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Five Misperceptions You Need to Overcome When Starting a Makerspace

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Abstract

In the UK, makerspaces are still a relatively new concept, especially in higher education, where pedagogical innovation encounters various obstacles. This paper tackles five common misperceptions encountered by staff and students during the creation of The iForge at The University of Sheffield in the following areas: building community, lack of resources, supervision models, educational value, and adequate preparation. It attempts to fill a gap in the UK evidence base through a survey of the literature, reflections on the experience at Sheffield in overcoming these obstacles, and by drawing out similarities and differences between UK and US examples.

Introduction

The makerspace scene in the US is well established, but in the UK, makerspaces are still a relatively new concept, especially in higher education. In April 2015, Nesta identified 97 makerspaces in the UK (Fig. 1), with eight of these being within HE institutions [1].

The University of Sheffield opened a new engineering building, The Diamond, in 2015, containing state-of-the-art manufacturing teaching facilities. However, there was a clear demand from students for space and equipment with which to make personal projects and parts for co-curricular activities, such as the Formula Student racing team, as well as to work on university projects outside class time.

Although the need had been identified for some time, no progress had been made in finding a way to make facilities available to students. This situation reflects the challenges of innovation in UK higher education: a lack of human and physical resources and funding, especially for approaches that have not been tried and tested; and a general aversion to risk, which is a barrier to managing and mitigating it to permit activities to go ahead. Moreover, Russell Group universities like Sheffield – those which are traditional and research-intensive – are often not innovators in pedagogy, because of their focus on evidence-based interventions. Most staff in UK universities have experienced the challenges of these issues, but the idea of creating a makerspace pushes them all to the extreme.

Having seen a number of successful models of makerspaces in the US, we knew that it would add real value to our students' experience in the UK. Georgia Institute of Technology's Invention Studio, in particular, had shown that safe and successful makerspaces are possible, and – importantly –that they can be student-led. In fact, they show that being student-led is preferable for better student engagement and learning outcomes. However, we also became aware, through engagement with various stakeholders, that whilst a definite appetite for a makerspace existed, so too did great concerns around the issues outlined above. Perceptions of challenges around those issues prevented colleagues from taking forward the concept of a makerspace. Issues of risk made the idea of a student-led model to parallel that at Georgia Institute of Technology a great concern, and there was a sense that health and safety regulation in the UK would make it impossible. There was also anxiety about the lack of a UK evidence-base for such spaces, which would make Sheffield an innovator if we were the first to implement such a space.

Nevertheless, at an initial meeting we convened to discuss the idea of a University makerspace, there was unanimous agreement that *if* it were possible, it would be a fantastic resource of great value to our students and to our teaching.

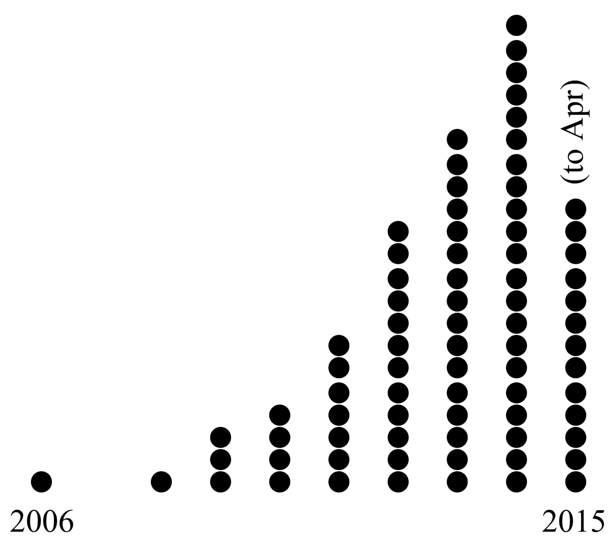

Fig. 1 New makerspaces per year in the UK, as of April 2015 (Nesta)

With that much buy-in, and despite the concerns, we therefore pursued the idea further and, in October 2017, the iForge was established at the University of Sheffield, initially to serve the Faculty of Engineering, but with a vision to serve the whole University and the city of Sheffield. In less than six months, it has seen over 3,000 visits from 800 unique users. To the best of our knowledge, the iForge is the first student-led university makerspace in the UK.

