Adopting a design approach to translate needs and interests of stakeholders in academic entrepreneurship: The MIT Senseable City Lab case

Abstract

Recent research calls for greater consideration of design, by considering it further from the perspective of technology innovation management. In the attempt to cover this gap, the paper intends to explore how design can be used to support translational processes that connect and align different stakeholders in academic entrepreneurship. Insights from the investigation of the processes adopted by Senseable City Lab – an academic lab at MIT (Massachusetts Institute of Technology, USA) – will demonstrate how various design artefacts – sketches, visualizations, prototypes – are used to support several semiotic translations aimed at multiple stakeholders. Findings will show that design can play a relevant role in fostering entrepreneurial activities and value creation in academia, by supporting the translation of the different needs and interests of stakeholders into a shared meaning that allows a coordinated way of working. The conceptualization of design as a form of translation allows bridging currently distinct research strands in design and entrepreneurship.

Keywords – Academic entrepreneurship, design, translation, semiotics, value creation.

1. Introduction

Over the past three decades, the university has seen its role changing from one where it was considered "a conserver and reproducer of knowledge" (Lu and Etzkowitz, 2008, p. 15) (i.e., engaging in teaching and research) to one here it is expected to take a proactive role in the innovation and regional development through the engagement in entrepreneurial activities (Urbano and Guerrero, 2013). This phenomenon stimulated scholarly research into that entrepreneurial dimension that allows academia to pursue innovation development and economic and social engagement with external stakeholders, for example through intellectual asset management, university spin-offs creation and technology transfer and brokering (Shane, 2004b; Wright et al., 2009). Whilst not necessarily denying the importance of the economic outcomes generated by these forms of academic entrepreneurship, some scholars argue for a view of academic entrepreneurship also oriented toward creating societal value (Botes, 2005). Along this line of thinking, Kingma suggests that the role of academics is precisely to be "entrepreneurial thinkers" and to "seek new ways to engage with the community to create value" (Kingma 2011, ix).

In this perspective, the interplay between academia and external stakeholders[1] such as industry, NGOs (Non-Governmental Organization), government institutions, investment funds and technology transfer offices (TTOs) is of paramount importance to generate jointly value. Value precisely emerges through joint collaborative endeavours, where these different stakeholders bring together their assets, competences and specificities. In these joint endeavours, the knowledge produced in academia, scientific organizations and private research labs plays a crucial role for entrepreneurial innovation (for a review, see: Powell and Snellman, 2004; Stam and Garnsey, 2008).

In the specific context of academic entrepreneurship, the term 'valley of death' is often used to describe the difficulty of adapting and transferring knowledge from laboratory to market. This concept was first coined by Merrifield (1995), referring to the transfer of agricultural technologies towards lower-income countries, but has since then been

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[1] The term stakeholder is used in a broad sense (Harrison and Freeman, 1999; Freeman, 2010), as to include all the actors that somewhat affect or are affected by a specific process or project or organization. In design, Krippendorff provided the following definition: "Designers are surrounded by intelligent professionals who have an interest in the outcome of a design process: clients, engineers, CEOs, financiers, sales people, and the members of institutions that provide data in preparations for a design or do research after prototypes are available" (Krippendorff 2006, 63).

adopted as a metaphor to describe the hurdles that exist between research and the commercialisation of new products (Markham 2002) and the differences in terms of needs, interests, languages and cultures of the various stakeholders involved in these processes. One route to address this issue is acknowledging the key role of design, which can provide a key 'interface' role (Boren et al., 2012) and enable a better collaboration. As argued by Sainsbury: "The use of design helps scientists to develop commercial applications for their work while it is still at the research stage or at the outset of the technology transfer process" (Sainsbury, 2007, p 151).

In spite of the increasing research and compelling evidence for the value of design in entrepreneurship, there has been little work exploring the potential impact that design might have as a route to bridging this 'valley of death' in processes of knowledge creation in an academic setting. In the attempt to cover this gap, the paper intends to study how design can be used to support translational processes that connect and align different stakeholders to create value in academic entrepreneurship. Design materials such as sketches, data visualization and prototypes can be used at various stages to coordinate the stakeholders: through the design process, ideas and concepts undergo semiotic translations and are materialized into visual, audio, and tangible formats. As such, these translations are a way of expressing meaning in different languages (e.g., translating state-of-the-art scientific advances into the visual language of a sketch or the tangible language of a physical prototype), which can be more easily understood by diverse stakeholders. Design can even be employed to facilitate participatory design session where all the stakeholders directly contribute to the design-as-translation process, jointly creating visual representations and prototypes that translate the multiple perspectives of the various stakeholders (Simonsen and Robertson, 2013).

To provide an empirical evidence to this perspective, this paper builds upon an ethnographic analysis of Senseable City Lab – an academic lab nested within the Department of Urban Studies and Planning at MIT (Massachusetts Institute of Technology, USA) – and its entrepreneurial dimension to demonstrate how design is used as enabling factor to support academic entrepreneurship and its process of value creation.

The remainder of the paper is organised as follows: Section 2 introduces the literature background around the topic of academic entrepreneurship and design as translation. Section 3 describes the research approach and the research context. Section 4 presents the

findings of the study. Section 5 elaborates on the results. Finally, the last section concludes the paper underlying the practical as well as the theoretical implications.

