Boosting Creativity in Disruptive Innovations with Fabrication: How is ideation affected by the physical distance from the model fabrication area?

Joachim E. Horn, Pierre-Arnaud Donnet, Céline Mougenot

Joachim E. Horn, Tokyo Institute of Technology, Japan

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Joachim E. Horn [1,2], Pierre-Arnaud Donnet [1,3], Céline Mougenot [1]

[1] Tokyo Institute of Technology, Japan
[2] Imperial College London, United Kingdom
[3] Arts et Métiers ParisTech, France

Abstract

The studied layout of successful creative spaces in design practices, artist studios, fabrication spaces, and corporate ideation spaces have led us to the following hypothesis: **Gathering the tools for active ideation and fabrication in a single place enhances the product outcome of a design process.**
This hypothesis will be tested in a Space dedicated to Innovation and Creativity, built at the Tokyo Institute of Technology. The design of this space will stem from further investigation ~~of~~ on both ideation and fabrication environments, their tools, processes, and atmospheres. The hypothesis will be tested by comparing the product creativity and innovation potential of the newly built space with other spaces tested during workshops and design projects.

1. Introduction

Fabrication spaces[1] have, in the past decade, opened to the non-specialised public as in the concept of Fab Labs. Previously restricted to research/educational institutions and private companies, the democratization of these 'idea materialization' spaces has formed enthusiastic communities of experimenters, artists, and designers. Depending on the Fab Lab model, these communities go as far as disclosing the knowledge on the entirety of their innovations and involve each other in various projects.
The authors distinguish these fabrication spaces from ideation spaces[2], which have mainly remained privately held in artist and design studios, advertisement agencies, architecture practices, and, most famously, in internet service companies such as Google and Facebook.

This paper outlines the preliminary conclusions from observing the environments of universities, corporations, mechanical manufacturers, and studios of artists, designers, and architects. These conclusions clarify the focus for further research

[1] Fabrication spaces are environments which provide the tools (pens, boards, coloured paper, cardboard, milling machines, lathes, laser cutters, 3D printers, etc.) necessary for *materializing a concept or idea*.
[2] Ideation spaces focus on the *creation of a concept*, an idea, an innovation to find the solution to a brief, or even creating a brief altogether. The tools used are often: suggestive objects, photographs, toys, white boards, post-its, etc.

to transform a design room at the Tokyo Institute of Technology into a Space for Creativity and Innovation.
The preliminary results of the research in fabrication and ideation trends are documented in section 2. Section 3 explains both the hypothesis in the effectiveness of “mixed spaces” and the testing methodology.

2. Classifying Fabrication Spaces and Ideation Spaces

2.1. Fabrication Spaces

Access to professional machinery, previously restricted to company professionals, has opened to individuals of the public, eager to materialise their ideas, desiring to expand their skills set, or curious to explore new means of fabrication. Acknowledging this transition in access, fabrication spaces are here classified in terms of their public access as *Closed, Semi-Open,* and *Open* fabrication spaces.

2.1.1. “Closed” Fabrication Spaces

These fabrication spaces are private and their access is restricted to specific members (employees or students) of the organisation owning the facilities. Examples are drawn from a typical specialised tool manufacturing company in Belgium and from the authors’ respective universities.

Capaul Precision Mechanics is a privately held company that manufactures highly specialised mechanical components for the aeronautics, railway, and various other industries. It hosts a vast array of turning, milling, grinding, and eroding machines (Figure 2). The manufactured products are all designed by outside clients, outside the fabrication spaces. Although the company minimises the down-time of its machines during the working week, they remain inactive during the weekend and public holidays.

Figure 2 | Capaul Precision Mechanics Machine Workshop

The Mechanical and Industrial Engineering School of Arts et Métiers ParisTech holds an area dedicated to fabrication, covering more than 2,000 square meters. Its resources are extensive: a forge, a foundry, a composite material making workshop, traditional machining tools, state-of-the-art multi-axes machines, 3D printers and scanners, and high-pressure water cutters. The machines are restricted to student learning and use, which amounts to significant idle time and even complete lack of use.

