DFL (e.g. metal 3D printing)	Training for direct access
Research	FDM, SLA, SLS, and DMLS 3D printing, CNC machining, test & evaluation tools, OEM 3D design software	Year-round direct access to technicians, indirect access to external professional facilities not available at DFL	Training for indirect access
Industry & External Community Partners	FDM & SLA 3D printing with open source 3D design software for most local community partners, full suite for institutional/commercial partners	Evening/weekend workshops, negotiated individual access, indirect access on agreed schedules for institutional partners, or via cloud scheduling platform	Training for supervised direct access, online training for indirect facility access

The scope of work for FLMS is the design, development and fit out that complements the Precinct's operations, research agenda, engagement with industry and the community. The work plan has been designed to take a low-risk approach to implementation in two phases.

Phase 1: **Develop an interim small scale digital fabrication facility**
This phase involves low-cost, rapid development of "The Hub", an entry-level digital fabrication facility in the public realm that will be used to quickly begin implementing digital fabrication techniques in undergraduate and graduate work. The Hub will focus on providing a space for desktop digital fabrication which does not require sophisticated exhaust extraction. Establishing a close link with the Science Gallery will be a crucial part of Phase 1, both for potential connections to projects and to the interdisciplinary, international network embedded in the institution. For this reason, a public facing facility is recommended. This will allow multiple groups to occupy the space and produce outcomes which test the facility and build the necessary relationships, networks and outreach for Phase 2.

Phase 2: Design and Commission the Digital Fabrication Laboratory in Innovation Precinct
During Phase 2, lessons learned from developing and operating The Hub will be incorporated into the final design and development of a world-class FabLab and Maker Space with state-of-the-art facilities in the Innovation Precinct. The installation and commissioning of the final FLMS is contingent on the final design for the Basement and Ground Floors.

The total project, including creation and operation of The Hub and commissioning of the FLMS is anticipated to be completed within 24 months with a total capital works and procurement budget of $3.5 million. The ongoing operation costs of the FLMS will be dependent on UoM KPIs. The risks associated with the project relate primarily relating to the availability and usage of equipment to be installed. The proposed programmatic approach inherently mitigates the greatest of these risks as demonstrated below.

Table 1: With a Focus on Students, the Project will embed the following principles

Student Focus	Project Alignment
Student-centred: policies and practices will focus on enhancing the student experience.	The Project has been designed to focus on rapidly delivering improved educational outcomes to students, recognising the opportunities for linkages to international graduate destinations.
Engaging: The Innovation Precinct will model excellence in the delivery of high quality student experience, industry partnerships and community engagement	The Project goes beyond lab equipment to include the principles, people, and processes required to emphasize integrated design and fabrication skills that enable successful and adaptive careers in existing and emerging professions where graduates are likely to find or create employment.
Adaptive: FLMS will respond to changing needs of students, staff, and community.	The Project has been designed to take an iterative approach that provides frequent opportunities for feedback to be incorporated, with an inclusive governance structure.
Future Focused: FLMS will deliver a unique future-focused teaching and learning environment.	The Project balances the relevant fiscal constraints with an ambitious plan to provide a world-class facility that will model next generation teaching and research opportunities.
Innovative: We will support and value innovation in teaching and learning.	The FLMS will lead to innovation in undergraduate education, graduate projects, research, and industry and community engagement through presenting new opportunities for the collaborative use of digital fabrication technologies.

3 APPROACH

The proposed approach has been developed to minimize risk and financial exposure with an understanding that many lessons will be learned in the early stages of the Project. It utilizes a low-cost initial phase (The Hub) to trial the processes that will be used to govern, operate and maintain the FLMS in the Innovation Precinct. This approach also provides the earliest possible access for students and an early on-ramp for engaging potential external partners in industry, government, and academia. Importantly, it establishes a public connection between Science Gallery activities and network and future FLMS collaborations.

1. Strategically align with University plans and strategies
2. Follow and build on global best practices (e.g. by closely referring to successes of existing similar facilities globally)
3. Minimize life cycle cost and risk for a defined capability (e.g. through leasing of major equipment)
4. Develop a "complete solution" including facilities, staff, processes, training and partnerships
5. Place a strong emphasis on student outcomes and high profile partnerships
6. Build research capacity to promote future-focused staff which grow UoM reputation

The overall architecture will have several parts, each of which serve multiple user needs in a single framework, as shown in Figure 8

3.1 Facility

Over the lifetime of the facility, the FLMS will hold an important position in activities associated with student recruitment. It will ensure that new partnerships can be created while extending existing collaborations into new realms. The FLMS will ensure that the creative practice and research expertise that resides within UoM can be channelled to meet University and Precinct agendas. The FLMS will enable greater recognition of the opportunities inherent in an interdisciplinary, outward focused precinct.

