A RECONCEPTUALIZATION OF THE PRODUCTION OF KNOWLEDGE IN ARCHITECTURE THROUGH RESEARCH LABORATORIES

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ABSTRACT

A RECONCEPTUALIZATION OF THE PRODUCTION OF KNOWLEDGE IN ARCHITECTURE THROUGH RESEARCH LABORATORIES

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This thesis defines a new organization for the production of knowledge in architecture through research laboratories based on the assumption that the concept of discipline is incapable of describing the current practices of knowledge production in the field. By emphasizing the inadequacy of the term ‘discipline’ within the broader scale of the whole field of knowledge, this study identifies an epistemological crisis that signals the dissolution of the hierarchical disciplinary system. A new lateral field of knowledge has already been constructed by utilizing the terms “multi-, inter-, and trans-disciplinarity” as the core vocabulary defining different levels of relationships between disciplines. This study argues for a further shift in architecture, which has been instigated by the urge for innovation in knowledge production and enabled by the proliferation of research laboratories in the schools of architecture since the 2000s. A historical and conceptual understanding of the notion of the ‘laboratory’ itself demonstrates that these laboratories are the conscious responses to the fact that knowledge takes on another shape rather than the disciplinary one. This study constructs a conceptual framework through an analysis of the laboratories’ self-descriptions to decipher how they reflect this new field of knowledge. A set of actions that defines the knowledge production practices in these laboratories is compiled, interpreted, and visually represented with reference to both positivist and post-positivist outlooks of science. This framework illustrates that the laboratory, as a multifaceted concept, has the capacity to accommodate the ever-increasing complexities of the field of architecture, and the term 'laboratory' in the organization and production of knowledge as a unit is better suited to architecture; rather than 'discipline.'

Keywords: Production of knowledge, laboratory, innovation, disciplinarity, multidisciplinarity, interdisciplinarity, transdisciplinarity.

ÖZ

ARAŞTIRMA LABORATUVARLARI ARACILIĞIYLA MİMARLIKTA BİLGİ ÜRETİMİNİN YENİDEN YORUMLANMASI

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‘Disiplin’ kavramının mevcut bilgi üretim pratiklerini tanımlamak için yetersiz olduğu varsayımına dayanan bu tez, araştırma laboratuvarları aracılığıyla mimarlıkta bilgi üretimi için yeni bir düzen tanımlar. Çalışmada, tüm bilgi alanının üst ölçeğinde ‘disiplin’ teriminin yetersizliği vurgulanarak, hiyerarşik disiplin sisteminin çözülüşüne işaret eden epistemolojik bir kriz olduğu ortaya konulmuştur. Bu bağlamda, disiplinler arası farklı ilişki düzeylerini tanımlayan “multidisipliner,” “interdisipliner,” ve “transdisipliner” terimleriyle yeni bir yatay bilgi alanı inşa edildiği gözlemlenmiştir. Bu çalışma ise, mimarlık alanında 2000'li yıllardan itibaren bilgi üretiminde inovasyon dürtüsünün tetiklediği ve mimarlık okullarında araştırma laboratuvarlarının yaygınlaşmasıyla mümkün olan bir değişim olduğunu savunur. ‘Laboratuvar’ terimi tarihsel ve kavramsal olarak incelendiğinde, yeni kurulan bu laboratuvarların bilgi alanının değişen yapısına verilen bilinçli cevaplar olduğu görülmektedir. Mimarlık okullarındaki araştırma laboratuvarların bu çalışmada tariflenen yeni bilgi alanını ne ölçüde yansıttıklarının anlaşılabilmesi için laboratuvarların kendi öz tanımlarının derlenmesiyle kavramsal bir çerçeve oluşturulmuştur. Laboratuvarlardaki bilgi üretim pratiklerini tanımlayan bir eylem listesi sunan bu çerçeve, bilime ilişkin hem pozitivist hem de post-pozitivist bakış açılarına referansla derlenmekte, yorumlanmakta ve görsel olarak temsil edilmektedir. Bu tür bir okuma çok yönlü bir kavram olan laboratuvarın mimarlık alanının karmaşık yapısını yansıtma kapasitesine sahip olduğunu ve bir birim olarak bilginin düzenlenmesi ve üretilmesinde 'disiplin' kavramına oranla mimarlığa daha uygun olduğunu göstermektedir.

Anahtar Kelimeler: Bilgi üretimi, laboratuvar, inovasyon, disiplin, multidisiplinerlik, interdisiplinerlik, transdisiplinerlik.

To Umut,

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INTRODUCTION

1.1 Context and Problematic of the Study

This study problematizes the adequacy of the concept of 'discipline' to define and order the knowledge production practices in architecture which has always been a matter of contention among its disciples. Two themes, in particular, stand out from the discussions on the disciplinarity of architecture. The first one is the extent of the frequent references to other disciplines within the discipline of architecture, and the second one is the so-called discrepancies between the production of architectural artifacts and the production of architectural knowledge. Due to these reasons, architecture could not find a place for itself in the university structure which is also organized according to the disciplinary model.[1]

Architecture's discomfort with the disciplinary norms is related to the conceptualization of 'discipline' as a uniform notion consisting of a set of rigorous epistemological and institutional units, which is in contradiction with the actual knowledge production practices. Architecture has never comfortably fit to the definition of discipline, as "it continually defines its own version of what it is to be a discipline, as an inter-, trans-, super, even un- or a-disciplinarity."[2] In this context,

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[1] Mark Wigley. "Prosthetic Theory: The Disciplining of Architecture," Assemblage, No. 15, 1991: 6-29.

[2] Igea Troiani, Suzanne Ewing and Diana Periton. "Architecture and Culture: Architecture's Disciplinarity," Architecture and Culture. vol.1, iss.1, 2013: 9.

this thesis mainly argues that the laboratory, as a multiform concept, has the capacity to employ the ever-increasing complexities of the field of architecture, and the term 'laboratory' in the organization and production of knowledge as a unit better fit to architecture rather than 'discipline.'

The inadequacy of the term 'discipline' had already started to be discussed prominently in the 1970s when the trilogy of inter-, multi-, and transdisciplinarity was constructed as a new terminology defining the different kind of knowledge production practices proliferating at the time. Yet, this trilogy did not offer a complete renewal of the dominant disciplinary terminology; as it was constructed with the additions of different prefixes before the term 'discipline' itself. This study offers to replace the formulation of the field of architecture as a 'discipline' with a framework based on the concept of 'laboratory,' which has the potential to describe the current knowledge production practices in the field of architecture more precisely.

While the notion of the laboratory has been successful in maintaining a multifaceted nature throughout its history as the term has been used for various types of places since its inception, the concept of 'discipline' do not diverge too much from its initial conceptualization.[3] Discipline, as the governing mechanism of the field of knowledge, is founded upon a positivist understanding of science which prioritizes the natural scientific method as the only legitimate way to produce knowledge and considers other forms of knowledge whose progress is not cumulative as having less or no value. This positivist understanding posits that the linear, cumulative progress of knowledge is a necessary condition to be acknowledged as a discipline.

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[3] It should be noted here that there are recent different interpretations of the term "discipline" regarding "increasing complexity of scientific knowledge and activity," however, it is argued here that it is not possible to generalize those interpretations for an abstract concept. See Anne Marcovich and Terry Shinn. "Where Is Disciplinarity Going? Meeting on the Borderland." Social Science Information. vol.50, no. 3–4, 2011: 582–606.

The main underlying reason behind this proposed shift from 'discipline' to 'laboratory' is related to the fact that architecture cannot claim scientificity in the positivist scientific outlook. Yet, to exist within the space of the university, architecture always aspires to this positivist scientificity in knowledge production. While incorporating 'laboratory' into its institutional setting, architecture aims to utilize the strong positivist connotations of the term. Having said that, the usage of the term 'laboratory' has been recently extended to define various types of knowledge production practices. The diverse places, virtual or real, that call themselves 'laboratory' or 'lab' share specific characteristics which are diffused into the whole field of knowledge from natural sciences to arts and humanities. It is this new type of laboratory which resonates well with the knowledge production practices in architecture. It is the claim of this study that, through this kind of laboratory, architecture can claim to scientificity without necessarily having to comply with the requirements of the positivist scientificity.

Laboratory, therefore, is regarded here as a 'concept word' that defines a set of distinct and diversified knowledge production practices rather than as a mere physical space of experimentation or an architectural archetype. When the concept of the laboratory is not constrained as the "privileged site" for the production of knowledge which lends a special credibility to scientific claims,[4] the diversity of possibilities for different types of knowledge emerges in the physical, conceptual, or virtual space of the laboratory. The laboratory is considered here as "a product of relations between the people, objects, practices, institutions, and discourses that it brings together."[5]

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[4] Thomas F. Gieryn. "City as Truth-Spot: Laboratories and Field-Sites in Urban Studies," Social Studies of Science. vol. 36, no. 1, 2006: 5.

[5] Darren Wershler, Lori Emerson, Jussi Parikka. The Lab Book: Situated Practices in Media Studies. Minneapolis: University of Minnesota Press, 2022. <https://manifold.umn.edu/projects/the-lab-book> (last accessed on 05.10.2021)

The laboratories in the schools of architecture are viewed here as conscious responses to the fact that knowledge takes on another shape than the pyramidal one constructed by the disciplinary system.[6] The new shape of knowledge is the network, and laboratories provide the necessary infrastructure for this new configuration of the field of knowledge, in which disciplines no longer held the primary position. Relationships formed in the field of knowledge are no longer based on disciplinary affiliations, rather, the urge for innovation governs these relationships between different parts of the knowledge field through laboratories.

This urge for innovation defines an approach in the knowledge production that is not confined to the previously established epistemological and institutional structures of the disciplines. This non-linear, non-cumulative way of producing knowledge could be outlined here with its main characteristics. First, this approach is freer in its scientificity than the disciplinary model, since new knowledge is not necessarily built on previously established methods, assumptions, concepts, and theories of a particular discipline. Second, it is more independent in disseminating its knowledge by utilizing the digital infrastructures for publishing knowledge; in other words, it is not confined to the limitations of 'paper' as the sole medium for producing and publishing knowledge. Third, it is more open in its use and share of data, as data becomes accessible to the whole field of knowledge before being assigned to a specific discipline.

True innovation is very rare in the sense of "invention of new products," but being 'innovative' is understood here mainly in the context of knowledge production. Still, the primary connotation of the term innovation as the practical implementation of ideas into products cannot be discarded because it is directly related to the laboratory

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[6] For further inquiry, see Zeynep Mennan's discussion on how this pyramidal representation of knowledge has been sustained in both metaphysical and positivist scientific traditions of the foundationalist epistemology. Zeynep Mennan. "An Interpretive framework for understanding architectural theory's self-representation," Unpublished Phd Dissertation. Ankara: METU, 1997: 62-79.

as the site of the invention. The laboratory could house both types of innovation or, more precisely, because of its close affinity with the industry and its constant search for innovative products has enabled laboratories to become the new locus for the production of this new type of knowledge.

The laboratories in the schools of architecture construct their 'customized' ways of producing knowledge that cannot be found in the conventional 'disciplinary' system. Through an investigation of the actual practices of knowledge production in the laboratories, the term 'laboratory' is offered here as a replacement as the unit of analysis for the field of architecture, as an analytical tool rather than as an actual replacement of the discipline. Through an inquiry into the concept of the 'laboratory' itself, this study offers a framework for the conceptualization of these recently emerging laboratories in the field of architecture.

1.2 Conceptualization of the Framework for the Laboratories

This study initially emerged from the curiosity regarding the certain uneasiness with the notion of discipline frequently expressed in architecture. The main obstacle in architecture's way to organize itself as a robust discipline with clear-cut boundaries is its knowledge production practices, which are fundamentally different from epistemologically "strong" fields.[7] This line of reasoning necessitated two different kinds of inquiries: first, an examination of the whole field of knowledge, and second an analysis of the current knowledge production practices employed in the field of architecture. After the back-and-forth investigations executed at these two different scales without losing the communication between them, reflections of the conclusions reached from the analysis of the larger scale of the whole field of knowledge are sought at the smaller scale of architecture, and in the same manner, it

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[7] Zeynep. Mennan. "An Interpretive framework for understanding architectural theory's self-representation," Unpublished Phd Dissertation. Ankara: METU, 1997.

is also attempted to discern how the changes observed at the scale of architecture are positioned within the greater scale of the field of knowledge.

Resulting from the analysis of the whole field of knowledge, this study addresses an epistemological crisis regarding three substantial disruptions in the knowledge production practices, framed as the change in the method, change in the medium, and change in the amount of data. The ‘change in the method’ implies the shift from positivism to post-positivism, or the renunciation of the idea that there is only one proper scientific method that guides the scientific knowledge production across different contexts, which is based on observation and ‘objective’ experience. With the rise of interpretation as an equally legitimate ‘method’ to produce knowledge, there emerges an evolutionary theory of knowledge, in which there are various circulating theories that are in competition instead of one possible “explanation” of the ‘truth.’[8]

The ‘change in the medium’ points out to the shift from paper to network as the medium of knowledge production. Rather than the digital reproduction of the previous knowledge, this shift suggests the removal of the physical restrictions imposed by the limitations of paper on knowledge production, which denounces the need to control the amount of knowledge by the established institutions. With the introduction of a scale-independent communication technology for the first time in the history, different fields of knowledge are networked to each other in previously unimaginable ways.

The change in the amount of data refers to the Big Data phenomenon, which is regarded here as the most recent term to denote the ‘information overload’ of the

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[8] Ibid.

In her dissertation, Zeynep Mennan discusses the rise of interpretation as a shift “from a foundationalist, positivist narrative to a post-positivist, textualist narrative, giving an account of the world as a conflict of interpretations.”

current age. To entirely explore the intricacies embedded in the concept is beyond the scope of this study; what is emphasized here is that the exponential increase in the amount of data also transforms the nature of data itself and results first in the dissolution of data, information, and knowledge hierarchy, then the deterritorialization of data.

These three changes destroy the possibility of a 'foundation' for the new knowledge to be built upon.[9] Thus, it is impossible to stabilize epistemologically and produce knowledge anchored to a previous one.[10] This results in an urge for innovation in knowledge production, which is disruptive in nature and therefore cannot be sustained in a disciplinary organization of knowledge. When these changes in the whole field of knowledge are juxtaposed with the analysis of the discipline of architecture, it is comprehended that the tripartite framing of the substantial disruptions in the knowledge production practices overlaps with the underlying reasons behind the proliferation of laboratories as the dominant locus of knowledge production in the field of architecture.

With regard to all these transformations, this study proposes that there is a new mode of knowledge production, which is enabled by the changes in the nature and amount of data and further supported and maintained by the ability of new communication tools to cope with the complexity resulting from these transformations. The whole field of knowledge has been radically altered with the changes in the knowledge infrastructure, such as digitalization, the growing quantity and accessibility of data,

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[9] This tripartite framing of the changes in the field of knowledge should not be understood as successive phases of a linear process. The change in the method or the rise of interpretation as an equally legitimate method to produce "scientific" knowledge is also related to the postpositivist recognition that the data cannot be value-free. This realization results in the urge for innovation, which is further facilitated and catalyzed by the change in the medium and change in the amount of data and establishes a new site of distributed system of knowledge. By virtue of those changes in the whole field of knowledge, innovation now has a site to emerge, and we can recognize it with much more ease.

[10] Ibid.

and the development of automated tools for data mining. These changes in the nature of data as the most fundamental component of knowledge production are also conjured with the developments in information technology that enables a complex network in which different constitutes of knowledge production relate to each other. To respond to these fundamental changes in the nature of knowledge and sustain its relevance, a new kind of institution, the 'research laboratory,' with its renowned outlook, is incorporated into the schools of architecture within the universities.

As an idiosyncratic discipline, architecture already has most of the qualities required for this new type of knowledge production defined by this study, which previously distanced architecture from the definition of a so-called "ideal" discipline. Even though architecture is used metaphorically both to describe the disciplinary knowledge production practices and to conceptualize the modern university as "a space of construction," where theses are established in "structural relationship to certain accepted grounds," the peculiarities of architecture could not emerge in the disciplinary outlook.[11] However, with these changes defined in this study, architecture finds the opportunity to return to its own practices by reorganizing itself through laboratories. Therefore, this new configuration of the knowledge field, which is enabled by the dissolution of the concept of discipline, has particular consequences for architecture.