2. Literature review

2.1 Academic entrepreneurship and the collaboration of multiple stakeholders

According to Rothaermel et al (2007), academic entrepreneurship refers to activities and assets of an entrepreneurial university, such as technology transfer, intellectual property licensing, science parks, incubators, university spin-offs, and other processes aimed to implement the third mission of the university (social and economic development). Some studies (Gibb et al., 2013; Rothaermel et al., 2007; Wright et al., 2007) specifically look at higher education institutions as entrepreneurial organizations with a key role within the innovation system, both as human and as technology capital providers (Etzkowitz, 2003; Mowery et al., 2001; Rosenberg and Nelson, 1994). Other studies (Oakey and Mukhter, 1999) see the entrepreneurial university as a place that can foster the growth of high-technologies small firms, in a knowledge economy where the networked dimension is articulated into ecosystems, which are globally and locally interconnected (Röpke, 1998). Other authors specifically look at academic entrepreneurship in terms of businesses started by academia as university spin-offs (Shane, 2004a; Wright et al., 2009). More detailed taxonomies include the 'research-based entrepreneurship' (Goel and Grimpe, 2011) or businesses started on the basis of academic research and technology.

Nowadays, academic entrepreneurship includes a large spectrum of entrepreneurial activities: from large-scale science projects, creation of technology parks, contracted research, industry consulting, patenting/licensing, spin-off firms, industry training, all the ay up to the more traditional academic activities of publishing academic results and producing highly qualified graduates (Cantaragiu, 2012; Klofsten and Jones-Evans, 2000), which can support entrepreneurial processes in a more indirect way.

From all these characterizations of academic entrepreneurship, the importance of collaboration with internal and external stakeholders clearly emerges, as well as the increasing accountability and responsiveness of higher education institutions in their environment (Maassen, 2000). Universities need to assume a more proactive role in the society by more directly engaging various stakeholders and their communities (Fayolle and Redford, 2014; Jongbloed et al., 2008); academic entrepreneurship precisely unfolds

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by intentionally developing a network of social contacts from which resources can be obtained and with whom the university will work to convert these resources into added value (Fayolle and Redford, 2014). From an entrepreneurial perspective, the multifaceted performance that a university is required to achieve embraces a larger meaning of social value creation through the management of stakeholder relationships (Post et al., 2002).

The literature includes many attempts to classify the stakeholders using various criteria; according to Freeman (1984), two main groups can be identified for a university: the internal stakeholders (alumni, faculty, administration and university staff) and external stakeholders (industry, government and regional/local community, citizens). The problem is that sometimes these stakeholders have different needs and interests, speak different languages and might not be aligned in terms of which kind of value has to be created. Activists from an NGO, venture capitalists and academic researchers involved into a joint project might have divergent interests: the academic researchers might want to further develop their scholarly investigation; the venture capitalists might see the potential of the project in terms of pure economic revenues and might want to patent some of this technology and market it; the NGO might instead be interested in releasing the results of the project as open source and open access in order to maximize societal benefits. These diverse notions of value can be complementary or in conflict, agreed upon or contested by the stakeholders. In all these cases, stakeholders engage in processes of negotiation and responses to external factors (McAdam et al., 2012) and create value by improving the socioeconomic environment (Fayolle and Redford, 2014). While interaction between the institutional spheres of industry and academia is not a new phenomenon (Etzkowitz, 2001; Martin and Etzkowitz, 2000; Shinn, 2002), the extent to which entrepreneurship is currently intertwined with academic activities and processes is unprecedented (Fayolle and Redford, 2014; Lazzeroni and Piccaluga, 2003).

Among the challenges of collaboration involving multiple and diverse stakeholders, Chiesa and Piccaluga (1998) note that given the different objectives and languages prevalent in academic and industrial contexts there is a need for translators between these groups. Consequently, it is necessary to recognise and balance the differing objectives of each stakeholder, thus ensuring that their needs and interests are systematically addressed, orchestrated and balanced (Fogelberg and Sanden, 2008; Garrett-Jones et al., 2005).

2.2 Design and entrepreneurship

Within technology innovation management, D'Ippolito (2014) provides a characterization of the concept of design as articulated into three dimensions: the creative, the shaping and the applicative dimension. According to the *creative dimension*, design can be seen as the creation of artefacts stemming from the creative inputs of individuals or firms (Krippendorff, 1989, 2006; Simon, 1969). Designers initiate, facilitate and monitor various exchange and adaptation processes, not only to create new products and services, but also to create value and meaning that can be appreciated by the actors involved (Krippendorff, 1989, 2006). In this vein, design is oftentimes seen as a problem solving activity, especially in new product development and innovation process, as such involving the definition of the problem, the identification and generation of alternative solutions, and the evaluation and selection of the most suitable one(s) (Buchanan, 1992; March and Smith, 1995; Petroski, 1996). According to the *shaping dimension*, design can be interpreted as a reflective, symbolic and meaning-making practice. By complementing Simon′s cognitive perspective, the designer is conceived as a practitioner focusing on the relation between creation and reflection-upon-the-creation (Bousbaci, 2008; Dorst, 1996; Schön, 1987; Rylander, 2009). Design can be interpreted as making sense of things, oftentimes through designerly reflective processes and negotiations between problem and solution, through activities such as analysis, synthesis, and evaluation. The designer can play a prescriptive role as s/he describes how the world might be (Cross, 2006; Lawson, 2006). Finally, according to the *applicative dimension*, design provides a key input for the strategy and is a means to achieve competitiveness of organizations (Gemser and Leenders, 2001; Kotler and Rath, 1984).