The engineering departments at Imperial College London share multiple mechanical and electrical workshops, for students to gain fabrication skills and materialize their engineering projects. Very strong health and safety procedures regulate these workshops, and access is restricted to students and researchers from specific departments. Due to the intensity of the university courses, the workshop policies, and the factory constraints, no time is dedicated to 'idea generation' and all fabrication activity is solution driven.

These three examples of fabrication spaces are assumed to represent the vast majority of manufacturing facilities. They are closed to the public and are solely intended to materialise specific parts or products, the purpose of which have been determined long before the manufacture. The "lost" potential for creativity lies in the lack of use for playful prototyping, restricted access outside of the determined brief , and machine idle time.

2.1.2. "Semi-Open" Fabrication Spaces

These represent fabrication spaces which are run both for a company/institution and are open to the public at specific times. The FacLab, affiliated to the university of Cergy-Pontoise, France, is open five days a week to the public. Aalto Fablab, affiliated to Aalto University's Arabia campus in Arabianranta, Helsinki, is open on Tuesdays for six hours in the afternoon (Fig. 3). These fabrication spaces do not charge members as long as they are willing to document their project in a completely open-source manner. Other FabLabs, such as those of the Netherlands and in Manchester vary between "Open Lab" days, available to the public, and "Appointment" days, available to members paying a fee per hour for certain machines.

Figure 3 | Aalto Fablab (Finland) and FacLab Cergy-Pontoise (France)

Semi-open Fabrication Spaces hold great potential with educational institutions such as universities and secondary schools. Students often pay little interest to the educational workshop hours due to uninspiring and non-personal exercises. An aficionado and entrepreneurial environment populating their workshop will both reduce machine idle time and very likely make them understand the great demand and attention their facilities receive from the outside. This is likely to

increase the student awareness of the opportunity these environments represent, and will increase their desire to learn.

2.1.3. "Open" Fabrication Spaces

Hacker Spaces and Fab Labs democratize the access to the fabrication and development of both Proof of Concept designs (POC) and prototypes. These spaces allow the public to access the fabrication process, especially for self-created briefs. Additionally, these fabrication environments may also encourage 'ideation'; as both casual social interaction and experimentation with tools are likely to generate new ideas or solutions. However, as the purpose of fabrication spaces is to materialize an idea rather than to create their concept, 'ideation' is usually not the priority of such spaces.

2.2. Ideation Spaces

Innovation think tanks, architectural studios, and design studios most often use ideation spaces to respond to a brief and specifications determined by the client. These companies are employed to provide the client with an innovative product. The team involved then goes through an active creative process, involving an iterative process of ideation and fabrication in order to reach a satisfying product as quickly as possible.

Somewhat differently, ideation spaces in internet services companies (Fig. 1) are for employees to provide their own company with an innovative product, without having been given a brief. This environment is meant to increase both the innovative and proactive potential of the employee. The employees are meant to generate 'ideas', concepts, and innovations, from casual discussion, inspirational lectures, or individual exploration.

These spaces seem to offer a mostly *passive* creative experience, as the employee is not prompted to be creative through an active an intense task such as brainstorming, but inspiration is meant to emerge from wanderings and casual coffee conversations. The authors believe that these spaces could yield a higher innovation output by an *active* creative experience, which includes the generation of ideas through themed brainstorming sessions and well-documented projects.