Although such a connection has not been established in the literature yet, which is in part due to the fact that there is no comprehensive history of the laboratory, particularly with reference to 'creative' practices, the design studio actually shows many similarities to the knowledge production described in this study within the context of the laboratory. It is argued in the study that the experimental knowledge production practices carried out in the laboratory aiming at innovation without

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[11] Mark Wigley. "Prosthetic Theory: The Disciplining of Architecture," Assemblage, No. 15, 1991: 6-29.

strictly distinguishing between conceptual and manual labor have already existed in the field of architecture. Therefore, instead of redefining the discipline of architecture, laboratories allow architecture to organize its already existing idiosyncratic practices in a more coherent way.

The concept of discipline lacks any analytical definition, still it organizes the entire field of knowledge. The disciplinary system is created to regulate the already existing knowledge production practices, which in turn, inevitably transformed them. In this study, it is argued that shifting the focus from 'discipline' to the practices of knowledge production themselves could provide a more accurate understanding of architecture, given the complexities involved when the concept of 'discipline' is juxtaposed with the particularities of the disciplinarity of architecture. Indeed, the notion of the laboratory naturally emerged from probing the current state of these existing knowledge production practices in the field of architecture.

As detailed in the third chapter, architecture has always questioned its own disciplinarity in various ways since its inception, mainly by comparing itself with other fields of knowledge. In the last decades, the primary reference in these accounts is the cross-disciplinary terminology, which seems to govern the whole literature on knowledge production, particularly the concerns around the organization of research in the universities. The most significant contribution of this study, in this sense, is to define a set of actions that are based on knowledge production practices of architecture to develop a completely specific framework for architecture. Obviously, while establishing this framework, this study refers to other fields of knowledge, but it is not an entirely external framework adapted to architecture.

1.3 Structure of the Thesis

The thesis starts with an extended discussion of the tripartite framing of the disruptions in the field of knowledge briefly explained above. The second chapter aims to understand some of the basic concepts that this thesis is founded upon, such as ‘innovation,’ ‘network,’ and ‘data.’ In addition to that, a historical account of the concept of ‘laboratory’ is provided. At the end of this chapter, the laboratory is presented as the locus of innovative knowledge production, and the concept of innovation is explored in the context of the university to demonstrate that the different innovation models define the university’s research practices, and the laboratory has always been an agent in those transformations.

In the third chapter, the discipline of architecture is conceptualized by revisiting the concept of ‘discipline’ as a unit of knowledge production and the most essential component of the terminology constructed to organize and categorize the formations and transformations in the whole field of knowledge. Diverse forms of knowledge production practices that are considered as different from the disciplinary way of knowledge production are still identified with reference to the term ‘discipline.’ By the addition of multiple prefixes before the term ‘discipline,’ a cross-disciplinary terminology is produced to maintain the primacy of the ‘discipline’ while at the same time contradictorily signaling the dissolution of it. A brief account of the cross-disciplinary terminology, particularly the trilogy of multidisciplinarity, interdisciplinarity, and transdisciplinarity, is presented to emphasize their differences, yet they are used interchangeably in the field of architecture.

After reframing the concept of laboratory in architecture, chapter four proposes a framework that aims to situate the knowledge production practices of the laboratories in the schools of architecture. For the purposes of limiting the scope of this research, university rankings are used as a basis for the selection criteria. All of the research units within the selected schools of architecture that define themselves as laboratories are included in this study. Even within such a limited scope, the variety of these laboratories escapes any attempts of producing an overall description. However, three distinct sets of actions emerge from the knowledge production practices in these laboratories, which are later identified as three main types.

Despite the linearity of the text itself, this thesis offers a horizontal reading in its organization across the second, third and fourth chapters, which constitutes the main textual body of the thesis. There is an implicit continuity between the concepts devised throughout the chapters, which must be mentioned here. The changes in the whole field of knowledge framed in a tripartite manner in the first chapter are reappropriated in the analysis of architecture's disciplinarity in the third chapter and the reconceptualization of the laboratory in the fourth chapter.

The urge for innovation framed in the second chapter as 'change in the method' is interpreted as the dissolution of borders between disciplines in the third chapter. Similarly, the fourth chapter formulates the laboratory as a place for the invention that leads to innovation. The change in the medium explained in the second chapter is construed as the dissolution of hierarchies between disciplines in the third chapter. The shift from hierarchical to lateral relationships between different fields of knowledge replaces the pyramidal representation of knowledge into a network-like structure. In this regard, in the fourth chapter, laboratories are regarded as nodes of knowledge exchange comprising an international network where lateral relations are possible. Finally, the recent exponential growth in the amount of data elucidated in the first chapter is discussed as the deterritorialization of data in the subsequent chapter. Laboratory where researchers collect, store, and analyze the data instead of working with the objects themselves is viewed as a place for scalar distortion in the fourth chapter.

CHAPTER 2

DISRUPTIONS IN THE FIELD OF KNOWLEDGE

2.1 Change in the Method: The Epistemological Crisis

The field of knowledge experiences an epistemological crisis due to three substantial disruptions in the knowledge production practices. The first change is in the method, which occurred when the scientific method lost its primary position as the only legitimate way of producing knowledge with the rise of post-positivist philosophy of science in the 1960s which disrupted the natural scientific ideal of a linear progression. The challenge to positivist epistemology was also resulted with the destruction of the possibility of a 'foundation,' in which new knowledge to be grounded or anchored to a previous one. The pyramidal representation of knowledge which is imposed by this foundational outlook constructed a hierarchical and vertical field of knowledge in which disciplines are founded upon each other.[12] This disciplinary configuration of knowledge production has been replaced with a radically new form of knowledge production mainly aimed at innovation. This kind of knowledge production is disruptive in nature that is not cumulative and not based on what comes before. In Kuhnian terms, this urge for innovation is the moment of revolution in which there is no epistemology to measure the produced knowledge. In such an epistemological context, each field is looking for innovation, and the 'research laboratory' is the locus for the production of this kind of innovative

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[12] Zeynep. Mennan. "An Interpretive framework for understanding architectural theory's self-representation," Unpublished Phd Dissertation. Ankara: METU, 1997.

knowledge. The proliferation of research laboratories in the schools of architecture, mainly since 2000, is considered an indication of a disruptive transformation in the processes of knowledge production in the field of architecture.

2.1.1 Innovation in Knowledge Production

Innovation is not a recent phenomenon in the context of the knowledge production. Thomas Kuhn, already in 1959, underlines an essential tension implicit in scientific research between tradition and innovation:

> Contrary to a prevalent impression, most new discoveries and theories in the sciences are not merely additions to the existing stockpile of scientific knowledge. […] Because the old must be revalued and reordered when assimilating the new, discovery and invention in the sciences are usually intrinsically revolutionary. Therefore, they do demand just that flexibility and open-mindedness that characterize, or indeed define, the divergent thinker.[13]

Kuhn's conceptualization of the sciences as successive phases of "normal science" and "paradigm shifts" is also based on this tension between innovation and tradition or, in other words, between convergent and divergent thinking. Similarly, as Peter Weingart argues, the discourse on cross-disciplinarity is a discourse on innovation in knowledge production that reveals itself "in visions of a yet uncharted, unclaimed, pristine territory where one can still roam freely without fear of transgressions."[14] Indeed, any type of knowledge production inevitably aims at novelty to a degree, and therefore innovation to some extent. In this study, not only the production of knowledge that leads to innovation; but also, the innovation in knowledge production

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[13] Thomas Kuhn, "The Essential Tension: Tradition and Innovation in Scientific Research," in The Third University of Utah Research Conference on the Identification of Creative Scientific Talent, ed. Calvin W. Taylor. Salt Lake City, 1959: 162-177.

[14] Peter Weingart. "Interdisciplinarity: The paradoxical discourse," Practising Interdisciplinarity. eds. Weingart P. and Stehr N., Toronto: University of Toronto Press, 2000: 30.

practices is fundamental. Since this study aims to depart from both disciplinary and cross-disciplinary terminology by removing the dichotomy between disciplinarity and cross-disciplinarity and introducing a new "discipline-less" organization for the knowledge, it scrutinizes the term 'innovation' from a broader perspective.

Obviously, a term like 'innovation' cannot be understood fully with its dictionary definition as it becomes an emblematic notion that characterizes our time, and it is the omnipresent buzzword with more than two billion Google results. Innovation is generally regarded as a 'novelty' that arises from 'creativity' and is also seen as a break from the past. The term signifies the implementation of a new idea, approach, practice, object, method, device, service, program, technique, or technology.[15] Innovation is usually coupled with collaboration, as it typically requires people from different places in an organization to work together. Innovation is also future-oriented; most of today's innovative projects aim to find solutions for a "better" future. Another related concept to innovation is disruption. In fact, the concepts of innovation and disruption are not very far from each other since innovation presents a challenge to the established traditions, institutions, organizations; it disrupts or even destructs the existing systems.[16]

There is a conceptual transformation in the way we look at the organization of knowledge, and this study aims to decipher how much these research laboratories illustrate this new field of knowledge. The 'laboratory' phenomenon is seen as the response of the field of architecture to the urge for innovation. This study identifies

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[15] Jonathan Vehar. "Creativity and Innovation: What Is the Difference," Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship. ed. E.G. Carayannis, Springer: New York, 2013.

[16] Clayton Christensen coined the term "disruptive innovation" in 1995 to define such situations. He describes disruptive innovation as "a process by which a product or service takes root initially in simple applications at the bottom of a market and then relentlessly moves up market, eventually displacing established competitors." <https://claytonchristensen.com/key-concepts/> (last accessed on 21.01.2021)

several reasons behind this for the urge for innovation, the first and foremost being the epistemological shortcoming that the field of knowledge experiences as a whole due to the dissolution of the positivist forms of knowledge production. It is impossible to stabilize epistemologically and produce knowledge in a cumulative fashion in this constantly disruptive epistemological context.

2.2 Change in the Medium: A Lateral Field of Knowledge

The second change is in the medium from paper to internet. This is not to be understood as the sole digitalization of knowledge that was already produced in paper. Paper, as the dominant medium of knowledge production was a fixed one. The invention of Gutenberg enlarged the intellectual space; however, the tools designed to manage information, such as the encyclopedias, were "only capable of coping with the extension of knowledge only vertically, by producing more and more specialized guides and then further guides of guides, in an endless hierarchy."[17] Since it was a physically limiting medium, it also had its own restriction on the amount of produced knowledge. On the contrary, "there's no practical limit to how much content the Net can hold" since "it doesn't have edges within which knowledge has to squeeze."[18]

Besides its ability to connect people, objects, and institutions in unparalleled ways with an unprecedented speed, the primary communication system of this age, the Internet, has "a crucial feature: It works at every scale."[19] The difference of this

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[17] Luciano Floridi "Internet: Which Future for Organized Knowledge, Frankenstein or Pygmalion?" The Information Society. vol.12, iss. 1, 1996: 9.

[18] David Weinberger. "The New Institution of Knowledge", Too Big to Know. 2011.

[19] "It worked back when an online index of the Net fit on a hard drive with half the capacity of a typical laptop today, and it works now that there are a trillion Web pages." See Weinberger. "The New Institution of Knowledge", Too Big to Know. 2011.

current age compared to earlier periods that faced information overload is that now "we have a medium big enough for knowledge."[20] The Internet has no edges and therefore no shape so that the "networked knowledge lacks what we have long taken to be essential to the structure of knowledge: a foundation."[21] Weinberger uses the term 'foundation' to refer to the role that facts have played in the production of knowledge before the advent of the internet. It is also related to the constraints on the processes of the publishing of new knowledge, which requires it to be verified and controlled by different mechanisms such as the peer review.

This global network, which Luciano Floridi defines as the most recent form of the organization of the system of knowledge, is "weakening the concept of specialization."[22] While the book era invited vertical specialization by providing a rigidly structured context, these new digital information technologies promote lateral interaction between different domains of knowledge since it is possible for one to "navigate so easily across the disciplinary boundaries."[23]

2.2.1 From Paper to Internet

David Weinberger argues that the previous medium, paper, in which knowledge was produced and disseminated, required elaborate filtering systems since the

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[20] Ibid.

[21] "The Internet's abundant capacity has removed the old artificial constraints on publishing—including getting our content checked and verified. The new strategy of publishing everything we find out thus results in an immense cloud of data, free of theory, published before verified, and available to anyone with an Internet connection. And this is changing the role that facts have played as the foundation of knowledge." See Weinberger. "The New Institution of Knowledge", Too Big to Know. 2011.

[22] Floridi "Internet: Which Future for Organized Knowledge, Frankenstein or Pygmalion?" The Information Society, 1996: 11.

[23] Weinberger. "The New Institution of Knowledge," Too Big to Know. 2011.

environment is too big to be known by anyone.[24] The paper-based system of knowledge cleverly adapted itself according to this fact; in order to pursue new inquiries, it was necessary to know when and where to stop the previous inquiry. The fundamental limitation is imposed by the media rather than our cognitive capacity. Books, for instance, "are designed to contain all the information required to stop inquiries within the book's topic."[25] The central claim in Weinberger's account is that the shift from paper to the internet is "changing the very shape of knowledge" since this new medium "can handle far more ideas and information."[26] Moreover, it is "a connective medium that connects ideas to ideas, people to ideas, people to people," that demands a change our strategy."[27]

This change signals a fundamental transformation in the ways the new institutions of knowledge work instead of the earlier ones like newspapers, encyclopedias, and textbooks, which established their authority by filtering the knowledge for the rest. Instead of "filtering out," Weinberger argues for a system he calls "filtering forward," that works by "bringing their results to the front."[28] The nature of filters has shifted from "reducing information and hiding what does not make it through" to "increase information and reveal the whole deep sea."[29]

Disciplines could also be regarded as one of the filtering mechanisms since they define a particular area of knowledge with predefined edges. Discipline is the sole authority to decide when or where inquiries should stop. However, instead of isolating a body of knowledge from others by defining its borders, this new medium

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[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Ibid.

[28] Weinberger. "Filtering to the Front", Too Big to Know. 2011.

[29] Ibid.

enables connections between them. That is why knowledge cannot be produced in isolation, particularly in this time of the networked world. As the production of new knowledge transforms the relations in the network, changes in the structure of the network alter the ways knowledge is produced.

As Luciano Floridi argues, "the passage from printed paper to digital data made possible a thoroughly new way of managing information, and a much more efficient control over the system of knowledge."[30] The increase in the amount of information demanded new, automatic methods to manipulate, access, and control. That is why Floridi considers the emergence of digital information technology as the long-awaited response to the invention of printing.[31]

> The required process of conversion of the entire domain of organized knowledge into a new, digital macrocosm began in the fifties. And since then, it has followed three fundamental directions: extension, visualization, and integration. The constant growth in the kinds of information that could be digitized has led to the construction of a domain that has come to include not only numbers and text but also sounds, images, and animation. […] Finally, the translation of alphanumeric texts, images, and sounds into the simple language of bytes has made possible an increasing integration of the various domains of knowledge into an ever wider and more complex encyclopedia.[32]

The digitalization process of the existing data or producing new data through the digital medium could be considered as the first step in this transition to networked knowledge infrastructure. Until the 1990s, most data were still shared through in-person exchanges or "by physically mailing hard-copy data, punched cards, or data tapes via the postal service."[33] It was the invention of "various types of software,

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[30] Luciano Floridi "Internet: Which Future for Organized Knowledge, Frankenstein or Pygmalion?" The Information Society. vol.12, iss. 1, 1996: 9.

[31] Ibid.

[32] Ibid., 10.

[33] William K. Michener. "Ecological data sharing," Ecological Informatics. vol.29, 2015: 37.

hardware and networking infrastructure, especially the Internet and World Wide Web, have facilitated data sharing."[34]

The most fundamental change the rise of the information technology bears upon is the 'disruption' of the "direct correspondence between ordering principles that manage the process of data collection and organization and possible questions."[35] While in the book age, "primary data sets were collected and organized in structures that were necessarily rigid and unalterable."[36] The ordering principles not only "create a domain, they also established de facto the limited range of primary questions that would be meaningful to ask."[37] As Floridi further emphasizes:

> For it is now possible to query the digital domain and shape it according to principles that are completely different from those whereby the primary data were initially collected and organized. The structure of our particular set of digital data can be modified to fit an infinite number of requirements, and hence provide answers to secondary questions that were not meant to be answered by the original structure.[38]

2.2.2 From Trees to Networks

The transition from paper to Web could also be considered in relation to the shift from tree to network diagrams. In the book "Visual Complexity: Mapping Patterns of Information," Manuel Lima considers tree model as "an important instrument in interpreting the evolving complexities of human understanding" and an early

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[34] Ibid.