In the attempt to combine these three dimensions and link them to entrepreneurship, design can be seen as the cumulative development of an initial creative act, its further elaboration within reflective and meaning-making practices (shaping dimension) and its applicative dimension, which translates in the artefact playing a more explicit role in strategy making and innovation practices (Ardayfio, 2000). Various authors have explored the role of design to support innovative processes and, consequently, its possible role for entrepreneurship and management (Filippetti, 2011; Verganti, 2003; Verganti, 2008). This opens up new challenges, as noted by Walker (1990) who, specifically referring to a condition of increasing centrality of design in organizations, argues that there is the need "to manage [design] more effectively" (Walker, 1990, p. 43).

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Adopting a more specific focus, some authors praised the role of designerly-based prototyping as a central element in innovation processes (Bogers and Horst, 2014; Gero, 1990; Jones and Jordan, 1998; Leonard and Rayport, 1997; Leonard and Sensiper, 1998). Prototyping is also one of the components that Rust (2004, 2007) identified when exploring the potential benefits of engaging designers in the scientific process. According to Rust, design can support processes of knowledge creation and scientific research in various ways, such as: visualising scenarios of use; early prototyping to quickly and iteratively test ideas; producing artefacts to aid understanding and stimulate new ideas; raising awareness of future applications; helping to communicate ideas between research collaborators and potential investors in an exciting and credible way; speeding up the process of commercialisation. In a similar vein, Moultrie (2015) explored how design demonstrators can be used in translating scientific activity from the laboratory to the market.

In line with the work of Rust (2004, 2007) and Moultrie (2015), this paper precisely intends to understand whether design can help academic entrepreneurship to generate added value involving multiple internal and external stakeholders. This appears to be a perspective not thoroughly investigated in literature. In order to carry out this analysis, this article adopts the concept of translation.

2.3 Design and translational processes for entrepreneurship

This paper builds upon a concept of translation that goes beyond its common use (i.e., the translation of a literary text from English to another language). Petrilli and Ponzio (2003) claim that "the problem of translation cannot be reduced to the problem of the relation among texts in different languages. Each time there is a sign process, semiosis, there is translation. Therefore, "translation concerns the relation among signs in general" (in the Preface of Petrilli 2003, p. 15). This view sees translation in light of its semiotic dimension and highlights both the interpretive component of translational processes and their generative, creative potential. According to this wider view, translation can also refer to processes where, for example, a sketch or a visual diagram translate some complex, technical ideas developed by some researchers in nanotechnologies into a format that is easier to grasp for non-professional, non-academic audiences. Venture capitalists or external companies interested in investing in nanotechnologies can be more

quickly engaged in collaborative academic entrepreneurship processes, if the researchers translate their academic work - as originally published in written form into scientific journals - into visually appealing and easy-to-understand formats. During such design processes, ideas, concepts, project requirements and features undergo semiotic translations and are materialized into various articulations:

• visual articulations, in the case of sketches, diagrams, visual interfaces;

• or material and tangible articulations, in the case of prototypes;

• or other forms of articulations based on one or multiple dimensions (visual, music, video, photography, performance, textual descriptions or stories).

Our interest here is not to state that all translational processes in academic entrepreneurship are design-based. For example, imagine a scientific lab that, after having described one of its innovative technologies in a scientific paper, creates some other texts that present these same technologies using a language that could be more easily understood by a layperson. Or imagine that this lab – located in the US – not only routinely produces these descriptions in English, but also translates them into other languages (e.g., Italian, French, Chinese). These are all examples of translations, which do not involve design and which are aimed at engaging non-academic audiences and keeping them informed in the work of the lab. Our specific interest is in studying situations where, for example, the lab produces some new diagrams or sketches or motion graphic videos or prototypes to further support these translational processes (Simeone, 2014, 2016; Simeone et al., 2015). In this sense, we refer to design specifically as a symbolic, meaning-making practice (Krippendorff, 1989) and, in line with Buchanan (2004), we believe that an approach focusing on user research and user testing, rapid and frequent prototyping, visualization techniques, task-based scenario building, attention to the brand experience mark a distinctive designerly way of thinking and operating (Buchanan, 2004). In the paper, consequently, we specifically direct our attention towards the design artefacts emerging from this meaning-making practice.

The concept of translation is not new in design research. Some scholars employ it in a quasi-literary sense, to talk about translational processes among the languages of different design methods or techniques, such for example Singh and Gu (2012), who investigate generative design in architecture. Some other scholars adopt translation in another quite commonly used connotation, as to describe design processes and outcomes (such as

sketches) in terms of 'translation of ideas' (see for example: Leblebici-Başar and Altarriba, 2013; Yi-Luen Do et al., 2000). Reich et al. show how participation in design is tied to "problems of interpretation and translation of varying user and expert perspectives" and argue in favour of "increasing access to technical knowledge and its translation for equal participation in a dialectical process" (Reich et al., 1996, p. 174). Tomes and colleagues focus on the negotiation between graphic designers and the clients and claim that "viewed in this light, the whole of the design process is directed towards the achievement of a mutually acceptable visual `translation' of the brief, and it is achieved through the medium of lesser translations from the verbal to the visual and back again" (1998, p. 127). Designers act as brokers of languages in supporting managers in their interactions and communication with designers (Dell'Era et al., 2011). A specific research strand explores how semiotics can be used to look at the translational dimensions of design (Baule and Caratti, 2016; Riccò, 2016; Zingale, 2016).