What follows is an attempt to help other colleagues over the hurdle of the lack of a UK evidence base, whilst at the same time addressing five common misperceptions that we regularly encountered as we moved toward and beyond launch of our space. Where relevant, we draw out differences between the UK and US examples upon which we closely modeled our approach, and in that sense, we hope that the paper will be of interest to US-based colleagues in highlighting some of the success factors in their own projects, which may not seem immediately remarkable to those working there.

1. If You Build It, They Will Come

Makerspaces are the latest fashionable accessory for your campus, but what constitutes a makerspace?

Attempts to implement a makerspace can range from simply adding 3D printers to traditional workshops and re-branding them, to building or acquiring vast facilities and filling them with the latest technology, on the premise: "if you build it, they will come" [2]. But these "makerspaces" will not attract makers if there are too many barriers to access, or they lack an atmosphere that makes students want to come back and bring their friends. Without people in it, a makerspace is just a space – it would not run, and knowledge would not be transferred from experienced to beginner.

So, what is required to make sure your makerspace is full of students?

The University of Sheffield had previously created a student workshop along the traditional model – technician-run, limited hours, and restricted activities (coursework projects and limited co-curricular projects). However, it ran into a number of problems: the inaccessible location, and sporadic access dependent on staff availability, meant that students on tight timelines were unable to rely on the space to be open when they needed it, so they stopped using the facility. Furthermore, the students reported that they felt no ownership of the space. When the technician holds the keys and makes all the decisions about how the space runs, the students abdicate responsibility. They look for ways to circumvent the rules and have little interest in maintaining standards of cleanliness or looking after equipment, since they have an underlying assumption that the technician will do it. This led the space to fall into disrepair and disorganization, and to staff losing trust in students acting responsibly.

It was clear that the best models for facilitating independent making were being produced in the US: the Learning Factory at Penn State, the Invention Studio at Georgia Tech, and the Maker Workshop at MIT are some of the best examples. What Craig Forest had done at Georgia Tech was to create an entirely student-run makerspace, where the students are empowered to make decisions about the day-to-day running of the Invention Studio (Error). He also fostered a sense of community amongst the student Prototyping Instructors (PIs) who volunteer their time to enable others to make. The Invention

Studio is open 24-7 to these PIs, and because “there’s no grumpy proctor managing the gear,” and nobody kicks them out at closing, the students know the space is theirs and they feel a pride of ownership, and a sense of privilege at having access to the facilities, which results in them taking responsibility for the upkeep and safe running of the space.

Seeing these amazing facilities in person, we were persuaded that such models that resulted in thriving makerspaces within a very short space of time were not specific to the US context, and that, if successfully applied, the principles should work equally well in the UK and elsewhere. One key takeaway was that, rather than first identifying a space and specifying equipment, we focused on pulling together a team of enthusiastic and capable students who could help us to create a makerspace that served students’ needs and was attractive to them. Their experiences at the Invention Studio and the iHub at Oklahoma University, whilst on a year abroad, were vital in helping us to work out what makes a makerspace work. We recruited more students on the Georgia Tech model, i.e. that they would voluntarily supervise users for three hours per week in return for 24-hour access. Our confidence in this model was rewarded when over 200 students applied to be on the team.

In the initial stages, we prioritized establishing the right culture: we created a soft seating area within the space, something that is generally seen as completely incompatible with a workshop, but is vital to presenting the iForge as a space where students can hang out and relax with each other, rather than a classroom, or a manufacturing facility you come into, work on your own, and leave without interacting with anybody. We also worked hard to both encourage responsibility and give trust. In setting up a student-run makerspace, you need to consider the time and effort that will go into mentoring the student team, particularly in the early stages. Students need support, but they need to feel that they own the space and are empowered to make decisions. Getting this right means that the space is student-owned from the outset, more likely to provide what students want, and therefore more attractive as a place for students to work.