The FLMS will play a vital role as an enabler of multiple emergent and future teaching and research activities which involve prototyping or digital production. As a result, FLMS will become a keystone of UoM activities which are strategically aligned to meet the Innovation Precinct Strategic Plan.

3.2 Use and Experience

Figure 8: UoM FLMS will support a breadth of activities that enhance the student experience, enable world-class research

3.3 Goals and Functions

For further clarity, the overall goals and functions of each of The Hub and FLMS are shown in Table 3 below.

Table 3: The Approach to Developing the Facilities is Designed to Minimize Risk and Provide Earliest Possible Start

Facility	The Hub (Begin Operations Within 6 Months)	FLMS (Begin Operations Within 24 Months)
Goals	• Near-term space with low capital expenditure and easier operations to quickly establish an initial operational capability, and to test processes, procedures, and train personnel • After FLMS is established, the Hub will be used for community/external use, workshops, etc.	• Long-term space with state-of-the-art equipment and capability to support undergraduate and graduate projects, research, and partner organization requests
Description	• 'Desktop' fabrication equipment for direct access • Primarily open source software • 1 Lab Director • 1 Lab Technician • 1 Sustainabilty Educator • Indirect access to industrial equipment similar to that which will ultimately be in the FLMS via a cloud platform connecting UoM to Australian fabrication facilities with relevant equipment	• Industrial fabrication equipment for direct access • OEM software • 1 Lab Director, 1 Technician, 1 Sustainability Educator • Indirect access to very high end capabilities such as CSIRO metal 3D printing • Ability to offer access to facilities for students, researchers and community via cloud

Key phases in the project and the high level activities have been planned to begin operations of The Hub as soon as possible, providing the earliest possible benefit while also giving UoM time to gain experience with operating The Hub before finalizing plans for the FLMS. This is a key risk reduction strategy that will enable lessons learned from early operations at The Hub to inform the establishment of FLMS.

4 MAJOR RISKS

The key risks to the project have been identified and mitigated through the choice of overall project implementation approach.

Table 4: The Major Risks and Suitable Mitigation Strategies Have Been Identified. No Unmitigated Major Risks Exist.

Risk	Probability	Impact	Recommended Mitigation Strategy	Impact After Mitigation
Equipment obsolescence faster than refresh cycle	Low	Significant	Cooperation with external stakeholders and ITM/Facilities to minimise 'purchased' equipment within this laboratory enabling industry turnover of equipment or leasing to minimise initial outlays and maximise future equipment relevancy.	Very Low
Mis-match between FLMS equipment and end user needs	Medium	Significant	Lessons learned from Phase 1 operations will provide key data to validate end user needs and usage patterns before procuring FLMS machines	Low
Equipment failure at critical time (e.g. end of term)	Medium	Significant	Schedule maintenance in line with utilization cycles, provide "hot-backup" through indirect access to external facilities via online platform	Low
Precinct infrastructure delayed, causing delay in opening FLMS	Medium	Significant	The Hub continues to provide interim capability; for projects requiring FLMS industrial-level capabilities, there is an ability to maintain indirect access to external facilities (from Phase 2) until FLMS is opened	Medium
External partnership strategy fails due to mis-match between available facilities and external needs or market developments	Medium	Medium	The FLMS is planned in consultation with tertiary institutions, industry, and other partners, enabling regular feedback and revision of plans to provide assurance that the FLMS will meet the needs of a broad group of external partners.	Low

5 CONSULTANTS

Figure 4 Example Maker Space. CULTURECYCLE 2016 – embedded video

CULTURECYCLE Pty Ltd. ACN 314 634 365
Director: Angelina Russo
Specialities: research, leadership, strategy and innovation, social network development, museum communication, design, critical making, design thinking, design enterprise, design entrepreneurship, digital fabrication

CULTURECYCLE is the lead microenterprise in a proposed consortium made up of researchers, academics, industry group representatives who, together, have the ability to connect with and work through their stakeholders to deliver new products and service. CULTURECYCLE has a large network of researchers well equipped to carry out the important research which underpins the future of the innovation agenda.
The CULTURECYCLE network links into its' vast network of potential public and private partners to position the growth of capacity in the regions towards a broader hub and spoke network of Creative Cities.