[35] Floridi "Internet: Which Future for Organized Knowledge, Frankenstein or Pygmalion?" The Information Society. 1996: 11.

[36] Ibid.

[37] Ibid.

[38] Ibid.

precursor of modern-day network diagrams."[39] The tree scheme has been potent in illustrating the way knowledge is organized and classified throughout the centuries. The peculiarity of this scheme is its emphasis on a hierarchical order in which all divisions branch out from a central foundational trunk. The ability of this scheme is to "express multiplicity (represented by its boughs, branches, twigs, and leaves) from unity (its central foundational trunk)."[40] Therefore, it is no surprise that "the idea of an arboreal organizational scheme is so ingrained in our minds," which in turn conditions the way we understand things and express them to others, as evident in the expressions such as "the root of scientific research," or "the branches of science."[41]

Tree metaphor represented the connectedness of different fields as well as a foundational order. As Gila Sher contends, the tree model, together with the pyramid metaphor, set "formal conditions on the grounding relation,"[42] since the fundamental principles of foundationalism impose a "strict ordering requirement" on "the grounding relation and, consequently, on the system of knowledge as a whole."[43]

Lima gives an overall account of the historical development of the tree metaphor as the model for organizing the system of knowledge. The first known concept for the hierarchical organization of knowledge comes from Aristotle, which philosophically "laid the foundation for all subsequent classification efforts."[44] Ramon Llull's *Arbor*

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[39] Manuel Lima. Visual Complexity: Mapping Patterns of Information. New York: Princeton Architectural Press, 2011: 21.

[40] Ibid.

[41] Ibid., 25.

[42] Gila Sher. "Epistemic Friction" Epistemic Friction: An Essay on Knowledge, Truth, and Logic. Oxford: Oxford University Press, 2016: 21.

[43] Ibid.

[44] Lima. Visual Complexity. 2011: 27.

scientiae from the year 1296 influenced the classification efforts of Francis Bacon and René Descartes centuries later. Even though "neither Bacon nor Descartes developed a visual representation of the tree of knowledge," it is possible to "ascertain the construction of such a hierarchical classification scheme" through their words, "which contributed decisively to the establishment of the general metaphor of the tree as the underlying epistemological model of all sciences."[45]

The tree metaphor was further extended into encyclopedias in the eighteenth century. The encyclopedic project put together by the efforts of Denis Diderot and Jean le Rond d'Alembert aimed to provide a systematic dictionary of the sciences, arts, and crafts. The encyclopedia, for Diderot, was "a directory of associations, where the connections between the different areas of science could be exposed and further pursued by each reader."[46] Diderot expresses a fascinating vision of the future,[47] which, according to Lima, is reminiscent of the "hypertext" of today:

> Thanks to encyclopedic ordering, the universality of knowledge, and the frequency of references, the connections grow, the links go out in all directions, the demonstrative power is increased, the word list is complemented, fields of knowledge are drawn closer together and strengthened; we perceive either the continuity or the gaps in our system, its weak sides, its strong points, and at a glance on which objects it is important to work for one's own glory, or for the greater utility to humankind. If our dictionary is good, how many still better works it will produce![48]

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[45] Ibid., 34-36.

[46] Ibid., 39.

[47] Even though the authors configured the encyclopedia as "a growing organism with many possible directions," the medium is still paper which is rather limited and static. See Lima. Visual Complexity. 2011: 39.

[48] Diderot, as cited in Lima. Visual Complexity. 2011: 39.

The logic of tree diagrams continues to exist in the structure and navigation of most modern computer systems, enabling "one to browse, filter, and organize files in a nested hierarchy."[49] The founder of the World Wide Web, Tim Berners-Lee's vision, was to link all the information stored on computers everywhere to make it closer to the working mechanism of the human brain. In contrast to a computer which typically keeps information in rigid hierarchies and matrices, the human brain has the special ability to link random bits of data.[50] While the systems organized hierarchically as a tree have the practical advantage of giving every node a unique name, it is an inflexible system in generating and managing links between the nodes. Therefore, as Berners-Lee contends, such systems fail to model the real world because the information is not naturally organized into a tree.[51]

The concept of "rhizome," proposed by Deleuze and Guattari, as a decentralized, nonhierarchical system is one of the most significant models challenging the authoritarian model of trees and their hierarchical modes of communication and pre-established paths. Different than a tree diagram, the rhizome has the potential to connect "any point to any other point, in a transverse and autonomous way, allowing for a flexible network of intercommunicability to emerge."[52] Lima claims that "one of the most famous demonstrations of the principle's applicability is hypertext," which is the fundamental building block of the World Wide Web– arguably the largest rhizomatic system ever created by man.[53]

The rhizomatic model replaces the traditional knowledge hierarchies of the paper world that are "unnecessarily restricted when it comes to organizing information in

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[49] Ibid., 41.

[50] Berners-Lee, and Fischetti. Weaving The Web. 2011: 3.

[51] Ibid.

[52] Lima. Visual Complexity. 2011: 44.

[53] Ibid.

the digital world."[54] The complexity of relationships in the digital world and the rising interconnectedness in the current age not only requires "new tools of analysis and exploration, but above all, it demands a new way of thinking." As Lima states:

> It demands a pluralistic understanding of the world that is able to envision the wider structural plan and at the same time examine the intricate mesh of connections among its smallest elements. It ultimately calls for a holistic systems approach; it calls for network thinking.[55]

As Lima underlines, the internet's same underlying principle of complexity and interconnectedness is applied to ever more tiny parts of its structure, from routers to servers, web pages, and now data.[56] In this context, "data becomes widely interrelated with and detached from constraining documents."[57]

2.2.3 The Network Age: Internet as a Scale-Independent Tool

The current age has been defined as the age of "information," "big data," "internet"; due to the increase in the amount of data we have compared to earlier periods and the advancement in the technologies for collecting and transmitting data and information. However, as the historian Robert Darnton notes, "every age was an age of information,"[58] and this expression has a twofold meaning; first, people have been concerned with the abundance of information during many periods of history, and

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[54] Ibid., 62.

[55] Ibid., 45-46.

[56] Ibid., 57.

[57] Ibid.

[58] Robert Darnton. "An Early Information Society: News and the Media in Eighteenth-Century Paris," The American Historical Review, Volume 105, Issue 1, 2000: 1.

second, "communication systems have always shaped events."[59] When considered together with previous periods of 'information overload' in history,[60] "Big Data can be seen as a chapter in a longer history (or, rather, histories) of observation, quantification, statistical methods, models, and computing technologies."[61] In each of these historical periods of 'information overload,' "the strategies and technologies developed to deal with it played a vital role in making knowledge itself."[62] The communication systems that were developed to manage the problems of 'information overload' include rings, hubs-and-spokes (stars), lines, trees, and meshes, and as Weinberger argues, "the Net, that is, the Internet is the messiest."[63] (Figure 1)

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[59] Ibid.

[60] "Over the past decades, historians of science have explored how previous societies coped with their own problems of "information overload," whether that meant a superabundance of manuscripts and printed works in the medieval and early modern periods, the inexhaustible supply of observations of natural history during the age of European expansion, or the bureaucratic accumulation of an "avalanche of numbers" in the nineteenth century." See Elena Aronova, Christine von Oertzen, and David Sepkoski. "Introduction: Historicizing Big Data," Osiris vol.32, no.1, 2017: 1-17.

[61] Aronova, von Oertzen, and Sepkoski. "Introduction: Historicizing Big Data," Osiris, 2017: 6.

[62] Ibid., 5.

[63] Weinberger. "The New Institution of Knowledge", Too Big to Know. 2011.

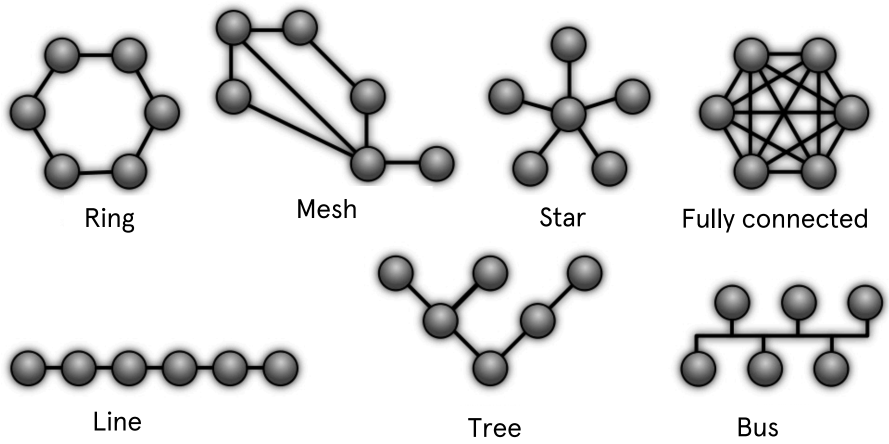

Figure 1. Diagram of different network topologies[64]

The Internet is the global system of interconnected computer networks, and the invention that transformed it into 'an information space' is the World Wide Web, or simply Web.[65] Tim Berners-Lee introduced the "World Wide Web"[66] as a tool for "the management of general information about accelerators and experiments at CERN."[67] It was particularly concerned with the problems of loss of information about complex evolving systems, which are constantly changing as new ideas are produced, and as new technology becomes available.[68] Berners-Lee was working with the 'data acquisition and control' group at CERN, which was responsible for capturing and processing the results of experiments. The complexity involving the

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[64] "Network topology," Wikipedia. <https://en.wikipedia.org/wiki/Network_topology> (last accessed on 23.11.2021)

[65] The World Wide Web Consortium Website. <https://www.w3.org/Help/#webinternet>

[66] The World Wide Web is not synonymous with the Internet, which pre-dated the Web in some form by over two decades and upon the technologies of which the Web is built.

[67] The World Wide Web Consortium Website. <https://www.w3.org/History/1989/proposal.html>

[68] Ibid.

experiments at CERN required a new information management system that is logically very distinct from the previous paper-based systems. What is needed within that group was to keep track of relationships between all the people, experiments, and machines, and a documentation system which allows for different kinds of information accessible to everyone.[69] As Berners-Lee states, "If a CERN experiment were a static once-only development, all the information could be written in a big book," however, "keeping a book up to date becomes impractical, and the structure of the book needs to be constantly revised."[70] As he further states:

> In providing a system for manipulating this sort of information, the hope would be to allow a pool of information to develop which could grow and evolve with the organisation and the projects it describes. For this to be possible, *the method of storage must not place its own restraints on the information*. This is why a "web" of notes with links (like references) between them is far *more useful than a fixed hierarchical system*.[71] (italics mine)

Tim Berners Lee's vision for the World Wide Web is to enable the "decentralized, organic growth of ideas, technology, and society" by proving the possibility in which "anything being potentially connected with anything."[72] Berners-Lee aimed at providing new freedom which "allows us to grow faster than we ever could when we were fettered by the hierarchical classification systems into which we bound ourselves."[73] The model Berners-Lee chose for this system was hypertext. He refers to Ted Nelson, who as early as 1965 envisioned that the computers would "enable

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[69] Tim Berners-Lee, and Mark Fischetti. Weaving The Web: The Original Design and Ultimative Destiny of The World Wide Web by Its Inventor. New York, NY: Harper Business., 2011: 15.

[70] The World Wide Web Consortium Website. <https://www.w3.org/History/1989/proposal.html>

[71] Ibid.

[72] Berners-Lee, and Fischetti. Weaving The Web. 2011: 1.

[73] Ibid., 1-2.

people to write and publish in a new, nonlinear format,"[74] called 'hypertext.' It is a "'nonsequential' text, in which a reader was not constrained to read in any particular order, but could follow links and delve into the original document from a short quotation."[75] Finally, in 1989, Tim Berners-Lee developed "Hypertext Markup Language" (HTML), which remains the basis for the public use of the Internet.

Berners-Lee describes two fundamental properties for the system he developed. The first one is 'accessibility': when a document, database, graphic, sound, or video, is made available by someone in somewhere, "it should be accessible by anyone, with any type of computer, in any country."[76] To accomplish that, the system had to have one other fundamental property: it had to be "completely decentralized"[77] so that it could be scaled nicely without failing, contrary to a hierarchical system with a central node to which everything had to be connected and whose capacity is eventually limited.

The Web has altered knowledge production practices in three main ways. First, it facilitated connections among people, documents, institutions because it is accessible to anyone with an internet connection. Second, since it has no scale, there are no limits to the amount of knowledge production. Third, it offers a flexible medium; it is possible to make alterations to the original document, so that knowledge does not only grow but also evolves.

The old medium of knowledge, paper, placed its own restraints on the production of knowledge that imposed a 'physical' limitation on the amount of knowledge produced. Following this, the old institutions of knowledge had to act as a 'filter,'

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[74] Ibid., 5.

[75] Ibid.

[76] Ibid., 37.

[77] Ibid., 16.

that decides what is pertinent for those institutions or when to stop the inquiries and to start the new ones. As Weinberger argues, the traditional “institutions are simply not big enough to contain knowledge.”[78] Knowledge is now a property of the network: “knowledge is becoming inextricable from –literally unthinkable without– the network that enables it.”[79]

2.2.4 Internet as the Extension of the Laboratory

The discovery of the internet is particularly compelling for this study since the main subject of this research is the ‘laboratory’ itself and “the dominant information and communication technology of today, the World Wide Web, emerged from the work conducted in the rather vast laboratory of CERN.”[80] The research project which eventually led to the invention of the WWW was aimed to “facilitate the international exchange between laboratory scientists and give them better access to the existing knowledge of their respective fields.”[81] There are intricate relationships between the working mechanisms of laboratory, and the World Wide Web. As Henning Schmidgen contends, “it is the extension of laboratory architectures into the virtual space of databases, models, and simulations that confirms the dominant model of the laboratory while also contributing to its dispersion into new forms.”[82] The similarities between the working mechanisms of the web and the research community is not limited to that. As Berners-Lee signifies, the “hypertext, as the basis of the WWW, is a concept already embedded in the practice of research. For

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[78] Weinberger. “The New Institution of Knowledge”, Too Big to Know. 2011.

[79] Ibid.

[80] Henning Schmidgen, "Laboratory," Encyclopedia of the History of Science, 2021. <https://doi.org/10.34758/sz06-t975> (last accessed 05.12.2021).

[81] Ibid.

[82] Ibid.

ages, the research community had used links between paper documents: tables of contents, indexes, bibliographies, and reference sections are hypertext links."[83]

Here, the laboratory is not regarded as an architectural archetype, and the spatial qualities of laboratory spaces are not taken into account. The laboratory space is considered as "a product of relations between the people, objects, practices, institutions, and discourses that it brings together."[84] As Marc Thompson and Mathis Schulte state:

> While the traditional view of labs may suggest that one knowledge domain is engaged in the lab activities (physicists, biologists, chemists, etc.), the focus on idea generation and creative solutions requires a diversity of knowledge domains, experiences, and perspectives in the lab as it sparks divergent thought processes and the connection of otherwise unrelated elements.[85]

In this regard, the laboratory has been seen as a nexus as it provides a platform for different entities of knowledge infrastructure to cooperate, such as industry and university. While facilitating the coexistence of teaching and research, the laboratory also enables the combination of different types of labor and knowledge, some of which are presented in a dichotomous way, such as conceptual and useful knowledge and manual and intellectual labor. The laboratory is the institution that does not impose pre-defined boundaries; on the contrary, it is the place to merge all boundaries and divisions of labor.

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[83] Berners-Lee, and Fischetti. Weaving The Web. 2011: 38.

[84] Darren Wershler, Lori Emerson, Jussi Parikka. The Lab Book: Situated Practices in Media Studies. Minneapolis: University of Minnesota Press, 2022. <https://manifold.umn.edu/projects/the-lab-book> (last accessed on 05.10.2021)

[85] Marc Thompson, and Mathis Schulte. "The Laboratization of Change: What Is It with Labs and Change These Days?," Research in Organizational Change and Development Vol. 29, 2021: 33.

2.3 Change in the Amount of Data: Data as the Unit of Exchange

The last change identified by this study is the increase in the amount of data which transformed the nature of data itself. Big Data is generally understood as the current term used for information overload, a concept that dates back to the invention of Gutenberg. A complete understanding of the notion of Big Data exceeds the scope of this study. What is important here is the potential of "data" to define knowledge production practices in the laboratory, where researchers "work with object images or with their visual, auditory, electrical traces, with their components, their extractions, their simulations," rather than the objects as they occur in nature.[86] What makes laboratory such a dispersed phenomenon among different bodies of knowledge is the fact that laboratory could be "a scalar displacement of a lot of issues debated on other levels"[87] since it works with data instead of the objects themselves.

