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ORIGINAL ARTICLE

Designing an Open Innovation Orchestrator: the case of Australia's Advanced Robotics for Manufacturing (ARM) Hub

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ABSTRACT

This paper describes a design-led workshop using a tangible modelling technique to actively construct an Open Innovation (OI) ecosystem. The purpose was to explore how such collaborative ecosystems can be intentionally designed. The technique allowed the development of memorable metaphors that enriched a discussion on the application of OI. The results emphasise the importance of understanding ecosystem stakeholder identities, and how this knowledge can be used to anticipate potential barriers to delivering value. Our work provides a set of principles for value creation and relationship management by an OI ecosystem, and will interest those seeking to navigate OI practices through a design-led approach.

Keywords: Design-led methods, tangible modelling techniques; open innovation, ecosystem

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INTRODUCTION

The current digital transformation of industry at a global scale, known as Industry 4.0, is occurring at an unprecedented rate (e.g. Lu, 2017). Highly regulated industries including healthcare, finance, (Aceto, Persico, and Pescapé, 2018; Pikkarainen, et al., 2015) and manufacturing (Rüßmann, et al., 2015) are grappling with a new set of digital requirements and competitive challenges. Alongside technical transformation, organisations are adapting to changes in consumer expectations - to the demand for mass customisation; economic and environmental sustainability; and emerging preferences for ethical production and consumption (United Nations DESA, 2018). In this emerging, but not yet prescribed reality, countries and regions are designing policies and initiatives to take advantage of their competitive strengths and expertise. The Advanced Robotics for Manufacturing (ARM) Hub, is an Australian response to this industrial transformation.

Launched early in 2020, the ARM Hub is a not-for-profit company, created to make accessible Australia's expertise in robotics and design-led manufacturing to local industry. Its mission is to accelerate economic growth in Australian manufacturing by facilitating access to, and development of, new industrial technologies. These new technologies include for example: robotic vision, augmented and virtual reality; and collaborative robotics. Australian manufacturing is dominated by small and medium sized organisations (SMEs), often without the resources to manage the digital transformation of their businesses on their own. A key role of the ARM Hub is therefore to ensure small and medium sized organisation are able to reap the benefits of Industry 4.0, including working in partnership with large businesses.

While a purposefully built Open Innovation (OI) community like the ARM Hub is not entirely unique (e.g. Dahl et al., 2011), to the best of our knowledge it is still a relatively new approach to industry transformation. At the same time, from a conceptual point of view, our understanding of how such collaborative ecosystems can be designed remains limited, despite the significance of this issue for ecosystem sustainability as underscored by leading scholars (e.g. Adner, 2013). In addressing these knowledge gaps both in practice and in the literature, we suggest that the complexity of such activities calls for new approaches and creative solutions. Embracing the crucial role *design* is increasingly being called on to deliver, this paper explores the core values of the orchestrator of an OI ecosystem from a holistic, design-led perspective.

THEORETICAL BACKGROUND

Open Innovation Ecosystems

Open innovation (OI) describes purposefully managed knowledge inflows and outflows to amplify innovation and value creation (Chesbrough, 2003; Chesbrough et al., 2014; Dahlander and Gann 2010). Firms practicing OI use "external ideas as well as internal ideas, and internal as well as external paths to markets" (Bogers, Chesbrough and Moedas 2018, p.6). Predominantly analysed from the perspective of large organisations, less is known about configuring ecosystem-level OI (Bogers et al., 2018; Adner, 2017) necessary to lift an entire industry.

We define OI ecosystems as "arrangements of interdependent value creation" (Adner, 2017, p.56), which focus on facilitating relationships and resources between other mutually reliant actors (Breidbach et al., 2016). When applied to manufacturing transformation, an OI ecosystem can provide smaller firms with greater opportunities for success through access to external, specialist knowledge and technologies that would otherwise be out of reach. Such an ecosystem aims to deliver a value proposition that is reliant on the actors of the ecosystem as well as their connections and resource flows (Adner, 2017). Furthermore, the OI ecosystem will be led by a central actor, referred to as the 'orchestrator' (Dhanaraj and Parkhe, 2006). Often, the orchestrator is an organisation equipped with an ecosystem-focused business model (Westerlund et al., 2014) that allows the deployment of various mechanisms - such as IP governance (Leten et al., 2013), innovation initiation, and managing the composition and processes within the ecosystem - to ensure success and sustainability (Batterink et al., 2010).