2. We Cannot Resource a Makerspace

Following the visit to the US, we organized a video conference with Craig Forest and invited various stakeholders from across the University – technical and academic staff, and students – to discuss the value of makerspaces and the barriers to implementing one. Our purpose here was threefold: to gauge the level of enthusiasm for a makerspace at Sheffield; to get colleagues’ concerns out in the open early; and to impart a vision that would enable them to see past these concerns to the impact such a facility could have on learning and the student experience. While there was unanimous agreement that a makerspace would be beneficial for the University and its students, a number of potential barriers were highlighted. One of the most common concerns was that a sustainable funding model could not be achieved. As the common argument goes, the US has a much more established tradition of alumni funding and industrial sponsorship. While Georgia Tech [4], Olin College [5] and other US institutions fund their makerspaces through capstone sponsorships from large industrial partners and philanthropic donations, most colleagues argued that the model would never work in the UK. However, the value proposition is the same: for industry, the benefits of a makerspace that attracts the best, most enterprising students and trains them in real-world, practical engineering skills, are obvious: Students who can apply their academic learning to solve real problems are more attractive as graduate employees. The opportunity to engage with and recruit such students is as valuable globally as it is in the US, and the iForge has demonstrated this. In the last few months, we have run hackathons with two large industrial partners, and received donations of equipment and materials from others, as well as receiving two large philanthropic donations to fund equipment purchases.

Many people also worried that a makerspace would add to the workload of technical staff. The previous model of supporting co-curricular activities was fairly ad-hoc, and required technicians to find lots of small amounts of time outside their core role, to support, train and supervise individuals or small groups of students on a variety of machinery. Understandably, this felt like a large drain on resources for a small return. In contrast, a student-led makerspace requires minimal input from technical staff, and utilises student enthusiasm and experience to enable access for large numbers of students over a sustained period. Rather than staff supervising and training every user, they invest defined periods into training a select group of student "superusers" who are then able to supervise and train hundreds of users. Employed staff time can then be used efficiently to maintain and procure equipment and materials, and increase student autonomy through further training. The iForge at the University of Sheffield is supported by a single paid technician, with up to 60 students using the space each day. During this time, there are two reps on duty simultaneously to supervise the work of users.

3. You Cannot Trust Students to Supervise Students

Traditional universities with a need to protect a long-held reputation are notoriously risk-averse, and balk at the idea of students supervising students. They still work on hierarchical models of education and training where ''grandfather rights" are everything – experience trumps training, and so students cannot be taught to be safe in the time they have at university. At the aforementioned event, when asked for potential drawbacks of a student-run makerspace, one response was: "We [would] have to trust students." There is an underlying assumption that staff are inherently safer than students, which is not backed up by evidence [6]. Health and safety legislation is generally much more concerned with training than with age or employment status. In fact, it could be argued that the motivation of students to act responsibly and avoid health and safety incidents so that they and their peers can continue to use the space is more compelling than that of paid staff. But the perception remains, and many find it difficult to let go of the old hierarchies.

Students coming into university pick up on this culture and start to expect a lack of trust from staff, which prevents them from initiating collaboration. Before the start of the iForge, a group of students were considering how to open a makerspace in Sheffield, but because of the assumption that no one at the university would work with them and trust them to make it happen, they were looking round for other spaces in the city. For the same reason, many students do practical work at home but do not feel able to access safer facilities on campus.

Many of the problems we encountered will be common to other contexts. However, there are some specific challenges associated with being in the UK, and you will need to consider your own context to understand how to tackle this problem. One of the main issues will be how to satisfy the health and safety requirements of your university and external stakeholders. A comparison of the UK and US regulatory systems for health and safety at work [7] noted: "When considering the reasons for the differences between the two systems, it is impossible to ignore the fact that the US has different attitudes to the role and size of government; Americans have a strong belief in individualism and a much higher degree of mistrust of government intervention in the operation of business…" although the level of involvement of regulation has swung wildly depending on the prevailing political orientation.

"American safety legislation is generally a lot easier to navigate than the UK's labyrinth of Acts, Regulations and ACoPs [Approved Codes of Practice] … Generally, the technical requirements of the OSH Act … are very prescriptive and tend to focus on basic mechanical and chemical hazards, with little emphasis on systems, process and leadership … America places a much higher reliance on the regulator to define what is acceptable," whereas in the UK, the underpinning principle is that "those that create risk are best placed to manage it." The measures that a US employer must take "are generally rigidly defined by the regulator and prescribed in statute" but "there is no requirement for employers to conduct risk assessments, although OSHA recommends the process."