None of these studies specifically addresses the relationship between design, translation and entrepreneurship. This article precisely intends to investigate if and how design can be used to support translational mechanism to align the needs and interests of multiple stakeholders in academic entrepreneurship.

3. Research method

Based on the logic of grounded theory (Glaser and Strauss, 1967) as recognized method in research on managerial and organizational issues, this study adopts the qualitative method of case study to identify meaningful insights through a limited number of examples (Pettigrew, 1990). In general, case studies are the preferred strategy when 'how' or 'why' questions are being posed, and when the focus is on a contemporary phenomenon within some real life context (Yin, 1994). As pointed out by Glaser and Strauss (1967), the aim of case study research is to discover 'grounded theory', which can be interpreted as a strategy to carry out research, involving an empirical investigation of a particular contemporary phenomenon within its real life context by using multiple sources of evidence (Robson, 2002).

Specifically, we have chosen an extreme case study (Eisenhardt, 1989; Yin, 1994) of a successful example of processes and environments where design is adopted to transform the needs and interests of different stakeholders into valuable innovative solutions. By

selecting an extreme case, we can better understand the role and meaning of design to support translational processes in academic entrepreneurship.

In order to generate, collect and analyze data for our case, we adopted a combination of methods: ethnographic observations, interviews and archival research. A multi-year ethnographic investigation was conducted (2011-2014) at the MIT Senseable City Lab in Cambridge, MA. The application of an ethnographic approach with the direct involvement of researchers in the field has proven to be a common element of a good number of recent studies on organizations (Czarniawska, 2012).

Following a grounded theory approach, data emerging from the fieldwork was subsequently analyzed in order to identify interpretation patterns. In the data analysis phase, we also relied upon a semiotic conceptual framework built upon the work of Eco (2003). In the following paragraphs, we provide further detail on the entire research process.

3.1 The research context

Senseable City Lab is a research group nested within the City Design and Development group at the Department of Urban Studies and Planning at Massachusetts Institute of Technology (MIT, Boston, USA). Senseable City Lab acts as an initiative that coagulates multiple creative streams and productive energies coming from in-house transdisciplinary researchers and external collaborations with other stakeholders such as institutions, laboratories, companies. Senseable City Lab's projects span from architectural interventions, such as *The Cloud,* a responsive environment for the city of London, to innovative product design, such as *The Copenhagen Wheel*, a concept that transforms ordinary bicycles through a set of sensors/actuators that provide feedback on pollution, traffic congestion and road conditions in real-time.

In 2011, the Senseable City Lab had been operating for 7 years and had already worked on more than 50 projects with roughly 350 collaborators[2]. These collaborators represent a wide variety of disciplines, from architecture, to computer science, engineering, interaction design, up to theology, game programming, Russian studies, medieval studies,

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[2] Figures collected from an analysis of Senseable City Lab official website (http://senseable.mit.edu/) and personal conversations with lab's directors and members carried out in Cambridge MA (USA) in March 2011.

space sciences, Asian arts, music and game programming. Projects are also widely distributed in different geographic locations across all the continents. A high number of stakeholders are involved in Senseable City Lab's projects and some of them come from different disciplinary perspectives and cultural viewpoints and have various agendas, needs and interests. This is how the lab describes itself on the home page of its official website: Senseable City Lab "speaks the language of designers, planners, engineers, physicists, biologists and social scientists. Senseable is as fluent with industry partners as it is with metropolitan governments, individual citizens and disadvantaged communities. Through design and science, the Lab develops and deploys tools to learn about cities—so that cities can learn about us"[3]. This paper, in a way, precisely intends to examine if design – as used by the lab, as an approach that relies on rapid and iterative visualization and prototyping, user research and user testing, attention to the brand experience, service-based scenario building and deploying, as well as on quite practical designerly skills in product, interaction, architectural, urban, service design – can support the lab in being 'fluent' with multiple stakeholders.

Senseable City Lab is pretty active across the different forms of academic entrepreneurship proposed by Klofsten and Jones-Evans (2000):

- Contract research: undertaking specific research projects with industry; many of these projects have a strong commercial focus.
- Grantsmanship: obtaining large-scale research grants from external sources for basic research.
- Publishing academic results: publishing a good number of books, chapters and articles in high-impact venues or in popular media.
- Consulting, by directly selling academic expertise to external organisations to solve practical problems.
- Industry-oriented training courses, including executive education.
- Spin off formation, the creation of firms based on university research.

In a good number of cases, Senseable City Lab's research projects are oriented to the design and development of technologies or models that can have a commercial potential,

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[3] http://senseable.mit.edu/ accessed 25 July 2016.

and as such are either backed up by grantmanship (e.g., *Live Singapore*[4], funded by the Government of Singapore), contract research (from Coca-Cola, to ENEL, Ericsson, Telecom Italia, GE and many others) or consulting activities (e.g., like in the project *Digital Water Pavilion*[5]). Outcomes of these collaborations are generally theoretical models or prototypes at different level of refinement, which can be evaluated by industrial partners as technologies to be implemented, internally employed and/or commercialized.

In some other cases, Senseable City Lab's research activities lead to the creation of start-ups, such for example *Superpedestrian*, which produces and commercializes *The Copenhagen Wheel*, a digitally-equipped bike that contains sensing technologies and that is able to offer real-time advice to the biker on matters such as traffic, weather and pollution conditions[6].