Since Chesbrough's seminal publication (Chesbrough, 2003), there has been noticeable academic effort to further our understanding of the open innovation phenomenon. Randhawa et al.'s (2016) review of the literature has shown that much of this effort has addressed firm-centric aspects, especially examining how the innovating firm deploys knowledge, technology, and R&D for open innovation. Opportunities remain to focus on issues such as managing the open innovation network, defining the role of users and communities in open innovation, diversifying the perspectives of open innovation, and formulating open innovation-based strategies (Randhawa et al., 2016). In this paper we direct our attention to the ecosystem that emerges through open innovation, and indeed how these ecosystems can be designed in advance.

A design approach

Both holistic and fundamentally human-centred, our work is grounded in a design mindset and in design-led methods. Rather than prioritising technical, or market drivers, design approaches adopt a holistic perspective, recognising, among others, technology, organisational and environmental considerations, while keeping *use* and *the user* at the centre of the process. The value of the Participatory Design (PD) techniques used in our research is in their "…interventionist methods of engagement, and active involvement with users in development practices" (Buur and Matthews, 2008, p. 7). The techniques achieve this by actively constructing the intended system or solution with users (Spinuzzi, 2005).

Tangible modelling (Burr, 2018), is a PD technique that uses "novel dynamic physical artefacts to represent components of a business and important relationships with other entities" (Mitchell and Burr, 2010, p. 29). The technique is motivated by consensus through collaboration, and the creation of a space where the knowledge and practices of diverse stakeholders are considered (Kensing and Greenbaum, 2012; Buur and Matthews, 2008).

The novel and accessible nature of tangible modelling levels the playing field. Working with tangible materials encourages the development of rich, memorable metaphors often inspired by the materials' physical properties. Specifically, though, the technique is intended to stimulate meaningful discussions about business models for people without specialist business knowledge (Mitchell and Burr, 2010). The discussions support reflective practice, where participants justify their decisions and the complex language of academic or business concepts, gives way to everyday, natural descriptions. The intention is to gain an understanding of the tacit knowledge and real world experiences of users (Spinuzzi, 2005), and harness those as sources for innovation.

The digital transformation of industry known as Industry 4.0 presents tangible opportunities for testing new collaborative models for innovation, as companies collaborate to gain or sustain competitive advantages. Open Innovation subsequently emerges as a paradigm that to increase the pace of innovation while reducing risks and costs associated with the innovation effort.

METHOD AND DATA

In an OI ecosystem such as the ARM Hub ecosystem, where there are numerous perspectives to consider - all of which form an important part of the ongoing success of the ecosystem - it is useful to make these members' perspectives explicit. To do this, we conducted a design-led workshop with the Hub's academic stakeholders in which we used tangible modelling techniques (Buur and Matthews, 2008) to explore how OI is shaping the ARM Hub ecosystem.

To establish how an OI ecosystem can be configured around the ARM Hub, the transdisciplinary research team started with a three-hour workshop using 'tangible modelling techniques' (Buur, 2018). With low-to-moderate knowledge about OI, participants used a curated

collection of small, physical objects like mesh, string, bottle tops and cable-ties to map out and build visual representations of the individuals and organisations involved in the ARM Hub ecosystem, and the industries it intends to serve (Figures 1 and 2).

The workshop involved two groups (of 3-4 people) completing two activities each. The brief for the first activity (Figure 1) was to use the tangible materials to identify the stakeholders involved in the OI ecosystem, including their needs and where they might be positioned in relation to each other. The brief for the second activity (Activity 2 Figure 2) was to use the collection of materials to build a physical representation of a business model, illustrating how the ARM Hub might function within the OI ecosystem.