CONSULTANT: PROFESSOR ANGELINA RUSSO, PhD, MBAHEM
Angelina Russo is a design academic who has run her own microenterprise (CULTURECYCLE) since 2011. She is a Visiting Professor in the Exertion Games Lab at RMIT University. Russo focuses on pathways to sustainable high value, low volume digital fabrication that draws on existing skill networks including craft, design and small scale manufacturing. She studies the connections between these pathways and blockchain technologies, attempting to make sense of the next disruption in our sectors.

Russo has an MBA in Higher Education Management form University College London (2014), a PhD in Architecture and Design (2004) and a Bachelor of Design, Human Environment Design (1988). She has received over 1million in Cat 1 and same in Cat 2 funding. Her awards include: Queensland Premiers' Smithsonian Fellowship (New York); Australian Post-Graduate Industry Award, Australian Wool Fashion Awards (2011 & 2016).

In 2017/2018 she has developed digital fabrication training for new migrants, established a nested program of innovation and wellbeing around maker practices (MAKEBREAK) and developed a preliminary approach to blockchain in the cultural sector. She has come to understand the importance of the collaborative triple helix (Parry 2016) and is applying this knowledge to university/ industry partnerships.

Prior to this, Russo held academic leadership roles including: Associate Dean Research, University of Canberra; Director of Higher Degrees Research, RMIT University; Chief Investigator, ARC Centre of Excellence for Creative Industries and Innovation and Head of Communication Design, QUT. She is recognised for her extensive social enterprise experience as a co-founder of the 4000 member global network, Museum3 which ran for 8 years providing an invaluable resource to the cultural sector.

EXAMPLE: COGNATE PROGRAM of WORK :Mobile Makers 2015-2017 (see attached prospectus)

This multi-institutional research project delivered an innovative overlay to small businesses in regional towns by

- presenting business development opportunities using digital fabrication technologies
- supporting small businesses to develop new types of products using digital fabrication technologies,
- providing skills, small business development opportunities and support to those not currently participating in the workforce.

This project included a partnership with Professor Florian Mueller – Exertion Games Lab, RMIT. The project extended an educational program to school children in regional towns with access to the latest digital fabrication technologies and access to learning from STEM and Design experts. Mobile Makers was a catalyst for innovation in the regions. Having trialled a small version of the lab insitu, a pilot Mobile Makers was funded for a one week installation in the Greater Hunter Makers Festival, Newcastle, May 2017.

The mobile digital fabrication laboratory was made up of decentralised, mobile facilities which spent time in specific regions, offering training, training, design and prototyping, infrastructure, promotion, marketing, and research. The mobile digital fabrication laboratory targeted regions with associated training programs and design expertise. Local manufacturers were able to work with the Mobile Makers team and each other to upscale their knowledge of digital fabrication, creating prototypes which could be tested for further development and commercial scaling for market.

The mobile digital fabrication laboratory reached back into schools so that school children had access to larger scale digital fabrication from which to learn the basics of digital fabrication. The mobile digital fabrication laboratory connected with the micro-enterprise sector and the under-employed, building awareness through access to technology, training and research to produce outcomes that could be scaled and eventually taken to market

EXAMPLE: CONSORTIUM MEMBER – FABRICATE STUDIO

Fabricate Studio researches Industry 4.0 knowledge and technologies to model new approaches to the industrial workplace. Our focus is on the cultural, social and design aspects of Industry 4.0. We liaise with local manufacturers, private and public educational institutions, cultural institutions and local councils to explore and promote the commercial, artistic and educational potentials made possible within i4.0.

As consultants, we create synergistic partnerships with manufacturers, health professionals, policy makers and those professionals seeking ways to engage companies in Industry 4.0 processes, such as big data, design and fruition practices, policies and micro-business development. As researchers, we have been monitoring and exploring the state of the art of i4.0, post-digital design and digital fabrication for projects conducted for public and educational institutions, such as RMIT and The University of Newcastle.

In 2017, CULTURECYCLE partnered with Fabricate to produce the following: partnership with Frankston Foundry to deliver the first of their digital fabrication workshops to high school students; Newcastle City Council to deliver the first digital fabrication Hub in conjunction with the Library; New Futures Creative Textile Enterprise to develop digital fabrication training for migrant and newly arrived refugee women.