The lab is very prolific and various kinds of publications are ways to disseminate the results of the lab to a wide audience, not only academic.

Although Senseable City Lab does not directly offer industry-oriented courses, its team members are included as faculty members in the wider educational offer provided by MIT.

3.2 Data collection and generation

In operational terms, data was collected and generated through archival research, direct observation, the authors' experience as participants and e-mail exchanges. Field source data mainly consisted of notes, photographs and audio-video recordings. Some semi-structured conversations with the labs' directors, members and internal and external collaborators in the period across January 2011 and April 2014 were conducted by one of the authors. Multiple data collection methods were used to exploit the synergistic effects of combining them via triangulation (Eisenhardt, 2002; Jick, 1979), which consists in the combination of investigative techniques to reduce the bias of a single observation in comparison of multiple data (Tarrow, 1995). During the first stage, secondary sources such as archival records, documentary information, official corporate communication tools, like the websites and other social network accounts such as the Senseable City Lab's YouTube channel have also been used.

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[4] http://senseable.mit.edu/livesingapore/ accessed 25 July 2016.
[5] http://digitalwaterpavilion.com/ accessed 25 July 2016.
[6] https://www.superpedestrian.com/ accessed 25 July 2016.

At a later stage, the case has been informed by 10 in-depth interviews with the directors of the center and other stakeholders identified as key informants (Kumar, et al., 1993). More specifically, the process of conducting in-depth interviews was articulated into the following phases: planning, developing the instrument, collecting data, analyzing data and disseminating the findings (Boyce and Neale, 2006). During the planning phase, we conducted a web research to identify the stakeholders to be involved and we identified the key informants: representatives of the Senseable City Lab (the directors and some members), some external collaborators and representatives from other organizations collaborating with the lab. Later, we developed the instruments in compliance with an interview protocol. Then, we carried out processes of data reduction, data display and conclusion drawing and verification (Miles and Huberman, 1994). As argued by Gilmore and Pine (1997), in case studies methodology, this approach guarantees the highest degree of reliability. Interviews have been based on semi-structured schemas using a flexible approach. Myers (2008) states that interviews offer an excellent 'window' of achieving the research objectives, either allowing to know the informant's perspective on the issue or to know whether the informant can confirm insights and information the researchers already hold.

3.3 Data analysis

In order to examine the various instances of translation at play in Senseable City Lab, the analysis of data followed an inductive and iterative process (Miles and Huberman, 1984; Strauss and Corbin, 1998). The first step was a descriptive code resulting from the consolidated framework of the categorization of translation modes offered by Eco (Eco, 2003). Diedrich used this categorization to analyse urban design (Diedrich, 2013). The categorization adopted is inspired by Diedrich's work, but it is slightly different as for the way in which we define the key concepts and the boundaries among the categories. Moreover, Eco states that there are infinite modalities of translation and that the richness and unpredictability of this continuum cannot be represented by a rigid categorization (Eco, 2003). In order to build his characterization of translation modes, Eco (2003) relies on some key concepts:

- *Intrasystemic interpretation*: it is a translational mode that happens within the same semiotic system. Intrasystemic interpretations can be, for example, a copy of a drawing with a different scale, the summary of a book or the paraphrasis or

reformulation of a sentence, a *performance*, like when the different actors read the same text[7].

- *Intersystemic interpretation with substance variation.* It is a translational mode that happens within different semiotic systems (e.g., like when we translate between two different languages such as English and Italian or when a 3D render translates an initial hand-draw sketch into a more refined design artefact).

- *Intersystemic interpretation with matter variation.* In this case, the semiotic systems are quite different and the translation only points to some elements of the original work. For example, a choreography of Picasso's *Demoiselles d'Avignon* might translate the painting through grimaces and disarticulated movements of the dancers. In this case, the translation points to some elements of the original work (for example, the angular and disjointed body shapes), but does not fully represents other elements (for example, the relationships among the various colour nuances and the volumetric bidimensional rendering used in the painting). Intersystemic interpretations happen in the case of *adaptations*, when a novel becomes a movie, or some pieces of classical music become a cartoon, like in the case of Walt Disney's *Fantasia*[8].

This categorization helped us in the processes of data reduction and organization and in the analysis of the findings.

Finally, as described by Eisenhardt (1989), a further series of iterations between the data, both secondary and primary, and the literature has been conducted to better ground the theoretical foundations of our investigation into current scholarly work.

3.4 Validity

There are no universal criteria that could fully assess the qualitative research (Eriksson and Kovalainen, 2008). However, four types of methods proposed by Yin (2009) to

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[7] The three examples refer to three distinct sub-categories (intrasemiotic interpretation, intralinguistic interpretation and performance). Performance is considered as a borderline category between intrasystemic and intersystemic (Eco, 2003).

[8] Eco (2003) further distinguishes between adaptation (*adattamento o transmutazione per manipolazione*) and adaptation as new work (*adattamento o transmutazione per creare una nuova opera*), like in the case of a novel that tells the story of Scarlett O'Hara after she says "After all tomorrow is another day" at the end of the movie *Gone with the Wind*.

improve the validity of a qualitative case research have been adopted: construct validity, internal validity, external validity and reliability.

- Firstly, the construct validity can be executed by utilizing a wide variety of sources of evidence to establish reliable chains of evidence. In our case, we used a combination of data collection methods, from ethnographic observation, to documented interviews, up to different types of archival documents, such as web sites, articles and printed report and materials. Using these different sources, it has been possible to crosscheck the findings and, therefore, to create trustworthiness.