Each activity took 20 minutes and was followed by a five-minute team presentation to explain the constructed models to the other team. Through this, the entire research team could reflect, justify decisions, question material choice or placement within the model, and share observations on the process and results. All participants had an opportunity to ask questions and provide feedback. This reflection encouraged collaborative and iterative development of the models. The presentations were video recorded to allow for detailed analysis at a later point in time (as per Goodwin, 1994).

Each video recording was reviewed and transcribed by a member of the research team, while printed images of the four workshop presentations were annotated according to the key verbal data including: identified stakeholders; ecosystem configuration; and more abstract concepts such as *success* or *trust*. While the analysis was informed by the literature, precedence was given to the voices of the participants. For example, teams rarely used the words *orchestrator* or *ecosystem*, though their descriptions of the ARM Hub and the network are synonymous with the definitions used in the literature. Results below are supported by excerpts from the verbal data.

RESULTS

Activity 1: Framing the Stakeholders of an Open Innovation Network

Participants described the tangible modelling (Burr, 2018) of Activity 1 (Figure 1) as "giving the people within the network a voice". Workshop teams identified ARM Hub stakeholders at various levels of the OI ecosystem. Stakeholders, from individuals to organisations, were described by their values and characteristics; relative strengths and disadvantages; opportunities afforded to them by OI; and any questions or concerns they might have about OI.

Table 1 summarises the results of Activity 1, showing stakeholders from three key domains, industry, academia and government. Stakeholders ranged from frontline workers and start-ups, to SMEs, investors and free-riders, who, while attractive, were "lacking any meaningful contribution". Teams visualised the characteristics and relationships of stakeholders in the ecosystem by their physical position in the models.

Fig. 1. Activity 1 – Tangible modelling - collaborative and iterative.

While workshop participants described ecosystem stakeholders in terms of their unique perspectives, all stakeholders were seen as seeking some kind of opportunity. One participant explained that each organisation had "a different idea on how open innovation should work", participants agreed that all stakeholders would have concerns about engaging in such an ecosystem with questions such as "What is in it for me?". Some stakeholders, such as *front-line employees*, were described as project-focused, with concerns about job security and upskilling opportunities. Others, such as *established firms,* were seen as powerful industry leaders, concerned about how they might "lock down certain parts of their IP".

Participants noted the presence of a c*hampion* in the models**,** observing the need for **"**one in every organisation". The champion was represented as the "trailblazer," the driver of OI who could be anyone "from the business owner to the front-line employee". The champion was also described as leaving a "wake of opportunities" for others in the ecosystem, such as researchers.

Workshop teams expected that these characteristics would guide interactions between ecosystem stakeholders and OI entities. As such, they informed the design of the ecosystem model in Activity 2 and the core values of the orchestrator of an OI ecosystem

Activity 2: Envisioning a Conceptual Model of the ARM Hub Ecosystem

During Activity 2, (Figure 2) workshop teams used additional tangible materials to build physical representations of the ARM Hub ecosystem. As expected, the tangible materials encouraged the development of rich metaphors: elastic bands were used to demonstrate flexibility; mesh was used to visualise the interconnected nature of the ecosystem (Figure 2); and during presentations teams used phrases such as "… all the pink symbolises success stories…" and "…the string

represents the group of messy stakeholders…you start to untangle the mess once you come into this thinking of open innovation and the Hub…" Reflecting the role of an orchestrator, both teams had the ARM Hub positioned at the ecosystem model's conceptual centre.

Table 1. ARM Hub ecosystem stakeholder characteristics.