Concurrent with the dissolution of hierarchy between disciplines, this study asserts that the hierarchy between data, information, and knowledge is also broken down. The purity that characterizes the relationship between the data-information-knowledge trilogy as separate entities has shifted as they become entangled, resulting in crossdisciplinarity. The difference of the current knowledge formation is the exponential growth in the volume of data, and the increased capabilities of information and communication technologies to collect, store and share this vast amount of data. Previously, data and information of various disciplines were confined to their borders for their use and shared only after they were turned into knowledge. Now, there is an abundance of data and information that are open to the whole field of knowledge. Disciplines work together to produce knowledge out of

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[86] Karin Knorr Cetina "Metaphors in the Scientific Laboratory: Why are they there and what do they do?", 2015: 334.

[87] Jussi Parikka. "The Lab Imaginary: Speculative Practices in Situ," Across and Beyond: Post-Digital Practices, Concepts, and Institutions. eds. Ryan Bishop, Kristoffer Gansing, Jussi Parikka and Elvia Wilk. Berlin: Sternberg, 2016: 82.

the data and information at hand. The production of knowledge from data and information is freed from disciplinary borders and constraints.

2.3.1 The Advent of Big Data

The advent of big data revolutionized the conduct of science. The arguments for the extent of this revolution have followed two different lines of thought. The first view argues for a 'data-intensive' research paradigm, historically differentiated from other scientific paradigms. As Jim Gray argues, science has evolved through four historically consecutive paradigms: empirical, theoretical, computational, and data exploration. While 'empirical' science focused on describing natural phenomena through experimentation, the theoretical paradigm used models and generalizations to do so. When "the theoretical models grew too complicated to solve analytically," the computational paradigm simulating complex phenomena emerged.[88] The fourth and last paradigm is data exploration that "unifies theory, experiment, and simulation." [89] The second line of thought considers that Big Data initiated "a new era of empiricism, wherein the volume of data, accompanied by techniques that can reveal their inherent truth, enables data to speak for themselves free of theory."[90]

The first 'paradigmatic' perspective contends that the advent of Big Data revolutionized not only the methods by which we conduct science but also the goals of scientific inquiry per se. They argue for a data-driven science which "seeks to hold to the tenets of the scientific method, but is more open to using a hybrid combination

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[88] Tony Hey, Stewart Tansley, and Kristin Tolle. "Jim Gray on eScience: A Transformed Scientific Method." The Fourth Paradigm. Data-Intensive Scientific Discovery. eds. Hey,T., Tansley, S., Tolle, K. Microsoft Research, 2009: xviii.

[89] Ibid.

[90] Rob Kitchin. "Big Data, New Epistemologies and Paradigm Shifts." Big Data & Society, April 2014: 3.

of abductive, inductive and deductive approaches to advance the understanding of a phenomenon."[91] It is different from previous paradigms in that it "seeks to generate hypotheses and insights 'born from the data' rather than 'born from the theory.'[92] As Sabina Leonelli states,

> Digital access to data and the development of automated tools for data mining are widely seen to have revolutionized research methods and ways of doing research. The idea that knowledge can be produced primarily by sifting through existing data, rather than by formulating and testing hypotheses, is far from novel; and yet, developments in information technology and in the financing, institutionalisation and marketization of data are making "data-intensive" approaches more prominent than ever before in the history of science.[93]

The second 'empiricist' camp advocates 'the death of theory,' based on the conviction that the capacity of Big Data to detect patterns is replacing theoretical analysis.[94] According to this view, raw data and correlation patterns are sufficient for scientific development, and the conventional scientific terminology is elusive. On the contrary, data-driven science "recognizes a role for the conventional scientific terms and methods beyond mere pattern recognition, but its hypotheses are derived from the data itself and not 'just' from guiding theoretical principles."[95]

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[91] Ibid., 5.

[92] Ibid., 6.

[93] Sabina Leonelli. "Data Journeys in the Sciences." Learning from Data Journeys. eds. Leonelli S., Tempini N. Springer, Cham, 2020: 1.

[94] An advocate of this line of thought in the field of architecture is Mario Carpo. See Mario Carpo. The Second Digital Turn: Design Beyond Intelligence, Cambridge, Mass: MIT Press, 2017.

[95] John Symons, Ramon Alvarado. "Can we trust Big Data? Applying philosophy of science to software." Big Data & Society. Vol.3, iss.2, 2016: 4.

Big data is not understood here as simply as "a lot of data."[96] Sabina Leonelli claims that the "epistemic power of big data lies in their capacity to bridge between different research communities, methodological approaches, and theoretical frameworks that are difficult to link."[97] This power has particularly pertained to two of the big and open data properties: mobility and interoperability. The quality of being mobile increases the value of data as prospective evidence as they travel across sites, "since this makes it possible for people with diverse expertise, interests and skills to probe the data."[98] Interoperability, on the other hand, is the extent to which data "can be linked to other types of data coming from a variety of diverse sources."[99] Leonelli further argues that "through linkage techniques and tools […] data become part of big data aggregates, which in turn function as empirical platforms to explore novel correlations, power machine learning algorithms and ask ambitious and innovative questions."[100]

2.3.2 "Data" and Data Infrastructures

Before dwelling on the notion of 'data' itself, understanding the infrastructure of data, which is necessary for collaborations across domains, is quite essential besides the aspects of mobility and interoperability. The data infrastructure in which big data aggregate is "the institutional, physical and digital means for storing, sharing and

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[96] Sabina Leonelli. "Scientific Research and Big Data", The Stanford Encyclopedia of Philosophy (Summer 2020 Edition), ed. Edward N. Zalta, <https://plato.stanford.edu/archives/sum2020/entries/science-big-data/>.

[97] Ibid.

[98] Ibid.

[99] Sabina Leonelli "Learning from Data Journeys," eds. Leonelli S., Tempini N. Data Journeys in the Sciences. Cham.: Springer, 2020: 2.

[100] Ibid.

consuming data across networked technologies."[101] "The ability to release, share, and reuse data depends upon the availability of appropriate knowledge infrastructures to do so."[102] So the data infrastructures play a crucial role in "the combination of datasets and the crowdsourcing of minds," which promises new discoveries and innovations.[103]

The structure and logical construction of these databases determine the future use, mobility, and interoperability of data in different contexts. As Geoffrey Bowker explains, the early databases were hierarchical: one needed to go down a detailed line of authority each time to retrieve a required datum. In these "old hierarchical databases, "relations between classes had to be decided once for all at the time of original creation."[104] From hierarchical databases, we move on to 'relational databases,' in which "there was still central control but much more flexible access the database system."[105] In the 1990s and 2000s; as information systems grow in scale and scope, "many databases incorporate object-oriented views of data whereby different attributes can be selected and combined on the fly for different purposes."[106] For Bowker, this sequence of developments signals the shift from a hierarchical understanding of data into a flat one, as he further states:

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[101] Rob Kitchin. "Small Data, Data Infrastructures and Data Brokers," The Data Revolution: Big Data, Open Data, Data Infrastructures & Their Consequences. London: SAGE Publications, 2014. <https://www.doi.org/10.4135/9781473909472>

[102] Christine L. Borgman. "Sharing, Releasing, and Reusing Data," Big Data, Little Data, No Data: Scholarship in the Networked World. Cambridge, Mass.: MIT Press, 2007: 206.

[103] Kitchin, The Data Revolution: Big Data, Open Data, Data Infrastructures & Their Consequences, 2014.

[104] Geoffrey C. Bowker and Susan Leigh Star. Sorting Things Out: Classification and Its Consequences. Cambridge, Mass: MIT Press, 1999: 292.

[105] Ibid.

[106] Ibid.

> Along the way, we have conceived ourselves and the natural entities in terms of data and information. We have flattened both the social and the natural into a single world so that there are no human actors and natural entities but only agents (speaking computationally) or actants (speaking semiotically) that share precisely the same features. It makes no sense in the dataverse to speak of the raw and the natural or the cooked and the social: to get into it you already need to be defined as a particular kind of monad.[107]

A thorough understanding of 'data' itself is significant for this study independent of the implications of the advent of big data to scientific inquiry, since they are "the primary building block of science."[108] As Sabina Leonelli states:

> Data can be easily construed as a starting point for scientific reasoning about the world, its structure, and functioning. They are the facts from which reasoning proceeds, and the empirical basis for testing and validating any assertion made by scientists about the nature of reality.[109]

In a special issue of the "Osiris" journal entitled "Data Histories," data is defined as a "fundamental epistemological category" in the history and philosophy of science.[110] In the introductory article of the issue, it is acknowledged that data played a prominent role both in the positivist and post-positivist configurations of science. The previous conceptualization of data as 'givens' in the original Latin sense of the word "enforced a particular vision of science as a steady accumulation of gathered empirical data," in which science was "narrated as a story of an upward, linear, and

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107 Geoffrey C. Bowker. "Data Flakes: An Afterword to "Raw Data" Is an Oxymoron," Raw Data Is an Oxymoron. ed. Lisa Gitelman. Cambridge, Mass.: MIT Press, 2013: 169.

108 National Research Council. "Preserving Scientific Data on Our Physical Universe: A New Strategy for Archiving the Nation's Scientific Information Resources." Washington, DC: The National Academies Press, 2005. <https://doi.org/10.17226/4871>

109 Sabina Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. London: Routledge, 2016: 191-192.

110 Elena Aronova, Christine von Oertzen, and David Sepkoski. "Introduction: Historicizing Big Data," Osiris vol.32, no.1, 2017: 1-17.

univocal progress."[111] The authors argue that Thomas Kuhn's book "Structure of Scientific Revolutions"[112] shuttered this "received view" of a cumulative progression of knowledge with the concept of the 'data loss' caused by the change of paradigms. This was also the underlying reason why the philosophers of science turned "their attention away from traditional philosophical appraisals of scientific theories" to "actual scientific processes."[113]

The emphasis on scientific practices rather than scientific ideas in Kuhn's "Structure" proliferated the "discussions of how experience and observations have been shaped and transformed into scientific data."[114] Laboratory studies,[115] in that respect, have demonstrated the importance of "data-mining techniques, quantitative algorithms, and qualitative visual selections" to make data meaningful.[116] Even though "the entire question of the role of technology, as well as techniques of making and moving data"[117] are missing in the "Structure," an understanding of the material culture of data has been a significant theme for the post-Kuhnian historians and philosophers of science, who "have found that strategies and technologies developed to deal with information and data played a vital role in making knowledge itself."[118]

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[111] Ibid., 4.

[112] Thomas Kuhn. The Structure of Scientific Revolutions. Chicago: University of Chicago Press, 1962.

[113] Aronova, von Oertzen, and Sepkoski. "Introduction: Historicizing Big Data," Osiris, 2017: 4-5.

[114] Ibid., 5.

[115] Laboratory studies were pioneered by Bruno Latour, Karin Knorr-Cetina, Michael Lynch, and Sharon Traweek in the 1970s and early 1980s.

[116] Ibid.

[117] Ibid., 6.

[118] Ibid.

2.3.3 "Histories" of Data: Relational versus Representational

There is no static meaning of the term data that is historically continuous and applicable to every context; instead, there are multiple definitions and interpretations. Since data means 'givens' prior to argument, Daniel Rosenborg argues that the meaning of data must always shift with argumentative strategy and context; and this "preexisting semantic structure of the term 'data' made it especially flexible in shifting epistemological contexts."[119] As Rosenborg contends, the main connotations of the term data shifted in the eighteenth century.[120] While at the beginning of the century, data refer to the "principles accepted as a basis of argument," by the end of the same century, they came to refer to the "facts in evidence determined by experiment experience, or collection."[121] "The term 'data' changed connotation without changing its meaning."[122] "It went from being reflexively associated with those things that are outside of any possible process of discovery to being the very paradigm of what one seeks through experiment and observation."[123]

This "semantic inversion," from data as the premise of an argument to result of an investigation, made the twentieth-century meaning of data possible since "our principal notion of data as information in numerical form relies on the late

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As claimed in the article, "the interconnection between data manipulation and ordering knowledge can be seen throughout the history of the natural sciences." For further inquiry see Bruno J. Strasser, "The Experimenter's Museum: GenBank, Natural History, and the Moral Economies of Biomedicine," Isis v.102, 2011: 60–96.

[119] Daniel Rosenberg, "Data before the Fact," "Raw Data" Is an Oxymoron, ed. Lisa Gitelman Cambridge, Mass., 2013: 36.

[120] Ibid., 33.

[121] Ibid.

[122] Ibid., 36.

[123] Ibid.

eighteenth-century development" yet today we still "think of data as a premise for argument."[124] Even though "the concept of data specific to electronic computing is evidently an artifact of the twentieth century," as Rosenberg asserts, "the ideas underlying it and the use of the term are much older."[125] So, "the arrival of computer technology and information theory gave new relevance to the base concept of data as established in the eighteenth century."[126]

One of the main tendencies in describing the term data is to contrast it with another term, 'capta' derived from the Latin *capere*, meaning 'to take' to emphasize that the "data harvested through measurement are always a selection from the total sum of all possible data available."[127] So that "data are inherently partial, selective and representative, and the distinguishing criteria used in their capture has consequence."[128] As Sabina Leonelli argues, the importance of human agency in attributing meaning to scientific data determines the epistemic value of data as 'given' or 'made,' which provides a starting point for philosophical analysis.[129] Leonelli differentiates between the representational and relational accounts of data. While the first one regards "data" as pure instances of the world, the latter emphasizes the related context in which data is 'produced.'

Leonelli's conceptualization of data within what she terms as the representational and the relational accounts could be associated with the two epistemologically

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[124] Ibid., 33.

[125] Ibid., 15.

[126] Ibid., 34.

[127] Rob Kitchin. "Conceptualising Data," The Data Revolution: Big Data, Open Data, Data Infrastructures & Their Consequences. London: SAGE Publications, 2014. <https://www.doi.org/10.4135/9781473909472>

[128] Ibid.

[129] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 192.

distinct approaches to data and knowledge relationship: positivism and post-positivism. "According to the representative approach, data are objects with fixed and unchangeable content, whose meaning, in virtue of being representations of reality, needs to be investigated and revealed step-by-step through adequate inferential methods."[130] Data, as providing a snapshot of the phenomena "also reflects the idea of data as 'raw' products of research, which are as close as it gets to unmediated knowledge of reality."[131] In the representational account, "data can be identified regardless of the ways in which they are used at any point in time, and it is possible to evaluate objectively, without any reference to the relevant research context, what information a given dataset contains, and whether this is being interpreted correctly or incorrectly."[132] This conceptualization aligns with the positivist epistemologies, in which knowledge is produced by observing data without adding any meaning to it. However, as Karl Popper argues, "[c]lassical epistemology which takes our sense perceptions as 'given,' as the 'data' from which our theories have to be constructed by some process of induction, can only be described as pre-Darwinian."[133] Popper argues that "there can be no pure perception, no pure datum; exactly as there can be no pure observational language, since all languages are impregnated with theories and myths."[134]

The relational view, by contrast, "acknowledges that objects regarded as data are often altered in their transit through different production, dissemination and reuse

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[130] Sabina Leonelli. "Scientific Research and Big Data", The Stanford Encyclopedia of Philosophy (Summer 2020 Edition), ed. Edward N. Zalta, <https://plato.stanford.edu/archives/sum2020/entries/science-big-data/>.

[131] Ibid.

[132] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 197.

[133] Karl Popper. "Epistemology Without a Knowing Subject." Objective Knowledge: An Evolutionary Approach. Oxford: Clarendon Press, 1972: 145.

[134] Ibid., 146.

sites."[135] Within this view data are not regarded as the "fixed representations of reality,"[136] rather it is argued that "depending on the research perspective interpreting it, the same dataset may be used to represent different aspects of the world."[137] This view aligns with the post positivist epistemologies, in which knowledge is produced by adding 'meaning' to data.

The conceptualization of data as man-made rather than as 'pure' instances of the world emphasizes their embeddedness in specific histories of inquiry, which in turn jeopardizes "the legitimacy of scientific knowledge as a reliable source of insight about the world."[138] To support the positivistic ideals of "purity" of knowledge production processes, which provides science its authority and legitimacy, Hans Reichenbach characterizes scientific inquiry to take place in two distinguished contexts: 'context of discovery' and 'context of justification.'[139] In this conceptualization, "the messy and sometimes serendipitous processes of data handling"[140] is considered as part of the 'context of discovery.' The 'context of justification', on the other hand, is carefully distinguished from these processes and

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[135] Sabina Leonelli. "Data Governance is Key to Interpretation: Reconceptualizing Data in Data Science," Harvard Data Science Review, vol.1, iss.1, 2019. <https://doi.org/10.1162/99608f92.17405bb6>

[136] Ibid.