- Secondly, the internal validity is assured by identifying causal relationships and patterns in the case research. This was executed by relating the empirical data with existing research.

- Thirdly, the external validity is proved by generalization of the study results. As the research only contains one case and a narrow amount of interviews, the generalization of the findings is limited. Awareness of these limitations improves the external validity.

- Finally, reliability has been improved in the following way: firstly, adopting a consistent structure for the interviews; secondly, all the data utilized in the research has been well documented into archival records eventually accessible by other researchers.

4. Findings

4.1 Senseable City Lab and its translational modes

Following Eco's characterization (2003), it is possible to analyse how Senseable City Lab uses design to operate translational processes among different categories of stakeholders, thus supporting academic entrepreneurship. In Table 1, various translational activities carried out by the lab are reported. At this stage, it is important to consider that not all the activities listed in the table are directly related to design processes.

Table 1. Design and translational activities carried out in Senseable City Lab

(a) Intrasystemic interpretations	
Mode of translation	**Examples in Senseable City Lab**
Intrasemiotic: e.g.,	Operating within the architectural domain, Senseable City Lab

a copy of a drawing with a different scale	frequently works with maps and models at different scale. Most of these models are kept at the lab and visitors/team members can interact with them also after the conclusion of the project. **Stakeholders involved**: internal team members, colleagues, visiting researchers, external collaborators.
Intralinguistic: e.g., the summary of a book or a paraphrasis of a sentence; or a sketch that translates another sketch	Generally, the lab produces abstracts or summaries of its projects (intralinguistic translations), for example to be used as short presentations for larger audiences or for archival documentation, using different channels and different languages for a variety of audience. All these descriptions are carefully reworded in order to be accessible to different target groups. Out of the 436 items listed as publications in the official website, more than 35% of them are destined to venues such as El Pais, La Stampa, Il Corriere della Sera, BBC, New York Times, Wired. Senseable City Lab's members also put great effort in disseminating (or marketing) their work, by systematically creating dedicated websites (or microsites) for each project, creating press kits and press releases, actively communicating on Facebook, Twitter and other social media channels. Another example of intralinguistic translation is the quite frequent situation when sketches translate other sketches, such as in some brainstorming sessions where some of the participants draw sketches and some other participants answer elaborating other sketches that translate the original one (for example, representing the same concepts from a different perspective). This happens quite often when team members with different backgrounds are collaborating on the same project (for example, some representatives from industry working together with internal Senseable City Lab's researchers). In these occasions, sketches are used to translate ideas and concepts among different stakeholders. **Stakeholders involved**: wide audience, from internal members to external collaborators and sponsors, up to press representatives and general public.
Performance: e.g., two different actors reading the same text	The senior members of the lab frequently give keynotes or public lectures. In some cases, the same PowerPoint slides are used and different speakers - sometimes the lab's director, some other times other lab members - present these same slides. This performative dimension is another way to translate concepts from quite technical academic research into a form that can be more easily understood by a large audience. **Stakeholders involved**: wide, but selected audience, depending on the presentation (e.g., the same PowerPoint slides can be used for a keynote at a scientific conference or for a TED Talk).
(b) Intersystemic interpretation with substance variation	
Mode of	**Examples in Senseable City Lab**

translation	
Intersemiotic interpretations: e.g., a photo of a painting	In this case, there is a sort of translation from one type of visual representation into another one. For example, during a project, the lab would start with some hand-drawn sketches and get to some digital bidimensional images and then arrive to 3D renders. All these material re-articulations can be considered as instances of intersemiotic translations precisely because they go through different semiotic systems. The progression of these design artefacts through various translations was also related to the stages of the process (at an initial stage, it was perfectly fine to share hand-drawn sketches among team members; at a later stages, for example in occasion of public presentations, these sketches needed to be translated into more polished artifacts). **Stakeholders involved**: internal team members, colleagues, visiting researchers, external collaborators, wider audience.
Interlinguistic interpretations: e.g., the translation of a novel from English to Italian	Some of Senseable City Lab publications are translated in multiple languages, especially those books for trade, which illustrate specific projects, such as the *Digital Water Pavilion at Zaragoza* (Nicolino and Ratti, 2008) published in Italian, French, Spanish and English. Also in light of the geographically distributed activities of Senseable City Lab, this mode of translation is important to further disseminate and market the results of the lab. **Stakeholders involved**: geographically distributed academic community, but also companies working in the design field (architects, urban planners, etc.).
(c) Intersystemic with matter variation	
Mode of translation	**Examples in Senseable City Lab**
Adaptation: e.g., a novel becomes a movie, or some pieces of classical music become a cartoon	Senseable City Lab frequently produces motion graphics videos that illustrate the key components of its projects. Some of these videos, posted on the YouTube channel of Senseable City Lab got hundreds of thousands of view[9] and got frequently re-posted and linked from other websites, activating viral dynamics. **Stakeholders involved**: wide audience, from internal members to external collaborators and sponsors, up to press representatives and general public.
Adaptation as new work: e.g., a novel that tells a story	Projects created by Senseable City Lab are all connected by some sort of overarching thematic orientation, such as the idea of smart cities or city operating system. In some specific cases, the projects are also further connected by a common storyline. **Stakeholders involved**: wide audience, from internal members to

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[9] Videos related to the already cited Copenhagen Wheel project got more than 5.000.000 views (figures collected 28 July 2016).

	external collaborators and sponsors, up to press representatives and general public.