Domain	Stakeholders	Characteristics	Needs/Wants	Concerns/Challenges
Industry	***Factory/ front-line worker***	Tech driven Personal innovator Uncertain about OI	Just wants to get the job done Seeking job security Upskilling	Perceptions on job security
	Professional (i.e. artist, architect)	Interested and curious about OI but cautious	Project focused Just want to get the job done	Not sure of fit in such a network
	Start-up	Five employees Have a good idea Some investors Open to possibilities	New: investors, markets, talent	To ensure delivery to market
	Small SME	Operating for 35 years Expert in the field Open to possibilities	Networking Changes to current practice New opportunities Looking to leverage reputation	Find a way to emphasise relevancy
	Large SME	Collaborative ****Champion:** **Leaving a trail of opportunities****	Fast paced Quick turn-around on investment Commercialisation?	Priorities Will OI slow us down? Will we get distracted by OI?
	Established Firm	Big partner Industry leader Powerful Lots of internal processes Protective	Fast paced Quick turn-around on investment/change	Wary of OI Want to secure their IP
	Hub Investor	'Big picture' thinker Positive None of the daily challenges of other members	What can OI deliver? Purchasing an outcome	Must deliver promise Public perception
	Hub Board	Outside of day-to-day operations	Convinced by demonstrated evidence	Ongoing stability of Hub organisation?
	Free-rider	Looks attractive and interesting Lack of contribution	Just wants to appropriate knowledge	Should be filtered-out from HUB
Academia	***Research Team/ Academia***	PhDs, Post-Docs, researchers and professionals at various career levels Various disciplines Various expertise Emerging field	Research Opportunities Partnerships Funding Longevity	Some researchers are not yet established Tensions between industry and academic priorities
	Research Partner / Academic Leadership	Looking in all directions towards all stakeholders	Impact Research Opportunities Partnerships Funding Longevity	Bound by constraints
Government	***Government Ministers and Leaders***	Becoming aware of research in the field (OI) Leading the investment	Need to see success measured by economic development—jobs and growth	Need to be seen as forward-looking

Building on the above results, and reflecting the focus of this paper, the remainder of results speak to the core values of the orchestrator of an OI ecosystem as modelled by the workshop teams. This includes the role of the Hub within the ecosystem, and the ways it may demonstrate values useful for managing stakeholder relationships.

The ARM Hub, Knowledge, and the Ecosystem

The ARM Hub was modelled as a centralised, dynamic entity managing knowledge, relationships and collaborative opportunities for its stakeholders. Teams expected the Hub to be proactive in engaging with external entities, and in bringing together the expertise of all domains identified in Activity 1- universities, research institutes, government, and businesses.

The workshop teams saw this engagement role as important for strengthening and growing the ecosystem. In identifying new opportunities for the members within it, *champions* were additionally seen as key to "getting the ball rolling" (as highlighted in Activity 1).

Ultimately, teams pointed to the ARM Hub's ability to *demonstrate* success, though "Success Stories" or "Flagship Projects", as instrumental. Hub projects would be diverse, collective efforts, allowing for the formation of new relationships, and the cultivation of new knowledge and expertise.

While the Hub was perceived as objective and independent, teams were clear that the managing the diverse needs and expectations of its stakeholders would be challenging.

Stakeholder Relationship Management

Teams described four ways to address relational challenges; 1) adopting a collaborative mindset; 2) being inherently flexible; 3) acknowledging stakeholder diversity; and 4) preparing strategies.

(i) *Collaborative mindset* - is a "way of thinking about open innovation within the Hub [ecosystem]… [in which] stakeholders begin to work together towards the sea of possibilities… they unravel and have a direction".

(ii) *Flexibility* was necessary for the ARM Hub to "set up and negotiate alliances between stakeholders". Building on Activity 1, stakeholders' needs, values and capabilities influenced the way they interacted with the ARM Hub, and how they contributed to, or accessed, the knowledge available.

(iii) Tensions could emerge from the *diversity* of ARM Hub ecosystem stakeholders and the conflicting priorities of the broader domains (Table 1) —between research and commercial priorities, for instance. This idea raised the questions, "How fast do they want to move?" and "What are they trying to achieve?" Participants wondered, "Is entering the Hub [ecosystem] a tense or challenging process?"

(iv) Participants expected the ARM Hub would need *strategies* to manage the potential tensions. They described these as "ground-rules, conditions of play, or rules of engagement" for its members to manage these scenarios.

Fig. 2. Activity 2 Rich metaphors in the ARM Hub ecosystem modelling.