[137] Ibid.

[138] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 194.

[139] See Hans Reichenbach. Experience and Prediction. An Analysis of the Foundation and Structure of Knowledge. Chicago, Illinois: University of Chicago Press, 1938.

[140] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 194.

described as “rational marshalling of data into evidence within neat arguments that is involved in the production of scientific claims about the world.”[141]

What is significant for this study is the fact that “only data that support the claims of interest are explicitly reported and discussed” within the context of justification, while “the vast majority of data produced in the course of inquiry– is lost to the chaotic context of discovery.”[142] So that data, which might have the possibility to give rise to the production of knowledge in another context is dismissed. In this conception, data aggregates very slowly since the majority of data that either does not support or contradict the hypothesis is lost.

This view of scientific knowledge has been challenged by the recent ‘practice turn’ within the philosophy of science. Starting from the 1970s, an increasing number of philosophers such as Thomas Kuhn, Karl Popper, Imre Lakatos started to pay more attention to examining the actual features of processes of discovery, rather than their post reconstruction. By specifically referring to Hans Reichenbach’s contexts of discovery and justification, Kuhn states that there were two distinct meanings of the word science. While in the first,” “science is conceived as an activity, as the thing which the scientist does,” in the second meaning “science is knowledge, a body of laws and of techniques assembled in texts and transmitted from one scientific generation to another.”[143]

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[141] Ibid.

[142] Sabina Leonelli. "Scientific Research and Big Data.” The Stanford Encyclopedia of Philosophy, 2020. <https://plato.stanford.edu/archives/sum2020/entries/science-big-data/>.

[143] Thomas Kuhn. “Two reasons to study early science,” lecture 1, (in hand- corrected typescript form): 7-8 as cited in Peter Galison. “Practice All the Way Down,” Kuhn’s ’Structure of Scientific Revolutions’ at Fifty: Reflections on a Science Classic. Chicago and London: University of Chicago Press, 2016: 59.

This study frequently refers to Thomas Kuhn because he "reinvented the history of science as the history of scientific practices rather than scientific ideas."[144] Within this line of the history of science that pays special attention to the practices of knowledge production, laboratory studies, which are mainly ethnographic depictions of the laboratory space and routines, are very significant for this thesis even though methodologically very different from it. These studies were influential in transforming the data and knowledge relationship by showing the complex network of actors and factors at work in the laboratories, which were brought together to make data meaningful. Laboratory studies also contributed to enhancing the understanding of the material culture of data, which is the complete tools and technologies used to collect, store, and analyze them.

Together with the efforts of other postpositivist philosophers of science, these studies overthrow the purity of data and strengthen the idea that the path from data to knowledge is not always straightforward. In Leonelli's words, "[d]ata are not, by themselves, a form of knowledge."[145] It is the claims based on the interpretation of data regardless of "whichever form and through whichever process it is achieved" that yields knowledge. The process of interpretation emphasizes that the same data could be "as evidence for one or more claims about phenomena."[146] This possibility to reappropriate the same data in different contexts leads to the production of new knowledge. The history of science is rich with examples of producing new knowledge by the reuse of past data. This is an important reason to protect data and increase its availability in different contexts. Exponential growth in volume also increases the likelihood of reinterpreting the data in different contexts.

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[144] Introduction: Historicizing Big Data Elena Aronova, Christine von Oertzen, and David Sepkoski Osiris 2017 vol.32, iss.1: 5.

[145] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 199.

[146] Ibid.

2.3.4 The Data-Information-Knowledge Trilogy: From Purity to Entanglement

Data, information, and knowledge inescapably compose a trilogy since they are all defined with reference to each other.[147] This interdependency is related with the sequential order, in which data are the raw material for information, and information is the raw material for knowledge. This sequential order also imposes a hierarchical ordering from knowledge to data. The interrelations between these terms will be interpreted here according to their level of mobility and interoperability. Here, the discussion will mainly be centered upon the question of how open they are to interpretation or to what extent they could be re-appropriated in different domains in comparison with each other.

Before the advent of big data and the open data movement, generally, the output of scientific research was in the form of a written text; and it was regarded as a product of a single discipline. The relevant data that has been put together to produce that 'text' was not stored, shared, or made accessible to anyone other than the author. Today, most of the knowledge production is still presented in articles and books in a written format. However, it is now possible to access the data, which generated the knowledge claims, before or after the end product. The conditions under which data had been collected or gathered together could be subjected to other processes of interpretation since they do not belong to the domain of a single discipline. Data become accessible to the field of knowledge before being assigned to or categorized into a single discipline. The whole field of knowledge is now dissected into its tiniest component: data, which could be easily allocated and re-allocated between different

[147] For a detailed account on the relationship between these concepts, see Chaim Zins "Conceptual approaches for defining data, information, and knowledge," The Journal of the Association for Information Science and Technology, vol. 58: 479-493. This article documents 130 definitions of data, information, and knowledge formulated by 45 scholars, and maps the major conceptual approaches for defining these three key concepts.

domains. What is argued here is that the level at which different domains collaborate has shifted from the level of knowledge to the level of data and information.

This study acknowledges the differences between data, information, and knowledge. While data does not need to refer to a physical entity, information should be physically embodied. The verb 'inform' comes from the Latin verb *informare*, which means "to shape or form an idea."[148] Knowledge, on the other hand, is embodied in human agents. Therefore, knowledge spatially accumulates; it cannot move freely as data and information. When this trilogy is considered in terms of complexity and generality, from data to knowledge, complexity increases but generality decreases.

Information, by virtue of being in the middle of this trilogy, is used interchangeably with other two terms. However, the concept of information mainly since the 1950s has been developed conceptually to form a new area of philosophical research.[149] In his book "Origins of Analytical Philosophy," Michael Dummett contrasts and compares the concepts of knowledge and information with respect to how they are acquired and transmitted.[150] Dummett claims that the concept of information needed to be concentrated on before approaching the concept of knowledge "in the proper sense."[151] He discusses that the concept of information is "a much cruder and more fundamental concept than that of knowledge," and to acquire information; one does not necessarily have to have "a grasp of the proposition which embodies it."[152] Based

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[148] Chaim Zins "Conceptual approaches for defining data, information, and knowledge," The Journal of the Association for Information Science and Technology, vol. 58: 481.

[149] Luciano Floridi. (ed.) The Routledge Handbook of Philosophy of Information. London: Routledge, 2016.

[150] Michael Dummet. Origins of Analytical Philosophy. Cambridge: Harvard University Press, 1994.

[151] Ibid., 186.

[152] Ibid.

on this claim, he argues that "the flow of information operates at a much more basic level than the acquisition and transmission of knowledge."[153]

Compared to the notion of knowledge, information is also perceived as more transportable, that it travels more freely in "channels of information" and is more easily storable in "data banks."[154] Yaron Ezrahi argues that, in comparison to knowledge, information seems more mechanical, and more accessible, since it is less dependent upon the mediation of "men of knowledge."[155] Therefore, as Ezrahi asserts, "information tends to conceal the interpretive layers and normative commitments underlying its structures and uses."[156] However, Cesar Hidalgo considers that the separation of information from meaning is still a complicated process for humans since they tend to "infuse messages with meaning automatically" and wrongfully assume that the meaning of a message is carried in the message."[157] The meaning associated with the information is "derived from context and prior knowledge" and "different from the physical order that carries the message, and different from the message itself." Hidalgo contends that the meaning "is not carried in the blots of ink, sound waves, beams of light, or electric pulses that transmit information."[158] In his book "Why Information Grows," Hidalgo claims that the concept of information "took science by storm" in the 1950s and the 1960s, as it was

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[153] Ibid.

[154] Yaron Ezrahi. "Science and the Political Imagination in Contemporary Democracies," States of Knowledge: The Co-production of Science and the Social Order. ed. Sheila Jasanoff, London: Routledge, 2004: 257.

[155] Ibid.

[156] Ibid.

[157] Cesar Hidalgo. Why Information Grows: The Evolution of Order, from Atoms to Economies Basic Books, 2015.

[158] Ibid.

welcomed in all academic fields as a concept that cut across scientific boundaries since it was not scale-dependent. As Hidalgo further states:

> Information was neither microscopic nor macroscopic. It could be inscribed sparsely on clay tablets or packed densely in a strand of DNA. For many practical purposes, the scale at which information was embodied was not crucial. This scale independence made the idea of information attractive to academics from all fields, who adopted the concept and endowed it with their own disciplinary flavor.[159]

The fact that the concept of information is so appealing for all disciplines can also be associated with the cross-disciplinary knowledge production. As Marilyn Strathern argues, if communication is the aim in the cross-disciplinary context, then "knowledge is transformed into information that can be passed on."[160] By comparison with knowledge, information is considered "more detached from the theoretical context in which it was produced, systematically conceptualized, and justified."[161] Information is "knowledge stripped of its theoretical, formal, logical and mathematical layers."[162] Ezrahi regards it as 'thin knowledge,' "a shortcut [] for decisions and actions without getting into the scientific accounts, the knowledge base or the metaphysical foundations that ground these guidelines."[163]

While information is "characteristically more restricted to the technical practical surface of knowledge,"[164] compared to knowledge, the relationship between data and

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[159] Ibid.

[160] Marilyn Strathern. "Useful Knowledge," Proceedings of the British Academy Volume 139, 2005 Lectures. Oxford: Oxford University Press, 2006: 78.

[161] Ezrahi. "Science and the Political Imagination in Contemporary Democracies," London: Routledge, 2004: 257.

[162] Ibid.

[163] Ibid.

[164] Ibid.

information is more intricate and reciprocal though underexplored. As Sabina Leonelli states, a "few philosophers, have ventured to examine how data and information are treated within scientific practices, and with which implications."[165] Luciano Floridi aimed at "providing a framework that places the study of data at the heart of the philosophy of information" and claims that "there can be no information without 'data representation' or 'physical implementation.'"[166] "Data thus function both as sources from which information can be obtained and as media in which information can be inscripted."[167]

David Weinberger relates this interdependency between data, information and knowledge to the concept of 'information overload'. Due to the increase in the amount of information, there emerges a need to characterize "the value extracted from information," and knowledge was formulated as such.[168] Weinberger refers to Russell Ackoff's pyramidal diagram in which the largest layer at the bottom of the triangle represents data, followed by successively narrower layers of information, knowledge, understanding, and wisdom. For Weinberger, the motivation behind this diagram, which was introduced in 1988, was to replicate the characterization of relationship between information and data, to the relationship between knowledge and information. Since information is characterized as "the refinement of mere data",

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[165] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 198.

[166] Luciano Floridi. "Is Information Meaningful Data?" Philosophy and Phenomenological Research, vol. 70, iss. 2: 351–370, as cited in Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 198.

[167] Leonelli. "The Philosophy of Data," The Routledge Handbook of Philosophy of Information.ed. Luciano Floridi. 2016: 198.

[168] David Weinberger. "The Problem with the Data-Information-Knowledge-Wisdom Hierarchy," Harvard Business Review. February 02, 2010. < https://hbr.org/2010/02/data-is-to-info-as-info-is-not> (last accessed on 04.12.2021)

knowledge was needed to be “formulated as the value we extract from information.”[169]

Extracting knowledge from information is far more problematic than extracting information from data since it presupposes that knowledge derives from filtering information.[170] However, this is a reductive approach to knowledge, which includes many different types in it and could be produced through many different mechanisms and processes. With the advent of big data, the purity which define the interrelations between these terms is replaced by the notion of ‘entanglement.’ As David Weinberger argues the idea that data and information are first gathered and then value is extracted from them “by reducing them with every step upward now seems overly controlled and wasteful.”[171] As Weinberger argues, the real problem with this pyramidal representation is

> its implication that knowledge derives from filtering information. It doesn’t. We can learn some facts by combing through databases. We can see some true correlations by running sophisticated algorithms over massive amounts of information.[172]

In this study, while acknowledging their differences, the hierarchy between data, information, and knowledge is dissolved in the sense that none of them has more “value” than the others. What is significant for this study is the fact that data could be used without the production of disciplinary or domain-specific knowledge. Not only it is grown in quantity, but the nature of data is transformed. In the context of this study, data and information are considered as “free” entities that are not yet utilized in a disciplinary setting. What adds meaning to data or information is derived

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169 Ibid.

170 Ibid.

171 Weinberger. “The New Institution of Knowledge”, Too Big to Know. 2011.

172 Ibid.

from the disciplinary context and prior knowledge. Since the notion of discipline dissolves, the concepts of data and information acquire roles as the enablers of exchange between various fields as it is operated in today's research laboratories.

The shift from positivism to post-positivism also gave rise to "interpretation," which poses a threat to the prominence of the "objective" observation as the only method to produce knowledge. This shift ultimately transformed the perception of data fundamentally. While in positivist understanding, data is considered pure and independent of knowledge, which is not contaminated with an added "meaning" or any type of "interpretation," with the post-positivism, data become something to be interpreted on makes it possible for competing stances to coexist. This change in the perception of data is quite essential for the field of knowledge since data is the most fundamental component of knowledge production.

This study claims that the changes first in the perception and then in the amount of data have redefined knowledge production practices. While the changes in perception of data from 'pure' to 'entangled' paved the way for the notion of cross-disciplinarity, the recent explosion in the amount of data ignited the research laboratory phenomenon.

2.4 Laboratory as the New Locus of Knowledge Production

This study does not question the existence of disciplines; instead, it claims that the concept of discipline is insufficient to describe the current processes of knowledge production. Discipline is only one of the classification systems that has been used to organize and control the growth of knowledge. Even though most of the previous classification systems are viewed as 'absurd' in the minds of the twenty-first century readers, these "older classifications of knowledge and divisions of labor appeared []

coherent to those who lived them."[173] It is no surprise that the constellation of sciences seems very natural to the people who are encapsulated by it, even though these divisions follow very distinct logics in their organizing principles. The criteria for the differentiation of fields of knowledge could be the subject matters or methods or the purpose of the produced knowledge.[174] The disciplinary division of the knowledge field served its purpose as with the other older classifications of knowledge, however, the depiction of the whole field of knowledge as rising vertically from the branches of a tree or by anchoring themselves to a "foundation" is outdated. There is now a network-like structure where the laboratory is both the site of knowledge production and exchange.

Laboratories play a pivotal role in the transformation of the knowledge infrastructure in which older knowledge institutions adapt to emergent ones and vice versa. As one of the oldest institutions of knowledge (older than disciplines), laboratories always redesign themselves for the needs and circumstances of that period. They are more flexible. They could be regarded as the common denominator of most of the disciplines. More than its flexibility, the laboratory is a multiform concept, which is inclusive rather than limiting, that has been evolving in the last four centuries. Laboratories also could be organized temporally, flexibly, and could easily be distributed. Since laboratories are usually associated with a set of practices, it is easier to identify the transformations in their structures compared to analysis based on an abstract concept such as "discipline."

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[173] Katharine Park and Lorraine Daston. "Introduction: The Age of the New," The Cambridge History of Science: Volume 3 Early Modern Science. eds. Park, K., and Daston, L. Cambridge: Cambridge University Press, 2006: 6.

[174] Ibid.

2.4.1 The Laboratory Phenomenon: A Historical Account

In an article in the "Science" journal dates back to 1888, the modern laboratory was regarded as "the most remarkable and influential creation of science" of that time.[175] The laboratory was defined as "a place well supplied with the necessary conveniences for watching and recording the special class of natural phenomena belonging to the science to which the particular laboratory is dedicated."[176] When the laboratory was originated in the sixteenth century, it was only considered as a "chemical workplace" instead of a distributed phenomenon among the sciences, however, the modern laboratory, which the article refers to, is "a product of the professionalization and institutionalization of science in nineteenth-century Europe."[177] The article points out the period after the 1850s, when "the material circumstances under which scientific discovery is prosecuted have been completely revolutionized."[178]

It is interesting to note that for such a central institution of science, "a comprehensive history of the laboratory has not yet been produced."[179] Mainly drawing on the entry on 'laboratory' by Henning Schmigden in the Encyclopedia of the History of

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[175] "The Laboratory in Modern Science," Science, vol. 3, no. 54, 1884: 172-174.

[176] Ibid.

[177] Catherine M. Jackson "The Laboratory", A Companion to the History of Science ed. Bernard Lightman. Oxford: Wiley, 2016: 301.