The penalties for noncompliance in the US are also very low so that "OSHA has become essentially irrelevant to most employers (although still vilified by many lobbyists). Infrequent OSHA inspections and small OSHA penalties provide little incentive for employers to pay attention to and comply with the agency's rules" [8]. From our conversations with US academics, the risk of suits from students and their families appears to be a greater barrier to student access to workshop facilities. In the UK, health and safety breaches are prosecuted independently of the inspection body, and can result in unlimited fines or imprisonment, and hence there is an imperative to be seen to comply with the legislation and have a well-considered health and safety policy.

When trying to construct a safety case in the UK for a student-supervised workshop facility, the emphasis was less on compliance with specific regulations and more on showing that due care and attention had been given to assessing and minimizing the risks to students, using technical expertise to identify risks and apply control measures.

The general principles of health and safety at work in the UK were set out in the Health and Safety at Work Act 1974, and the responsibilities of an employer with regard to health and safety are laid out in the Management of Health and Safety at Work Regulations 1999. Some guidelines on how to apply this to workshops are set out in HSG129 [9]. Using this as a prompt, we identified around 200 separate hazards, including standard equipment-related hazards like entanglement and cuts, and those specific to a 24-hour student makerspace, such as fatigue or the possibility of students bringing in alcohol. We then listed around 150 control measures to reduce these risks. The main components of this were training and provision of a handbook, correct use of personal protective equipment (PPE), and use of specific risk assessments for all new tasks.

It was also important to stress that those students responsible for supervising in the iForge would be carefully selected for their ability to act responsibly, make informed decisions about safety, and exercise authority where necessary. The training was designed and delivered to this carefully selected group by an experienced technician. Our trust in the students was rewarded when they took copious notes from the training sessions and returned with a series of training videos they had created, along with associated quizzes. We now have a full online training system that enables us to pull up training records as users sign in and ensure they have completed both the online and in-person safety training required for each piece of equipment. To date the only injuries have been two minor cuts from sharp edges.

Throughout the six months the iForge has been open, the students have consistently validated our trust in them and exceeded our expectations when given responsibility. We have therefore been able to release them to make big decisions about how the iForge is run – what equipment we buy, how we handle the budgets, what the rules should be, and so on.

Handing over responsibility to students for supervising and making decisions is difficult, but it becomes easier when you recognize the contribution they bring and that there are plenty of situations in which they do know best.

4. There is No Educational Value in Tinkering

The University of Sheffield sits in a group of long-established, traditionally research-led universities in the UK known as the Russell Group. Similar to the Ivy League, it prides itself on academic excellence. Unfortunately, this can often be interpreted, at least by those away from the forefront of learning and teaching, as meaning that education should be traditional, taught, structured, and crammed with academic content. Makerspaces do not sit well in this paradigm because they encourage unstructured, self-directed learning, and focus on innovation through experimentation and design skills rather than primarily on theoretical knowledge.

However, evidence is growing for the educational benefits of maker education. As Fleming [10] says, "Maker education fosters curiosity, tinkering, and iterative learning, which in turn leads to better thinking through better questioning. I believe firmly that this learning environment fosters enthusiasm for learning, student confidence, and natural collaboration. Ultimately the outcome of maker education and educational makerspaces leads to determination, independent and creative problem solving, and an authentic preparation for real world by simulating real-world challenges." In fact, it is possible not only to simulate real-world challenges but to engage with them – the iForge has run a number of successful hackathons along these lines and industry partners are often keen to give design challenges to makerspaces since their route to a working prototype is much faster than going through university procedures to set up formal academic projects.

Because of the desire for academic rigour, some universities [11][12] limit users in their makerspaces to working on university projects and approved co-curricular activities. The danger of this approach is that in limiting students' freedom to explore making outside academic constraints, you discourage creativity and miss out on opportunities for students to learn techniques and acquire knowledge that may be used for more academically rigorous projects later on. If students are working on coursework projects, they are less willing to take risks and experiment, because of the potential negative impact of failing on their grades [13]. If students do not feel welcome or able to come into the space without a concrete plan of what they want to make, many of them will never cross the threshold. Burke [14] says that "what is made may not matter at all; it can still influence the thought process, vision, and ability to connect of a learning maker. These abilities can enhance a person's thinking and work in many different fields." So, in the iForge, as in the Invention Studio at Georgia Tech, students can make whatever they like – when they make coasters they learn how to use a laser cutter; when they make LED light displays for their room, they learn electronics and programming; when they make musical instruments they learn woodworking and CNC skills. And it means they will not wait until their final project is due before they visit the makerspace.