Although not all the translational modes described in Table 1 relate to design (i.e., the intersemiotic interpretation mostly refers to textual translations), the majority of the translational modes were supported by design, for example through the creation of sketches, architectural model, prototypes, motion graphics videos and visually appealing PowerPoint files. Also in the case of textual translations - such as a paraphrasis of a technical and academically-oriented description aimed at translating it into a language that could be more easily understood by a layperson - Senseable City Lab tended to accompany these textual descriptions with dedicated visualizations or motion graphics videos that could better explain and communicate.

For example, while working on The Copenhagen Wheel - the already cited project aimed at creating a hybrid e-bike, which through a set of embedded sensors can detect various parameters related to both the cycling activities of the owners (e.g., preferred routes, cycling habits, etc.) and the external context (e.g., air pollution, traffic and weather conditions) - Senseable City Lab created a design artifact (Figure 1) to provide a simplified representation of some features of the hybrid bike.

Figure 1 Screenshot from The Copenhagen Wheel website

This representation is not a blueprint that offers enough technical detail to guide the subsequent product development activities, but only an initial outline that translates some underlying technological advances behind the Copenhagen Wheel into a visual articulation that can be shared and potentially understood also by people without a background in engineering and computer sciences. It is a representation that is spatially

dislocated outside the lab and its academic and technological domain and repositioned as an external communication material that also speaks to non-expert and non-academic target audiences. This and other design artefacts specifically created for the Copenhagen Wheel – e.g., various visual mock-ups, 3D renders, motion graphics videos and prototypes - helped Senseable City Lab in translating the conceptual and technological complexity behind its activities into forms, which were more accessible to stakeholders with a different academic or technical background.

The use of all these translation modes from Senseable City Lab and the efforts invested in creating design artefacts to be distributed to multiple audiences give an idea of how important it was for the lab to communicate/interact/exchange ideas and collaborate with external stakeholders.

5. Discussion

5.1 How design can support translation and thus enable academic entrepreneurship
A semiotic categorization built upon the work of Eco (2003) has been used as a framework:

- To show the extent and the breadth of the translational processes carried out by Senseable City Lab
- To show how design can be employed to support translation across almost all the translational modes used by the lab.

We will now reflect upon how these processes of translation can be used as enabling factor to support academic entrepreneurship (Table 2).

Table 2. How different modes of translation support academic entrepreneurship

Mode of translation	How different modes of translation support academic entrepreneurship
Intrasemiotic: maps and architectural models or models for new products, created at various phases of the projects.	- Aligning internal lab members and external collaborators, thus leading to better team coordination. - Models are also a way to translate early ideas into formats, which can be shared with external investors and sponsors.
Intralinguistic: a wide variety of written publications, which present projects to different audiences,	- Translating the labs' scientific results and activity – oftentimes originating from state-of-the-art advancements in fields such a nanotechnologies or robotics – into a format that can be easily understood by wide audiences.

different channels and using a different language. Oftentimes, these written publications included visual artifacts such as diagrams, data visualizations, 3D renders, etc.	• As such, it is not uncommon that Senseable City Lab's projects get mentioned in press and media outlets, such as Wired, TIME, CNN, Fast Company. • This helps the dissemination and marketing activities of the lab and its 'brand'. An external sponsor might be more interested in investing into the lab, if there are chances that the joint project is going to be featured on a TV show or an internationally distributed magazine.
Performance: the lab members frequently give public presentations in several venues, sometimes also adding a performative dimensions (such as in a talk for TED).	• The presentations developed for keynote addresses, invited lectures and seminars are generally oriented to different targets, depending on the type of event: from an academic conference, to a technology fair for industry, up to a TED talk. • These presentations are ways to translate and summarize the lab's activities into a 15-30 minute easy-to-understand talk. • These venues are a good way for the lab members to create and curate connections and forge alliances, within and beyond academia.
Intersemiotic interpretations: the lab frequently uses design artifacts – sketches, visualizations and early prototypes - during brainstorming sessions and the concept and development processes.	• Design artifacts are frequently used in brainstorming sessions, which see the participation of teams that are distributed in diverse organizations and different geographic locations. • Design artifacts translate ideas into formats that can more easily circulate across these organizations and locations, thus streamlining the concept and production processes.
Interlinguistic interpretations: in some cases, Senseable City Lab documented his projects through some books translated in multiple languages.	• These multilingual translations give an idea of the geographic articulation of the lab and its way of operating, also involving actors that might not be comfortable with reading/speaking in English. • The lab also has sponsors located in countries where English is not the main language: e.g., Spain, Germany, France, and so on. This collaboration is in itself something that some sponsors consider qualifying for their own brand and therefore they tend to use it in their communication activities.

Adaptation: Senseable City Lab frequently produces polished and professionally crafted videos that illustrate the key components of its projects.	• Professionally shot short videos and motion graphics animations are generally produced by the lab and distributed through social media channels (such as Youtube).
	• These videos are important translation mechanisms because:
	    o They document the project in a format that is engaging and visually appealing
	    o They can be easily understood also by an

	audience of non-professionals
	o They can be easily re-shared. This is an incentive for the sponsors to activate partnerships with Senseable City Lab.
Adaptation as new work: some Senseable City Lab's projects – such as 'MoMA-followup' – can be seen as adaptions of previous work, which is translated in a way that can travel to different contexts, in this case an art exhibition.	• Senseable City Lab works in a way that his research and development activities are translated into multiple ways, from an academic paper to an artwork to be exhibited at a Museum of Modern Art in New York. • This is a way for Senseable City Lab to strategically position itself as a lab that operates across the borders of academia.