[178] In the article it is stated that "Forty years ago there were very few, more properly no laboratories which we of to-day would consider even tolerable. Now every university of importance and high repute, the world over, has large suites of rooms for each department of science, and often numerous great buildings within whose walls thousands and thousands of students are daily brought face to face with the facts and laws of nature." See "The Laboratory in Modern Science," Science, vol. 3, no. 54, 1884: 172-174.

[179] Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021.

Science[180] and Ursula Klein's article on early modern laboratory,[181] a brief historicity of the laboratory will be provided here by probing the mutual transformations on the conceptualizations of the laboratory space and the production of scientific knowledge. As the laboratory paves the way for the transformation of science, the transformations of science alter the laboratory space. When the ways of "doing" science change, the laboratory fits into it and vice versa.

In the sixteenth century, the laboratory was primarily a space that was known as the workshops of alchemists, pharmacists, and metallurgists. It was not until around the end of the seventeenth century, laboratory paved the way for a new type of science or way of "doing" science, or in other words, science became an activity. Henning Schmigden particularly points out to Francis Bacon and Robert Boyle, who "promoted the view that human craft should "challenge" nature, to "subjugate" it for the sake of truth and usefulness."[182] "The aim of this science was to discover useful facts about nature by concrete actions and, in doing so, to contribute to a renewal of the world."[183] Boyle "established a practice in which experiments were performed before a learned audience and were then published in a manner designed to be easily understandable so that others could repeat them. This new, active and experimental method of 'philosophizing' was also the aim of the first scientific academies."[184]

The depictions of the space of the early laboratory "frequently displayed books along with instruments" implied "a new synthesis of manual and textual knowledge" and

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180 Ibid.

181 Ursula Klein. "The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation." Isis 99, no. 4, 2008: 769-782.

182 Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021.

183 Ibid.

184 Schmidgen lists the "Academia dei Lincei in Rome (1603), the Academia Naturae Curiosorum (later Leopoldina) in Schweinfurt (1652), and the Royal Society in London (1660)" as the first scientific academies aimed at active and experimental method of "philosophizing".

"defined the laboratory not only as a place of manual work, but also as a space of reading, writing and calculating."[185] With this coexistence of different types of knowledge production practices and through the "interdependency of science, handicraft and text that the term 'laboratory' received its ultimate meaning: the production site of scientific knowledge."[186]

After their institutionalization at universities and academies as well as in the newly founded professional and technical schools in the eighteenth century, the term 'laboratory' was still frequently used instead of 'shop,' 'workshop,' 'atelier,' 'boutique,' etc. to designate innovative sites of material production that employed techniques of "chemical" operations.[187] Even though one "should expect a wholesale transformation of an artisanal workplace into a scientific institution" would somehow be reflected in "an increasingly narrow use of the term "laboratory" to denote only academic laboratories," however, exactly the opposite was the case.[188] By the end of the eighteenth century, the term 'laboratory' was increasingly used to include, "in addition to academic-chemical and pharmaceutical laboratories, workplaces in arsenals, metallurgy (assaying), mints, dye manufactories, porcelain manufactories, distilleries, and perfumeries."[189] As Ursula Klein asserts, "[m]ore

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[185] Ibid.

[186] Ibid.

[187] Ursula Klein. "The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation." Isis 99, no. 4, 2008: 770-771.

As Ursula Klein states, "This use of the word "laboratory" corresponds with the fact that the Latin word "laborare," from which "laboratory" is derived, meant any kind of manual work, including commercial labor. As also underlined by Klein, Diderot and d'Alembert's Encyclopedie translates "laboratory" ("laboratoire") with "shop" ("boutique") and defines it as a "closed and covered place" that "contains chemical equipment [utensils]" such as furnaces, vessels, and instruments []"

[188] Ibid., 774.

[189] Ibid.

historical studies are necessary to understand why the use of the term "laboratory" was extended in the eighteenth century."[190]

The extended use of the term 'laboratory' is related to coexistence of two different experimental traditions in the early modern period: one is the experimental philosophy and the other one is the laboratory tradition that "meshed studies of nature with technological innovation."[191] While the main purpose of the newly established academic laboratories was the inquiry into nature, the artisanal workshops, then designated as "laboratories," were the "sites of the technological venture, of knack and innovation."[192] Klein claims that "the early modern laboratory produced not only knowledge, let alone knowledge about an immutable nature, but also artifacts and things;" and suggests that the specificity of the institution should be taken as an incentive to study the question of how "experimental inquiry into nature" was interconnected with "technological innovation"[193] Laboratory should not be taken as an emblem of "experimental philosophy" and it should not be inspected under "the narrow epistemological focus on the experimental sciences."[194] "The early modern laboratory was the outcome of a long tradition in which innovative forms of labor, technical expert knowledge, and text-based philosophies developed in tandem."[195]

In the nineteenth century, the course of the laboratory phenomenon took another direction with the reform of existing universities and the founding of new universities. "After 1800, universities were no longer only places for the collection

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[190] Ibid.

[191] Ibid., 769.

[192] Ibid., 779.

[193] Ibid.

[194] Ibid.

[195] Ibid., 779-780.

and ordering of knowledge; they increasingly became places of scientific and technical research."[196] Henning Schmigden points out the early nineteenth century as the moment when the laboratory revolution happened. Schmigden further claims that with the success of individual private teaching and research laboratories", even in the early nineteenth century, there is a "widely distributed system of laboratories," in which the individual laboratories act as "exchange or transit point of discourses, concepts, and recipes."[197]

During the first decades of the twentieth century, with "the intensification of the founding of industrial laboratories and the emergence of large-scale laboratories," the modern laboratory became a global institution.[198] The 'industrial laboratories' emerged apart from scientific laboratories,[199] focused on producing useful knowledge which could be employed for commercial advantage. Rather than scientific publishing in journals, researchers in these laboratories aimed at having patents recognized to have "commercial control of the processes and products involved in their research."[200] The new type of large-scale laboratories, on the other hand, "was meant to foster rationalized, quasi-industrial forms of research while also providing latitude for innovative forms of interdisciplinary cooperation."[201] "The corresponding buildings were no longer molded on single disciplines. They

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[196] Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021.

[197] Ibid.

[198] Ibid.

[199] "In 1875, the Pennsylvania Railroad Company set up its own research laboratory, followed by Eastman Kodak in 1886 and General Electric in 1900, the latter after one of its founding directors, Thomas Alva Edison (1847–1931), had run similar laboratories in Menlo Park (1876) and West Orange (1886)." See Henning Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021 <https://lps.library.cmu.edu/ETHOS/article/id/450/> (last accessed on 06.12.2021)

[200] Ibid.

[201] Ibid.

constituted centers and envisioned overarching "programs" or "areas of research" with shifting horizons of time." [202]

The introduction of large-scale laboratories is also simultaneous with the expansion of laboratory concept to many different fields. However, the establishment of laboratories within disciplines not historically linked to "laboratory culture" is generally considered one of the stages of the scientification of these areas.[203] Forming laboratories is generally seen as equivalent to intensive use of data and applied methods and the appropriation of new research practices such as collaboration and experimentation, which are the traits usually associated with natural science disciplines. The proliferation of research laboratories within universities is both related to the growth in data and increase in the collaborations between fields and is not peculiar to architecture. As it is argued in this study, the proliferation of laboratories is a result of various shifts and disruptions in the field of knowledge which cannot be limited with urge for scientification of various fields. This study in fact challenges such literal pairings between scientific and laboratory practices.

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[202] "On the level of architecture, these new laboratories featured large structures with variable layouts that could be adapted to the specific needs and interests of dynamic research groups. At the same time, they provided meeting places such as "streets" or "plazas" that serve as trading zones for international scientists from different disciplines or mixed groups of scientists, engineers, and computer experts." See Henning Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021 <https://lps.library.cmu.edu/ETHOS/article/id/450/> (last accessed on 06.12.2021)

[203] For instance, Urszula Pawlicka-Deger considers "forming laboratories" as one of the different forms of the scientification of the humanities which also includes "the use of new research data and applied methodologies (qualitative methods, data mining), new research practices (collaboration, experimentation), new methods of evaluating research (parameterization, falsifiability, the ranking system of universities)." See Urszula Pawlicka-Deger "The Laboratory Turn: Exploring Discourses, Landscapes, and Models of Humanities Labs," Digital Humanities Quarterly. vol.14, no.3, 2020.

2.4.2 Laboratory as a Place for both Production and Representation of Knowledge

In this study, laboratories are understood as a conceptual setting for a new way of producing knowledge which is governed by the urge for innovation and enabled by the lateral relationships between different fields of knowledge. A brief history of the laboratory as an institution demonstrates its innovative nature from the very early beginnings.[204]As Ursula Klein argues, the early history of the laboratory illustrates "the existence of a broad spectrum of forms of knowledge, with differences only in degree, and these are combined together to develop innovative making practices."[205] Therefore, the naming of these research institutions as 'laboratories' should not be understood as simply as "an increasing interest in scientific discourses."[206] Likewise, within the context of the research laboratories in architecture schools, innovation should not be understood in the sense of the commercialization of the research by producing technological solutions or products. Although research activities are transformed with technological advances, the main concern for these laboratories that are under scrutinization here is not the latest technological hype but "using the latest technology to foster architectural understanding."[207]

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[204] Ursula Klein. "The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation" Isis, vol. 99, No. 4, December 2008: 769-782.

[205] Klein, 2008: 781.

[206] Neil Leach. "Digital Morphogenesis," Architectural Design. Special Issue: Theoretical Meltdown Volume79, Issue1, 2009: 36. "If the 1980s and 1990s were characterised by an interest in literary theory and continental philosophy the first decade of the 21st century can be characterised by an increasing interest in scientific discourses. It is as though the dominant logic of today has become one of technology and material behaviour."

[207] The Extraction Laboratory at the Columbia official website. <https://www.arch.columbia.edu/research/labs/11-extraction-lab> (last accessed on 21.01.2021)

The book 'Laboratory Life'[208] which is based on fieldwork done by Bruno Latour in Roger Guillemin's laboratory at the Salk Institute from 1975 to 1977 is considered as a seminal contribution to the emerging field of "laboratory studies." The anthropological approach employed in the book described the "scientific work in the laboratory [] as "literary inscription."[209] As Schmigdgen asserts, in this book, "the aspect of production is largely neglected, whereas the aspect of representation moves to center stage."[210] It seems incorrect to conceive of the laboratory as a writing space only, since the "notion of the laboratory could have been based in a broader notion of the modern emphasis on technologies, machines, and infrastructures which make possible and shape the process of writing and the production of laboratory inscriptions."[211] However, as Schmigden argues, in Latour's account, the computer and similar information technologies hardly play a role. Even if, in later years, Latour describes the laboratory as a "center of calculation," he remains committed to considering to the world of scientific practice predominantly as a "paper world."[212]

Even though this book is considered as the foundational work in the field of laboratory studies, and many scholars employed and further developed the approach introduced in the book in the decades after its publication, it is not very well suited with the understanding of the concept of laboratory in this study. First, this study considers the laboratory as the locus of scientific knowledge production rather than its representation. As Schmigden argues, the "modernity of the laboratory resides in

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[208] Bruno Latour and Steve Woolgar. Laboratory Life: The Construction of Scientific Facts. Princeton, N.J.: Princeton University Press, 1979.

[209] Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021.

[210] Ibid.

[211] Ibid.

[212] Ibid.

the very fact that it embraces both aspects, i.e., production and representation."[213] Second, it is argued here that the laboratory is an important apparatus in the transition from the paper to the digital world as a site of the production of knowledge.

From the particular perspective of this study, it is no surprise that "it is the extension of laboratory architectures into the virtual space of databases, models, and simulations that confirms the dominant model of the laboratory while also contributing to its dispersion into new forms."[214] As Schmigden further states:

> Today's "laboratory" is a globally networked knowledge infrastructure tied together by digital technologies. Using "Big Data" and developing "Artificial Intelligence" (AI), this infrastructure allows for performing innovative experiments in real and virtual space, for example distributed experiments in ecology. Within this network, single laboratories continue to constitute crucial nodes where combinations and confrontations of human and machine, body and technology, organisms and instruments continue to occur in order to produce similarly innovative results.[215]

2.4.3 University as a Site of Knowledge Production

The production of new knowledge, which is not initially built into the very idea of the university, is mainly achieved through research.[216] It is only from the last third of the nineteenth century that 'research' has grown to be the most important function for the dominant conception of the university compared to 'scholarship' and

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[213] Ibid.

[214] Ibid.

[215] Ibid.

[216] In fact, research is a relatively new academic mission for the universities which dates mainly from the nineteenth century.

'teaching': the other objectives of the same institution.[217] University as an 'institution' is significant for this study because of architecture's inconsistent institutional setting in the universities or the recently established research "laboratories" within those institutions.

The proliferation of laboratories in the schools of architecture, mainly since the 2000s, is considered as an indication of a disruptive transformation in the processes of knowledge production in the field. The MIT Media Lab, founded in 1985, and its predecessor, the Architecture Machine Group,[218] paved the way for the current transformation of university research.[219] Today, "no self-respecting architectural institution [] lacks a 'research laboratory' or 'lab' of some kind."[220]

This study claims that there is a new model of knowledge production at work for the discipline of architecture via this new institutional framework. There is no single paradigm ruling over all knowledge production of the discipline; each of these laboratories construct their 'customized' ways of producing knowledge. It is an open system whose boundaries are not predetermined, and the nature and scope of its components and the structure of their interrelations are not premeditated. These

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[217] Today, universities combine the functions of pursuing new knowledge through research, maintaining and enhancing existing knowledge through scholarship, and transmitting knowledge through teaching.

[218] "The Architecture Machine group at MIT was founded in 1967 as a 'workshop of ideas for the development of human-computer interfaces', headed by a recent graduate, Nicholas Negroponte. It eventually grew to become the MIT MediaLab we know today with wide-ranging research into future applications of new technologies." See Jeroen van Ameijde "The Architecture Machine Revisited: Experiments exploring Computational Design-and- Build Strategies based on Participation," SPOOL, vol.6, no.1, 2019: 18.

[219] Architecture Machine Group was active from September 1967 to September 1985. Nicholas Negroponte co-founded the MIT Media Lab with Jerome B. Wiesner in 1985, and served as its first director. MIT Media Lab Website. <https://www.media.mit.edu/> (last accessed on 29.05.2021)

[220] Willem de Bruijn. "Writerly Experimentation in Architecture: The Laboratory (not) as Metaphor," Writingplace, vol. 1, 2018: 50.

recently founded laboratories are not seen as places for "experiment" or as substitutes for the traditional design studio but as the locus for the production of knowledge.[221] It is argued here that these laboratories produce knowledge in a way that cannot be found in the conventional "disciplinary" outlook.

As stated above, the notion of the university as an institution for the production of new knowledge did not build into the very idea of the university at the beginning. Initially, universities were essentially devoted to teaching. Today's emphasis on research was later implemented into the institution, and the research laboratory became a significant agent in this transformation. One significant example could be the laboratory founded by Justus von Liebig at the University of Giessen in the 1830s. Even though historians did not quite agree on whether or not Liebig's laboratory at University of Giessen sets a "principal model from which the modern teaching-research laboratory has descended,"[222] it is usually underlined that "the scale and efficiency of Liebig's laboratory set an entirely new standard for training in chemistry and transformed popular ideas about effective scientific education."[223] Benoît Godin emphasizes the role of professors such as Justus von Liebig to incorporate the research activities into the university structure that established itself as a "teaching" institution. By defining themselves first and foremost as researchers,

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[221] Therefore, although frequently recognized as the origin of the architectural laboratory in the domain of design education, the never-realized idea of Bauversuchsplatz (building laboratory) of Bauhaus, "which was conceived as a large-scale experimental studio where practical workshop problems may be addressed in both the technical and formal senses, under the direction of a highly qualified practicing architect", is not treated as the starting point for these recently founded laboratories in this study. See Willem de Bruijn. "Writerly Experimentation in Architecture: The Laboratory (not) as Metaphor," Writingplace, vol. 1, 2018: 50, and Barbara Elisabeth Ascher. "The Bauhaus: Case Study Experiments in Education," Architectural Design, vol.85, iss.2, 2015: 31.

[222] Joseph S. Fruton. "The Liebig Research Group: A Reappraisal." Proceedings of the American Philosophical Society 132, no. 1, 1988: 2-3

[223] Greta Marchesi. "Justus von Liebig Makes the World: Soil Properties and Social Change in the Nineteenth Century," Environmental Humanities vol.12, iss.1, 2020: 205–226.