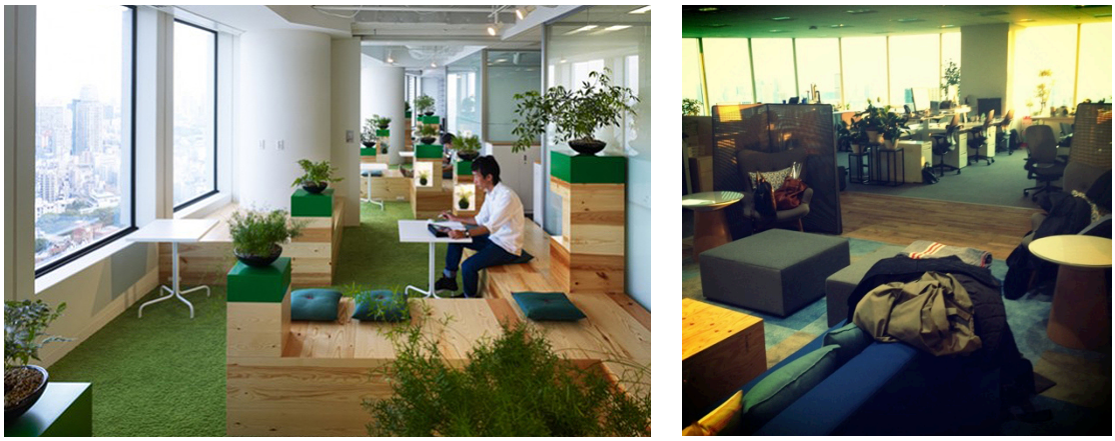

Figure 1 | "Ideation" Spaces at Google and Facebook

Open or *Semi-Open* active ideation environments can be created by organizing talks, lectures, debates, competitions, within the facilities of the *Closed* ideation

environments. These would allow the public to flock in, exchange ideas and challenge the knowledge of the employees of the company.

Currently, these spaces are falsely represented by competitions and incentive based crowd innovation systems over the internet for “for-profit” companies such as OpenIDEO and Quirky. These spaces take advantage of the shear number of their members, and their ideas, to generate innovation and turn it into a profit for the company. The winning and participating members are rewarded with an increased social rank on the website and sometimes with a fragment of the profit.

2.3. Mixed ideation and fabrication

Certain environments combine fabrication and ideation with various degrees of proximity. The results of the preliminary research are restricted to the private sector and are classified as: *Separated* + *Far, Separated* + *Close,* and *United*.

Separated + *Far* environments offer both ideation and fabrication spaces, but these spaces are physically separated from each other over a distance covered in more than one minute walk. Examples include research institutions, and certain artist studios, such as Imperial College London and Olafur Eliasson Studios (Coles, 2012).

Separated + *Close* environments reduce the distance between fabrication and fabrication to less than one minute from each other. Figure 2 shows the floor plan of SITU Studio, a research, design, and fabrication firm with the fabrication workshop a door away from the design studio. The ideation and fabrication spaces are shown in blue and red respectively.

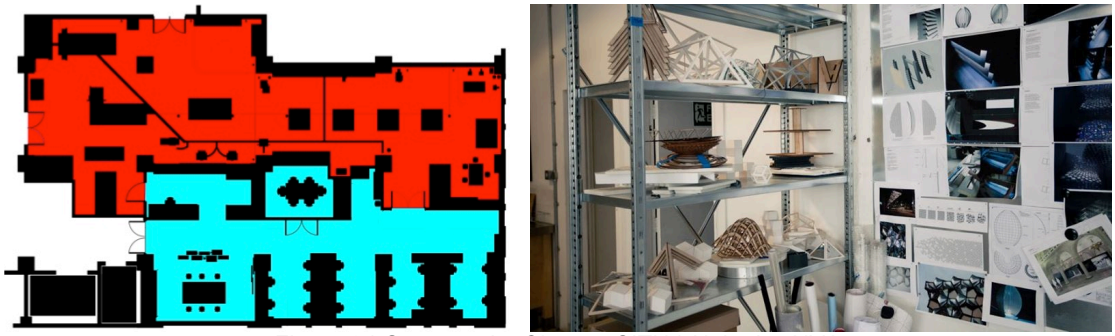

Figure 2 | *Separated* + *Close* at SITU | *United* at UVA

United environments bring both the ideation and fabrication environments to the same physical location. In such spaces, ideas are actively generated with immediate access to prototyping. IDEO, a design and innovation consultancy, is an example where brainstorming is usually operated in the vicinity of material used for rapid-modeling. United Visual Artists (UVA), a London-based design and artistic practice, unites the prototyping area, the ideation area, and the main office in the same room. The state of project progress is immediately visible to the employees and the technological concept can be reiterated at will in the open workshop (Figure 2). The united environment at Architecture School in Delft isolates noisy and dusty fabrication rooms by a glass window, whilst keeping them within the ideation space and allowing visual feedback of what is happening inside.