5.2 How do design-based translational processes support value creation in academic entrepreneurship?

The previous paragraphs described various forms of academic entrepreneurship carried out by Senseable City Lab (contract research, grantmanship, publications, consulting, spin-off formation) and how design supported translational processes and, as such, worked as enabling factor in academic entrepreneurship:

- Streamlining research, concept and development processes

- Creating a strong brand and a clear strategic positioning for Senseable City Lab

- Presenting the activities of the lab to a wide variety of audiences in an engaging way, also for communication and marketing purposes

- Coordinating and aligning the lab's internal team members and the external collaborators and stakeholders and their convergent and divergent needs and interests

- Forging and managing connections and alliances

All these elements support academic entrepreneurship in processes of value creation. What kind of value is created in these processes? This is a crucial question, especially going back to the already presented and discussed notion of academic entrepreneurship by Kingma (2011) defining academic entrepreneurship as a way to jointly create value with external communities. As documented in literature (Rothaermel et al., 2007), academic entrepreneurship contributes to building economic, social and cultural value in various ways:

- Knowledge produced in academia can lead to economic development of industry and other external organizations.

- Academic entrepreneurship enhances the reputation of the university, which attracts industry to the region and may lead to production of further forms of academic entrepreneurship. Engaging in contract research contributes to stronger social relations between university and industry that can lead to deeper interaction in the future.

- When the results of research are accessible to external, non-academic audiences and academics engage in conversations with external stakeholders, there is a potential for more inclusive knowledge production processes that are oriented towards the interests of multiple social groups.

- Upskilling the national or regional workforce as regards the emerging state-of-the-art in terms of theoretical models, practice and technology. This ensures that regional industry and maintains its competitiveness by increasing its internal skill-base.

- Creation of new entrepreneurial ventures in an economy that transfers models and technologies from the lab to the market, through several forms of intellectual property management.

In short, a stronger interconnection between academia and external stakeholders operating in the market sphere is generally seen in a positive light.

However, this interconnection can become problematic and open up a series of important questions related to how and to what extent research should maintain some degrees of independence from the market. This is an open point, frequently debated in academic entrepreneurship literature (Kingma, 2011) and articulated into the following questions: To what extent should researchers be granted some levels of independence in order to have the freedom to follow their research trajectories and/or express critical positions? To what extent is academic research accountable to external stakeholders (industry, NGOs, government, citizens)? To what extent can or should these external stakeholders be an active component in shaping the course of academic research?

These questions also impact more specifically on the notion of academic entrepreneurship and how it is defined, measured and seen from many different viewpoints, such as the

ones strictly focusing on the importance of monetary outcomes or the ones supporting the creation of long-term societal value, sometimes at the expense of more immediate economic benefits. These are all important issues that need further debate.

6. Conclusions

This paper built upon a wide definition of academic entrepreneurship as a way to connect academia with external stakeholders in order to jointly create value. The stakeholders' value network centred on academic entrepreneurship can respond to different needs and interests, not necessarily aligned, and can focus on various forms of value to be created. Potential divergences in the involvement of various stakeholders in academic entrepreneurship are a key issue, also in relation to the 'valley of death' that characterizes the transition of knowledge from academic research to the external world.

In the attempt to cover this gap, this paper provided insights on how design can be used to support translational processes and, consequently, connect and align different stakeholders. Insights from the investigation of the processes adopted by MIT Senseable City Lab demonstrated how design artefacts (e.g., sketches, data visualization and interactive prototypes) were used at various stages across a wide variety of translation modes. These design artefacts helped Senseable City Lab in translating the conceptual and technological complexity behind its research activities into forms, which were more accessible to stakeholders with a different academic or technical background. For example, translating complex scientific outcomes of research projects into an easy-to-understand motion graphics video was a mechanism frequently used by Senseable City Lab to communicate with external stakeholders and negotiate a shared way of working.

The paper outlined several ways in which these translational processes support academic entrepreneurship: coordinating and aligning the lab's internal team members and the external collaborators and stakeholders; streamlining research, concept and development processes; creating a strong brand and a clear strategic positioning for Senseable City Lab; presenting the activities of the lab to a wide variety of audiences in an engaging way. Ultimately, these translational processes were, for Senseable City Lab, a way to forge and manage connections and alliances among stakeholders, aligning their different needs and interests.

Like MIT Senseable City Lab, other academic institutions are nowadays challenged to follow entrepreneurial trajectories. The perspective offered by this paper can help these

institutions in reflecting upon their strategies for managing the interplay of various stakeholders. When academic institutions are aware of the potential of design as a translational mechanism, they might want to consider employing design approaches and methods in their own activities.

Existing scholarly work investigating interplay between design and entrepreneurship is sparse (Hobday et al., 2012; Sun and Linton, 2014). This paper offers an initial contribution to this area of investigation, with a specific focus on entrepreneurial activities carried out by academic institutions.

Further work is needed, also considering the limitations of this research, which only relies upon a single case study. As such, this article can only pinpoint to the need of additional studies to fully explore issues related to design, translation, entrepreneurship and processes of value creation in academia.

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