"the professors set about recreating within the academic institution conditions compatible with research activities."[224] This, according to Godin, explains how the research laboratories came about and how research training programs (Ph.D.) were developed in the universities.

There are other significant turning points in the history of knowledge production in the universities that the laboratory has become a significant part of.[225] Henry Etzkowitz, and Loet Leydesdorff, the authors of the "Triple Helix Model," which identifies the relations between university, industry, and government, point out to the late nineteenth century as the period when the modern university went through a revolutionary transition with the "emergence of the industrial research laboratory and the scientification of industrial production."[226] They argue that "[u]niversities offered a specific place for integration and differentiation among functions in the knowledge infrastructure like scholarly learning, theorizing, and experimental practices."[227]

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[224] Benoit Godin. "Writing Performative History: The New New Atlantis?" Social Studies of Science vol.28, no. 3, 1998: 467-468.

[225] The thesis of Etzkowitz and Leydesdorff is that "a new academic model, the entrepreneurial university is created as universities combine teaching and research with the capitalization of knowledge," They identify it as "the second academic revolution" (the first was the development of the research university in the late nineteenth century). MIT was the first entrepreneurial university, "creating formats for interaction with industry and then diffusing them to other schools" (p. 1). He assigns the Bayh-Dole Act of 1980, which gave universities the patent rights to federally sponsored research, a central role in bringing the university and industry closer together. Much of the knowledge developed as part of academic research programs falls under university ownership.

[226] Henry Etzkowitz and Loet Leydesdorff. "The Triple Helix---University-Industry-Government Relations: A Laboratory for Knowledge-Based Economic Development" EASST Review. vol. 14, 1995: 14-19.

[227] Ibid.

2.4.4 Different Innovation Models in the University through Research Laboratories

Innovation previously had been understood as a linear process, which is reflected in the historical understanding of the relationship between science and technology. Benoît Godin explains the linear model of innovation through one of the "first (theoretical) frameworks developed for [] understanding science and technology and its relation to the economy."[228] This model presupposes a duality between basic and applied research since it postulates that "innovation starts with basic research, then adds applied research and development, and ends with production and diffusion."[229] The linear model of innovation is considered "dead" today.

When the relationship between science and technology is construed as two poles, one of which is guided or driven by the other, constantly pushing and pulling each other, it implies the linear innovation model. When this relationship is interpreted differently, in which science and technology develop independently of each other or, on the contrary, when they are thought to form an undifferentiated continuous unit, there emerges a non-linear innovation model.[230]

These different models of innovation also accompanied by the shifts in the practices of the university. The first of these shifts was from teaching to research in the late nineteenth century, which transformed the infrastructure of the university to be

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[228] Benoît Godin. "The Linear Model of Innovation: The Historical Construction of an Analytical Framework." Science, Technology, & Human Values vol.31, no. 6, November 2006: 639.

[229] Ibid.

[230] "Relations between science and technology are usually thought of in terms of five configurations: (a) science drives technology; (b) technology guides science; (c) science and technology develop independently from one another; (d) science and technology form a "dialectic" relationship in which they constantly push and pull at each other; (e) science and technology make up an undifferentiated continuous entity." See Terry Shinn and Bernward Joerges. "The Transverse Science and Technology Culture: Dynamics and Roles of Research-Technology." Social Science Information vol.41, no. 2, 2002: 207-251.

compatible with research activities. "During the early post-war era, the concept of basic research culminated in the linear model of innovation as a one-way flow from fundamental to applied research to product development."[231] The second shift is from linear to nonlinear mode of innovation, with the Bayh-Dole Act that was signed into law in 1980. This legislation permitted universities to patent technologies whose development was funded by federal grants and contracts. With the destruction of the linear model of innovation and the "change in emphasis from a sole concentration on the production and dissemination of knowledge to technology transfer" in universities required a "spiral model of innovation to capture multiple reciprocal linkages at different stages of the capitalization of knowledge."[232] Henry Etzkowitz, and Loet Leydesdorff present an alternative Triple Helix Model, which is "based upon interdisciplinarity and spiral feedback links between technologies, sciences, and markets, and among universities, industry, and government."[233]

The final shift, which is defined by this study, postulates that there is a new distributed system of innovation that is again made possible by the network of laboratories proliferating in all fields of knowledge. This shift is enabled by the availability of scale-independent tools for storing and sharing an abundant amount of knowledge and the simultaneous increase in the processes of globalization and decentralization. The increasing network character of new research practices again gave laboratories a prominent position in the transformation of science.

Innovation is not a novel concept for this century; however, when the inventions of the Internet and the integrated circuit chip "joined together, an explosive force was unleashed that changed the very nature of innovation, relocating it from the center to

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[231] Ibid.

[232] Ibid.

[233] Henry Etzkowitz and Loet Leydesdorff. "A Triple Helix of University-Industry-Government Relations: Introduction," Industry and Higher Education. Vol.12, iss.4, 1998: 197-201.

the edges."[234] The centralized version of innovation is replaced with an emergent model, in which expertise and knowledge emerge from distributed networks like the Internet.[235] Joi Ito, the former director of the MIT Media Lab, considers this as the triumph of emergence over authority which "amounts to a tectonic shift in the way knowledge is produced and distributed."[236] Ito claims that the emergent systems "foster the kind of nonlinear innovation that can react quickly to the kind of rapid changes that characterize the network age" compared to authoritarian systems "which enable only incremental change."[237]

Innovation models define the university's research practices, and there is currently a distributed system that the laboratory network can provide. The agents of these shifts are always laboratories, but the resulting models of innovation differ from each other. The innovation model postulated by the recent shift does not offer a global model. The specific innovation model of each of these laboratories is unique to themselves.

2.4.5 A New Model for the University

James J. Duderstadt states that these "rapidly evolving technologies are dramatically changing the way we collect, manipulate, and transmit information" and "the implications for our universities are profound."[238] He presents three themes that

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[234] Joi Ito and Jeff Howe. Whiplash: How to Survive Our Faster Future. New York, NY: Grand Central Publishing, 2016.

[235] Ibid.

[236] Ibid.

[237] Ibid.

[238] James J. Duderstadt. "Preparing for the Digital Age," Positioning the University of Michigan for the New Millennium: A Case Study In University Transformation. Ann Arbor, Mich., 1999: 344.

illustrate the impact of these technologies upon universities.[239] Among those implications, he introduces a shift in intellectual focus, "from the preservation or transmission of knowledge to the process of creation itself"[240] as the tools of creation are expanding rapidly in both scope and power. Duderstadt associates the act of creation with the "creative professions" such as architecture, engineering, urban planning, music, and art, as opposed to fields such as law, business, accounting, and politics "which manipulate and rearrange knowledge and wealth rather than create it."[241] The dominance of analytical disciplines and professions in the late twentieth century, has been replaced by this recent shift to the distributed model of innovation.[242]

Similarly, in the book "Designing the New American University," Michael M. Crow and William B. Dabars argue that laboratories are pivotal to the transformation of the university. They claim that the "structures long evident in industry and government laboratories", which they define as a matrix in which people move freely should serve as a model for the new university, in contrast to existing configurations of disciplinary-based "silos."[243]

Besides these disciplinary "silos," or divisions constructed between individual disciplines, the differentiations between science, engineering, technology, and art becomes visible when the university structure is analyzed. While scientific

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[239] Theme 1: The University as a Knowledge Server, Theme 2: A Shift from Analysis to Creation, Theme 3: Shifting Social Structures, Ibid., 344-348.

[240] Ibid.

[241] Ibid., 346.

[242] However, I take this as a broader transformation to creative practices, and not as a shift from some fields to others. The proliferation of laboratories in new fields is also related to this shift.

[243] Michael M. Crow and William B. Dabars. "Designing Knowledge Enterprises," Designing the New American University. Baltimore, Maryland: Johns Hopkins University Press, 2015: 187-188.

departments are regarded as producing "basic" knowledge, application of that knowledge is allocated to the faculty of engineering and "professional" schools. The claim that the "university of the future" will be more integrated through a web of structures implies not only horizontal integration between "basic" sciences but also among the departments of science, technology, and art, as illustrated in the graphic below. (Figure 2) This restructuring of the disciplines inevitably will induce a new formation of the university. "Responding to these fundamental changes in the nature of knowledge is critical to the continued relevance of institutions like research universities."[244]

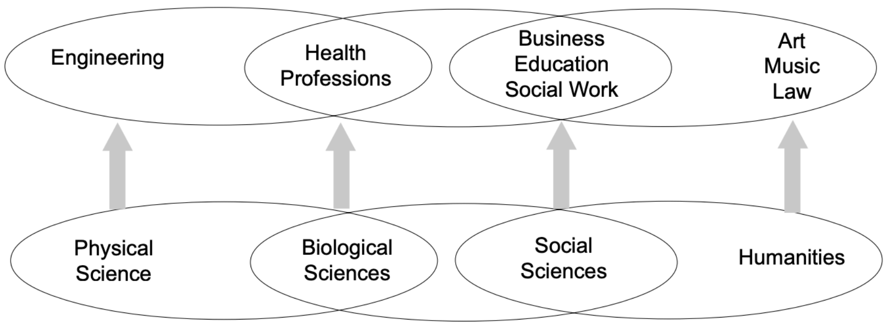

Figure 2. Academic organization of the university by James J. Duderstadt [245]

[244] James J. Duderstadt. "Shifting Paradigms," Positioning the University of Michigan for the New Millennium: A Case Study in University Transformation. 1999: 557.

[245] Ibid., 558.

CHAPTER 3

FROM DISCIPLINE TO DISSOLUTION

The primacy of ‘discipline,’ and the disciplinary model which presupposes rigid boundaries and hierarchies between the fields, was the outcome of the positivistic thought that initiated the formation of the individual disciplines at the end of the eighteenth century with the breakup of individual sciences from philosophy. This study poses a challenge to the positivist depiction of the field of knowledge, which is started with Auguste Comte, the most prominent figure of positivism, who ordered disciplines hierarchically according to the complexity of the phenomena they study, and their stage of intellectual development.[246] Sciences were presented in this scheme as successive to each other, and each science is interdependent to the one that comes before it. Comte related fields in “an encyclopedic scale that goes from the general to the particular and from the simple to the complex: moving from mathematics to sociology, generality decreases, and complexity increases.”[247] Mathematics was the first science as it was the most general of all sciences, while he regarded sociology as the most complex of all sciences. His hierarchy supposes a historical order for the development of disciplines in which the knowledge they produce accumulates on top of each other in an orderly fashion. For example, astronomy requires mathematics, and chemistry requires physics. “Each science thus rests upon the one that precedes it.”[248]

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[246] Stephen Cole “The Hierarchy of the Sciences?” American Journal of Sociology, vol. 89, no. 1, 1983: 111- 139.

[247] Michel Bourdeau "Auguste Comte", The Stanford Encyclopedia of Philosophy (Spring 2021 Edition), ed. Edward N. Zalta. <https://plato.stanford.edu/archives/spr2021/entries/comte/>.

[248] Ibid.

In contrast to the positivist knowledge production, which presupposes the advancement towards the 'truth' through a linear scientific progress, this study describes the scientific research practices and the configuration of the knowledge field as far more complex processes. Since knowledge can never be exhausted and grows in all directions; the production of new knowledge always results in more knowledge. The expansion of knowledge leads to further, and more refined specialization and the discovery of new research areas since "no theory or conceptual framework can continue to encompass the entire field."[249] This continual reconfiguration of the field of knowledge resulted in terminology based on the term 'discipline' to structure and categorize these new formations since "discipline" was considered the most essential component of this vocabulary.

Dogan and Pahre offer a process of specialization-fragmentation-hybridization to explain the constant reconfiguration of the field of knowledge. Even though their view is based on the concept of 'innovation,' their interpretation of the concept is based on the disciplinary division of knowledge. They argue that innovation occurs at the periphery of the disciplines where exchanges with other fields belonging to different disciplines are performed. According to this model, when the core of a specialty reaches a point of density, it is fragmented, and by the recombination of

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[249] Mattei Dogan and Robert Pahre. Creative Marginality: Innovation at the Intersections of Social Sciences. Oxford: Westview Press, 1990: 58.

these fragments, new hybrid fields are formed.[250] This model aptly presents that knowledge is always "in a state of flux- a continual process of reconfiguration, with existing subject domains merging and seceding, and new ones emerging."[251] However, it is insufficient to describe the current state as it is limited in a disciplinary understanding of knowledge production.

This study acknowledges the impact of the big and open data phenomenon in this constant reconfiguration of the sciences. The advent of Big Data does not only transform the ways knowledge is produced, but also introduced new modes of analyzing the field of knowledge itself. Besides revolutionizing knowledge production processes, big data has also transformed science from a different perspective, at least our comprehension of it by enabling us to measure and analyze the production of knowledge in the finest detail. The "large-scale and heterogeneous sources of streams of data" enabled the exploration of "the complexity of the development of scientific knowledge from a broad range of perspectives."[252]

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[250] As Dogan further explains, "[t]he new hybrid field may become independent, like political economy; or it may continue to claim a dual allegiance, like political geography. In the latter case, we cannot be sure whether to place a work in the category of geography or of political science. See Mattei Dogan "Political Science and the Other Social Sciences," A New Handbook of Political Science ed. Robert E. Goodin and Hans-Dieter Klingemann, Oxford: Oxford University Press, 1996: 97-130. These hybrid disciplines, or as Sven Ove Hansson terms them "integrative disciplines", "such as astrophysics, evolutionary biology, biochemistry, ecology, quantum chemistry, the neurosciences, and game theory have developed at dramatic speed and contributed to tying together previously unconnected disciplines" since the second half of the twentieth century. See Sven Ove Hansson. "Science and Pseudo-Science", The Stanford Encyclopedia of Philosophy (Fall 2021 Edition), Edward N. Zalta (ed.), forthcoming <https://plato.stanford.edu/archives/fall2021/entries/pseudo-science/> (last accessed on 23.08.2021)

[251] Carole L. Palmer. "The Context of Interdisciplinary Science," Work at the Boundaries of Science: Information and the Interdisciplinary Research Process. Springer Science+ Business Media, B. V, 2001: 1.

[252] Chaomei Chen. "The Dynamics of Scientific Knowledge," Mapping Scientific Frontiers: The Quest for Knowledge Visualization London: Springer-Verlag, 2003: 2.

The previous attempts to map the production of knowledge, which mainly focused on relationships between disciplines, were performed by employing the methods of bibliometrics.[253] Alan Pritchard, who coined the term "bibliometrics," defines it as "the application of mathematical and statistical methods to books and other media of communication."[254] The bibliometric techniques, including the word frequency analysis, citation analysis, co-word analysis, and simple document counting,[255] were used to evaluate and assess the impact of research outputs. With the establishment of the Science Citation Index in 1964 by Eugene Garfield as a comprehensive index that includes multiple disciplines,[256] scientific outputs were started to be assessed from various perspectives more orderly. Among the numerous methods, analysis of citations remains the most basic method of bibliometric studies.[257] In these studies, it is claimed that "[t]he act of citing another person's research provides the necessary linkages between people, ideas, journals, and institutions to constitute an empirical field or network that can be analyzed quantitatively."[258]

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[253] Or scientometrics as the "bibliometric" analysis of science.

[254] Alan Pritchard, "Statistical bibliography or bibliometrics?" Journal of Documentation, vol.25, 1969: 348–349. See also William W. Hood, Concepción S. Wilson. "The literature of bibliometrics, scientometrics, and informetrics," Scientometrics. Vol. 52, No. 2, 2001: 291–314.

[255] Mike Thelwall. "Bibliometrics to webometrics," Journal of Information Science. vol.34, no.4, 2008: 606.

[256] Eugene Garfield launched other index products, including the Social Science Citation Index (SSCI) in 1973 and the Arts and Humanities Citation Index (AHCI) in 1978. Moreover, along with Web of Science, since 2004, a very similar rival database is available from Elsevier called Scopus. These two databases have been the traditional source for most major bibliometrics studies.

[257] A few of these analysis methods are: subject clustering analysis, journal diversity, text analysis, co-citation analysis, co-authorship analysis, betweenness centrality, betweenness diversity, journal impact factor etc.

[258] John Mingers and Loet Leydesdorff. "A review of theory and practice in scientometrics," European Journal of Operational Research, vol. 246, no.1, 2015: 2.

With the advent of big data, it is now possible to perform more profound analyses to scrutinize many different layers of the field of knowledge. The new methods for data mining give us more detailed knowledge about the mechanisms of knowledge production, not only about the 'context of justification' but also regarding the 'context of discovery.' "As the structure of knowledge grows in both scope and specificity, the conduct of research is also changing."[259] Similarly, the changes in the way knowledge is produced affect both the definition of knowledge and the organization of the whole knowledge field.