5. You Need All the Answers Before You Start

There are some key questions that need to be answered before a makerspace can be opened – Where will it be? Who is on your team? How will it run safely? – but you do not need to have answers for everything. When we started out, all we had was a concept. The concept drew a team together, and then we found a space and some equipment. Finally, we worked out our health and safety case. But many other things are still evolving now – What 3D printers do we want and how many do we need? How will we supply material, and how much will we charge? Can we let alumni access the space, and on what terms? Who else might use the space and when?

A student-led makerspace is by nature an evolving concept. The student population is always changing, which means your team will constantly be changing, losing and acquiring new skills. When we started out, we had seven students. Those seven students are now leaving, but along the way, we not only created a successful makerspace that people are attracted to, we created graduates who know how to solve the kind of problems they will encounter beyond university: how to negotiate a space for your start-up; how to write proposals and attract funding; how to manage customer relationships and expectations; how to market your business; how to train and manage staff. Even if it had been possible for staff to work out all of these things ourselves before we brought the students on board, they would have missed out on a multitude of learning opportunities.

Furthermore, many of these things cannot be worked out until you've tried things, and in some cases failed and learned how to do it better. Although the team of students we recruited was of a fantastic calibre, we learned that recruiting on the basis of the benefits available to team members, without emphasizing the expectations of commitment to the project and to helping it run better, is not the most effective way to build a team, and the students developed a much better recruitment process for the next round.

Another reason you will never have all the answers before you start is that each context is different – while we took many of the principles from the Invention Studio, we do not run a carbon copy, and the longer it goes on, the more we develop our own identity, in response to the unique challenges at The University of Sheffield. Some of these, like the health and safety landscape, we have explored in this paper, and some we are yet to discover.

If the appetite for a makerspace exists amongst staff and students, you need to capitalize on this and get going without waiting until you have all the answers. There will always be opportunities to refine the model and make things work better.

Conclusion

Few doubt the value of makerspaces within higher education institutions. However, many find it difficult to conceive of the right set of circumstances in which one might succeed in their own context. It is important to engage with both staff and students to overcome the common misperceptions that prevent them from initiating or supporting a makerspace. By doing this at The University of Sheffield, we have created a highly successful student-led makerspace in the space of a few months.

We discovered that gathering the right people and creating a welcoming culture where students are trusted and given responsibility is far more important than buying all the latest kit.

We have also shown that the Invention Studio model of student-student supervision can be successfully implemented in a very different health and safety context, allowing much greater access to workshop facilities for students without increasing staff workload. Although the initial stages of careful training and mentoring will require higher staff input, the superuser model used at the iForge results in a sustainable method for passing on skills and training.

Although we have now gathered significant evidence of the success of a student-run makerspace, it was necessary first to engage with the University and construct a substantial health and safety case to justify such a radical supervisory model, supported by the successful implementation of the model elsewhere, and emphasizing the extent to which the potential benefits outweighed the perceived risks.

We have also shown that the value of makerspaces to industrial partners is not a uniquely American phenomenon, and we are already building successful partnerships and attracting funding, defying predictions to the contrary.

The educational value that is recognized by both industry and academia is not due to the strict academic rigor of every project undertaken in the iForge, but because, as long as they are tackling the challenges of design and manufacturing, they are always learning, and those skills can only benefit them in the workplace. Giving students the freedom and resources to be creative contributes to their education and produces graduates that are more employment-ready.

Finally, we discovered that you don't need all the answers to set up a makerspace. If it is truly student-led, it will by nature be constantly evolving, and every new challenge is an opportunity for the students to learn and to take the lead. If you wait until you know exactly how everything will work, your makerspace will never open.

We still have a lot to learn at the iForge, but the more than 3,000 visits we have had are testament to the fact that these misperceptions need not prevent you from creating a truly fantastic makerspace for your students.

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