To develop these management strategies, participants expected the ARM Hub to have a clearly communicated vision or manifesto driven by an understanding of the values and identities of potential partners by the ARM Hub's leadership team. Participants determined this vision was to "transform and lift up Australian manufacturing", noting that the ARM Hub was fundamentally motivated by this; with no mention of profit or financial gain.

Teams expected that the ARM Hub would need to lead by example and demonstrate values of its own. To this end, we synthesised the results from both workshops into six core value principles. These values were seen to be instrumental in effective communication and in sending out "messages of opportunity" to ensure the continued growth of the ecosystem.

These value principles (Table 2) may be generalisable to industry-level OI ecosystems. Driven by the various stakeholder characteristics (Table 1), and the differing capabilities that influence their engagement in the ecosystem, workshop teams expected the ARM Hub ecosystem to be fundamentally balanced, neutral and dedicated to opening up the collective knowledge of the Australian manufacturing industry.

Just as the ARM Hub is dynamic, so too are these demonstrable principles. OI ecosystems such as the ARM Hub should commit to regularly reassessing their

vision and values with partners, to ensure the ecosystem continues to thrive.

Table 2. ARM Hub's core, demonstrable principles.

Principle	Description
Proactively collaborative	• Bringing together multiple domains of expertise; continually seeking collaboration opportunities
Embracing challenges	• Future-oriented; open to innovative technologies, projects and approaches
Research-driven	• Committed to being at the forefront of knowledge; to learning and forging new paths
Values-driven	• Be the standard bearer, lead by example, and have a clearly communicated vision built on trust
Balanced and neutral	• Be responsible for meeting the needs and expectations of all ecosystem members while remaining inherently non-commercial
Open and flexible	• Designed to have a permeable structure guided by core values of openness and flexibility (e.g. IP Models)

DISCUSSION AND CONCLUSIONS

Intentionally designing an OI ecosystem with diverse stakeholders requires an understanding of their needs and expectations (Breidbach et al., 2016). Creative techniques provide approachable and accessible ways for Hubs, orchestrators and ecosystems to do this.

By emphasising member values and identities, Tangible Business Modelling (Buur, 2018) helped envisage the interconnected nature of an OI ecosystem. (Adner, 2017). It encouraged participants to build future scenarios and consider ideal strategic alliances.

Using creative techniques to map the needs of stakeholders in an OI ecosystem, means orchestrators may identify characteristics useful in managing tensions and delivering value in such a collaborative network. This ecosystem design activity is particularly useful as it made the abstract concept of OI tangible and easily understood. By doing so, it allows stakeholders, with various levels of business knowledge, along with the orchestrator (Kensing and Greenbaum, 2012; Buur and Matthews, 2008), to forecast anticipated barriers to delivering value and the engineering of solutions ahead of time (Adner, 2013).

Documenting the creation of the ARM Hub is ongoing, which means we plan to review the efficacy of its structure and development in future research. This work includes conducting a similar workshop with the ARM Hub's recently established leadership team, which will allow us to understand how the core value principles in Table 2 are realised in practice. Table 2 may also be used as a framework to compare whether these principles drive the development of other innovation hubs and orchestrators in manufacturing, other industry sectors and geographic regions.

Other opportunities for future work examining OI ecosystems include:

- Who 'orchestrates the orchestrator' in the early stage of OI ecosystem configuration?
- Who or what provides a guiding impetus for development? What are their characteristics?
- How do firms join an OI ecosystem? Is there a screening process? Can anyone join?
- How can OI ecosystems demonstrate values and successes in the early stages?
- How do stakeholder values and expectations change over time?

Creating the ARM Hub serves to fulfil a need for OI that Australian manufacturing SMEs cannot be expected to meet on their own, and OI as a framework is a valuable approach for the ARM Hub. The design-led workshop enabled a variety of ARM Hub stakeholder characteristics to be identified. These characteristics informed a set of core value principles which establish a meaningful foundation for the ARM Hub to optimise its collaborative relationships. Such workshop activities can be applied by those seeking an engaging and approachable way of exploring the design and potential value of an OI orchestrator.

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