link between those public spaces and the influence of this public situation on (professional) idea generation

3. Results and Discussion

'Mixed' spaces are adopted by various successful design, architectural, and innovation practices. The iterations of the design process are done indoors, and the proximity to the prototyping tool encourages idea exploration and communication. Fabrication spaces hold the potential to facilitate and externalize the cognitive process (Kristensen, 2004). A preliminary conclusion from the findings of section 2 is the potential to improve the design process by combining "workspace and problem space" (Kristensen, 2004), ideation and fabrication, in one single environment. As explained by (Kelley, 2001), ideas should be prototyped as soon as possible, for facilitated communication and exploration. As such, the use of different media to present the concept allows for an exploration of the concept from different perspectives.

3.1. Application to a university design lab

These united spaces could enhance the output of a design process by reducing the time of the design and innovation process, encouraging technological exploration, improving communication, or removing the need for a leader to nourish the creative spirit of a group. It is the hope that generating ideas near fabrication tools will more likely result in disruptive innovations or eccentric creativity. Following Kristensen (2004), the ensuing creative space should contain the tools for each stage to deal with the particulars, while enabling communal space for intensive exchanges and collaboration.
Our investigation will determine whether gathering the tools for prototype fabrication and ideation in the same physical location leads to a better quality of output in the creative process.

As described by (Dong & Mougenot, 2013), a "passive" method of ideation is currently used in the cm design lab at the Tokyo Institute of Technology (Fig. 5). An *active* method of ideation, achieved by adding fabrication tools or creating an active brainstorming tool is hoped to accelerate the thought process.

Figure 5 | Current "passive" creativity space at Tokyo Institute of Technology (cm design lab)

Documentation and analysis of ideation spaces, fabrication spaces, and the instances in which they are united should answer the following questions about the conception of a 'mixed' space:

- Which tools should be included for active ideation?
- Which tools should be included fabrication?
- Which level of finalization should the fabrication tools allow the designer to attain (proof of concept, prototype, pilot)?
- What should be the interior design of such a space?
- Should the environment be open to the public?
- Should the access be restricted to selected applicants?
- Should outside activities, such as exhibition visits, debates, and talks, be organised?

3.2. Methodological Approach

The results from the analysis of generation and innovation environments will be followed by the **implementation** of the findings in the cm design lab environment at the Tokyo Institute of Technology. The environment: its members, its "openness", its activities, its goals, and its philosophy will be chosen and materialised by January 2014.

Comparative studies will then be performed to **test** the validity of the space created. The students and faculty members at the Tokyo Institute of Technology will be encouraged to join the creative space at the design lab. Several design briefs will be created and official competitions will be selected throughout the year, on which the community in the lab will work.

The experimental protocol will refer to well-established protocols that are used in cognitive science (see for example [Dong & Mougenot, 2013]), to compare creative performances of teams of students in two different conditions:
- environment where ideation and fabrication are separated
- environment where ideation and fabrication are united
To get reliable and significant evaluation of creative performances, the order in which several teams of designers will take the "test" will be counter-balanced.
Also, well-established protocols will be used to evaluate the creative performances, based on the subjective evaluation of outcomes creativity by external experts (e.g. professional designers).

4. Conclusion

Preliminary research in successful creative and innovation practices has demonstrated the potential of gathering ideation and fabrication in the same room to improve the design process. Our lab at the Tokyo Institute of Technology, will therefore continue the investigation with an experimental approach; first researching, documenting, and analysing the processes of leading creative and innovative practices, the tools they use for ideation and fabrication, and their proximity. The results will serve to design and produce an 'optimal' creative and innovative design lab. The eccentricity, innovativeness, and feasibility of the ideas generated and produced in this laboratory will be tested experimentally against the ones of other determined environments.

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