Regarding the changes in the organization of the whole field of knowledge that were resulted with the dissolution of borders and hierarchies between disciplines, this study claims that the consequences of these changes in the larger scale of the knowledge field to the disciplinarity of architecture remain unaddressed compared to the plurality of previous attempts of the discipline of architecture to position itself as a misfit in the disciplinary organization of knowledge. However, these initial discussions on disciplinarity in general and the disciplinarity of architecture in particular are very much related to the concept of innovation and the main argument of the thesis. What makes these laboratories on innovation possible is the certain epistemological context and crisis in which knowledge could only be produced by way of cross-disciplinary, lateral relations. Modern epistemologies, which conceive knowledge as cumulative and grounded on each other and in a hierarchical manner vertically constructing itself on top of each other, do not work anymore. The dissolution of hierarchy between disciplines that is replaced by a lateral re-organization of disciplines leads to such innovation laboratories in terms of research. It is based on the argument that the idea that the disciplinary system is insufficient to describe the knowledge production practices led to the emergence of these

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[259] Carole L. Palmer. "The Context of Interdisciplinary Science," Work at the Boundaries of Science: Information and the Interdisciplinary Research Process. Springer Science+ Business Media, B. V, 2001: 1.

innovation laboratories, therefore, it would be useful to return to the disciplinary discussions and describe the crisis.

3.1 Revisiting the Concept of Discipline

As Julie Thompson Klein states, "[i]f there is an undisputed truth about disciplinarity; it is that disciplines change"[260] however, it is only very recently that disciplines are regarded as "historically specific" forms. Michel Foucault was the first to call attention to the discipline as a "system of control in the production of discourse"[261] and as "a larger set of strategies and techniques of control that have come to dominate much of modern life."[262] Yet, as Shumway et al. argue, the Foucauldian analysis is by no means the only approach available for the study of disciplines[263]; on the contrary, the "dispersed nature" of disciplines allows one to study a particular discipline from a rather broad perspective.

> It [disciplinarity] is neither a field in itself nor a metafield in which one can study disciplines. It is neither the essence of disciplines nor their foundation. Rather**,** disciplinarity is about the coherence of a set of otherwise disparate elements: objects of study, methods of analysis, scholars, students, journals, and grants, to name a few**.** To borrow from Foucault, we could say that

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[260] Julie Thompson Klein. "Blurring, Cracking and Crossing: Permeation and Fracturing of Discipline," Knowledges: Historical and Critical Studies in Disciplinarity ed. Ellen Messer-Davidow, David R. Shumway, David Sylvan. Charlottesville and London: University Press of Virginia, 1993: 186.

[261] Michel Foucault. The Archaeology of Knowledge. New York: Pantheon, 1972: 224.

[262] Michel Foucault. Discipline and Punish: The Birth of the Prison. New York: Pantheon, 1978. as cited in David R. Shumway and Ellen Messer-Davidow. "Disciplinarity: An Introduction," Poetics Today, Vol. 12, No. 2, 1991: 202.

[263] David R. Shumway and Ellen Messer-Davidow. "Disciplinarity: An Introduction," Poetics Today, Vol. 12, No. 2, 1991: 202.

> disciplinarity is the means by which ensembles of diverse parts are brought into particular types of knowledge relations with each other.[264]

Discussions around "disciplinarity" mainly focus on the etymological roots of the term "discipline" itself. There is "a growing acknowledgment of the internal complexity of the concept of an academic discipline" in the recent literature, Peter Osborne writes.[265] "Discipline is derived from the Latin *discere* (learning), and it has been used since late antiquity and the early Middle Ages as one side of the distinction of *disciplina* vs. *doctrina*. Both terms meant ways of ordering knowledge for purposes of teaching and learning."[266] Osborne contrasts the definitions of "discipline," as "pertained to the disciple or scholar with "doctrine," as "the property of the doctor or teacher"; and claims that 'discipline' has been associated with practice or exercise and 'doctrine' with abstract theory.[267] As Shumway and Messer-Davidow further state:

> Given this opposition, we can see why "discipline" might have been chosen to describe the new science based on empirical methods and claiming objectivity. To call a field a "discipline" is to suggest that it is not dependent on mere doctrine and that its authority does not derive from the writings of an individual or a school, but rather from generally accepted methods and truths.[268]

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[264] Ellen Messer-Davidow, David R. Shumway, David Sylvan. "Disciplinary Ways of Knowing," Knowledges: Historical and Critical Studies in Disciplinarity ed. Ellen Messer-Davidow, David R. Shumway, David Sylvan. Charlottesville and London: University Press of Virginia, 1993: 3.

[265] Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," Theory, Culture & Society vol. 32, iss. 5-6, 2015: 6.

[266] Rudolf Stichweh. "Differentiation of Scientific Disciplines: Causes and Consequences," Encyclopedia of Life Support Systems (EOLSS), Paris, 2003.

[267] Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," 2015: 6.

[268] Shumway and Messer-Davidow. "Disciplinarity: An Introduction," 202.

One of the very common tendencies in defining the term ‘discipline’ has been describing it as a set of diverse epistemological and institutional components. In most of the definitions, there is always a set of requirements that a field of study should fulfill to be acknowledged as a ‘discipline.’ Thomas Kuhn was the first to offer such a list in 1970 when he conceptualized the cognitive framework of a discipline as consisting of three elements: its underlying theory, idealized models and analogies, and exemplars (specific instances of generalizations and models).[269] Foucault, similarly, claims that discipline is defined by “a domain of objects, a set of methods, a corpus of propositions considered to be true, a play of rules and definitions, of techniques and instruments.”[270] After four decades, this tendency is still valid as could be noticed in Allen Repko’s definition of a discipline as “a particular branch of learning or body of knowledge whose defining elements– [its] phenomena, assumptions, epistemology, concepts, theories, and methods– distinguish it from other knowledge formations”[271] in 2012. The following definition by Robin Valenza is the most detailed one up to date:

> A discipline is a field of study that has a recognized community of researchers who have in common most of the following: an agreed-upon name, a loosely identified object of knowledge, shared research goals, a finite set of methods of inquiry, a generally accepted intellectual tradition, a group of institutions that persist and remain stable over time (such as university departments and academic journals), a system for perpetuating the discipline by training new practitioners, a group of

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[269] Thomas Kuhn. “The Structure of Scientific Revolutions,” International Encyclopedia of Unified Science Vol. 2, No. 2. Chicago, IL: University of Chicago Press, 1970: 193-194 as cited in Lisa Lattuca Creating Interdisciplinarity: Interdisciplinary Research and Teaching Among College and University Faculty Vanderbilt University Press, 2001: 28.

[270] Michel Foucault. “The Order of Discourse,” Untying the Text. Robert Young, ed. London: Routledge, 1981: 59.

[271] Allen Repko. “Introduction,” Interdisciplinary Research: Process and Theory. London: SAGE Publications, 2012: 4.

> working concepts and rules for adding new rules and concepts, and an established manner for communicating their findings.[272]

Valenza considers this tendency of using a set of specifications to define a discipline as an adaptation of the biological definition of species as a model for 'discipline.' So it does not indicate that "every disciplinary species will fall into exactly the same mold, meet the same set of specifications, or possess a single quality that separates it from all other disciplines."[273] Still, what unites the practitioners of a particular discipline over time and over geographical distances is to have many, if not most, of the qualities enumerated above in common.[274]

The term discipline is, in fact, a historically and contextually contingent concept used for organizing knowledge production. Discipline only offers one level of differentiation between various kinds of knowledge. In the conventional landscape of knowledge, differentiation starts with the broad areas of knowledge, i.e., natural sciences, social sciences, and humanities; then comes the individual disciplines followed by sub-disciplines, finer segregation within individual disciplines. This crystallization process is followed by integration between different fields of knowledge such as multidisciplinarity, interdisciplinarity, and transdisciplinarity. There is a continuous sequence of segregation and integration in the attempts to organize knowledge production.

> Specialization, to be sure, as a progressive branching of knowledge, increases the potential for integrative research at the same time. But integration can also mean a new form of specialization driven by the expectation that the merging of specialized forms of knowledge can produce

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[272] Robin Valenza. Literature, Language, and the Rise of the Intellectual Disciplines in Britain, 1680-1820. Cambridge: Cambridge University Press, 2009: 5.

[273] Ibid., 6

[274] Ibid.

gains in knowledge that would be impossible without an explicitly integrated approach.[275]

Disciplines are the principal organizational units for the production and diffusion of knowledge. Not all forms of knowledge-production are disciplinary, yet, the notion of knowledge is central to a discussion on disciplines. As Foucault underlines, "[t]here are bodies of knowledge that are independent of the sciences[276] but there is no knowledge without a particular discursive practice; and any discursive practice may be defined by the knowledge that it forms."[277] What forms a discipline is, then, the kind of knowledge it produces; even if disciplines are not the only way of producing knowledge. In fact, it is only for two centuries, "knowledge has assumed a disciplinary form" and even "for less than one, it has been produced in academic institutions by professionally trained knowers."[278] As also asserted by Immanuel Wallerstein, "[e]ven until the late eighteenth century knowledge was considered as

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[275] Matthias Bergmann, Thomas Jahn, Tobias Knobloch, Wolfgang Krohn, Christian Pohl and Engelbert Schramm. "Chapter I: The integrative approach in transdisciplinary research," Methods for Transdisciplinary Research: A Primer for Practice. Frankfurt/New York: Campus Verlag, 2012: 23.

[276] Discipline is a more general term than science for Foucault. As Gary Gutting observes "what Foucault calls "disciplines" are the "groups of statements that borrow their organization from scientific model, which tend to coherence and demonstrativity, transmitted and sometimes thought as sciences." There are two terms in French that refer to the term 'knowledge' in English: 'connaissance' and 'savoir'. Connaissance refers to a particular corpus of knowledge, a particular discipline; savoir is usually defined as knowledge in general. "In Foucault's view, a particular science (or more generally a discipline) is the locus of 'connaissance' whereas a discursive formation is the locus of 'savoir'." See Gary Gutting. "The Archeology of Knowledge," Michel Foucault's Archeology of Scientific Reason. Cambridge: Cambridge University Press, 1989: 227- 260.

[277] Michel Foucault. The Archaeology of Knowledge, London and New York: Routledge, (1969) (1995), 201.

[278] David Shumway, David Sylvan, Ellen Messer-Davidow eds. "Preface," Knowledges: Historical and Critical Studies in Disciplinarity. University of Virgina Press, 1993: vii.

a unitary field."[279] As Shumway et al. claim even though we tend to perceive disciplines so natural and "fail to imagine how else we might produce and organize knowledge" in a different way; disciplines are relatively recent phenomena.

The study of disciplinarity involves a critique of the existence of the disciplines themselves. As Bryan Turner maintains, disciplines are "artificial constructs"; they are not "naturally occurring intellectual divisions that might refer to divisions of the mind" and that is why "they can always be transformed, relocated or destroyed."[280] The study of disciplinarity then, is against the Whiggish historical perspectives that "cannot imagine alternatives to the current regime of disciplines."[281] In a study of disciplinarity, disciplines are "knowledge-formations unlike those that have preceded them and may very well be unlike the knowledge- formations of the future."[282] As Steve Fuller indicates, "discipline" is one of the few units of analysis that requires the cooperation among different disciplines,[283] because they are "intellectual constructs, organizational containers and cultural communities" at the

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[279] Immanuel Wallerstein. "Historical Origins of World-Systems Analysis: From Social Science Disciplines to Historical Social Sciences," World Systems Analysis: An İntroduction. Durham and London: Duke University Press, 2004: 2. It should also be noted that "Before the modern disciplines assumed primacy in colleges and universities in the late 1800s, knowledge was categorical: the medieval university divided the seven liberal arts into the quadrivium (arithmetic, geometry, astronomy, and music) and the trivium (logic, grammar, and rhetoric)." See Lisa Lattuca. "Considering Interdisciplinarity," Creating Interdisciplinarity. Nashville: Vanderbilt University Press, 2001: 5.

[280] Bryan S. Turner. "Discipline," Theory, Culture & Society vol. 23, iss. 2–3, 2006: 184-185.

[281] Steve Fuller. "Disciplinarity Versus Interdisciplinarity," The Knowledge Book: Key Concepts in Philosophy, Science and Culture. Stocksfield, U.K.: Acumen, 2007: 19.

[282] As Shumway et al. claims "Not all studies of disciplinarity need to be histories, but they do need to assume that knowledge is historically and socially contingent."

[283] Steve Fuller. "Disciplinary Boundaries and the Rhetoric of the Social Sciences," Poetics Today, Vol. 12, No. 2, 1991: 301.

same time, or in other words, the concept of discipline applies to these three different phenomena simultaneously.[284]

3.1.1 The Construction of Disciplinary Terminology: Disciplines and Sub-Disciplines

This study considers two kinds of hierarchy in the classification of knowledge into different categories. The first kind of hierarchy is constructed through the pyramidal representation of knowledge in the foundationalist epistemology in either its metaphysical tradition, throning philosophy, or the positivist tradition, which prioritizes natural scientific disciplines.[285] There is also another hierarchical organization in the field of knowledge constructed through sorting fields of knowledge into smaller and more specific categories according to their levels of specificity. When a field of knowledge is defined as a sub-discipline, it cannot transcend the main discipline. Vincenzo Politi argues that the analogy of the 'tree of scientific knowledge' could be misleading in this sense because it "risks obscuring, instead of clarifying, the relation between mother-disciplines and new disciplines."[286] As he further states:

> The creation of a new discipline is not an event as innocent and innocuous as the addition of a new sub-branch to some pre-existing trunk; rather, a new discipline may supersede some of the existing branches. Science, therefore, may not develop by simple 'proliferation' of new disciplines; rather, it appears to grow through fragmentation and dissolution: in some cases, though not necessarily

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[284] Joe Moran. "Introduction," Interdisciplinarity. London and New York: Routledge, 2002: 15.

[285] Zeynep. Mennan. "An Interpretive framework for understanding architectural theory's self-representation," Unpublished Phd Dissertation. Ankara: METU, 1997: 92.

[286] Vincenzo Politi, "Scientific Revolutions, Specialization and the Discovery of the Structure of DNA: Toward A New Picture of the Development of the Sciences." Synthese 195, 2018: 2290.

> every time, *the creation of a new discipline does not change just the number of the branches of the tree, but the very structure of the tree.*[287] (italics mine)

The chances for innovation are increased in these specialties, as researchers decenter in relation to their original discipline(s) is a move away from shared assumptions of the main discipline.[288] In some instances, the creation of a new sub-field might disrupt the field of knowledge in a more significant way.

3.1.2 Disciplinarity of Architecture

Architecture's 'disciplinarity'[289] – the way that it "defines, creates, disseminates, and applies the knowledge within its domain of influence"[290]– has always been a contentious issue due to the extensive amount of extra-disciplinary references it has within its own field. In order to strengthen its disciplinary authority, architecture forms connections with more 'established' disciplines by utilizing tools, methods, and theories that are originally developed in those disciplines. In return, as a material discipline, architecture 'supports' them in their attempts to concretize certain concepts. Hence the identity of architecture has been "constructed through

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[287] Ibid.

[288] Ibid., 2274.

As Vincenzo Politi argues "[t]he process of specialization does not look as 'destructive' as scientific revolutions. After a scientific revolution, the old scientific tradition is discarded once and for all. By contrast, a new specialty does not replace its parent-discipline(s). Nevertheless, Kuhn sometimes speaks of revolutions and specialization as if they were somehow associated."

[289] Discipline of architecture", refers to "a collective body of knowledge that is unique to architecture." Stanford Anderson. "The Profession and Discipline of Architecture: Practice and Education," Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 294.

[290] Julia Williams Robinson and Andrzej Piotrowski. "Introduction," Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: ix.

exchanges with other disciplines"[291] because of architectural theory's "recourse to seemingly more stable disciplines outside of architecture such as philosophy, science, and mathematics."[292] Architecture has always "borrowed from other disciplines to illuminate its central questions, to augment its legitimacy, to find a language to redefine its agenda."[293] As it infiltrates and be infiltrated by other disciplines, the boundaries of the discipline of architecture are widely disputed. It has been frequently labeled as inherently interdisciplinary. This was the prevalent view for the discipline of architecture, particularly in the years between the 1980s to 2000s.

There are various interpretations on the disciplinary status of architecture. Jane Rendell suggests that "[i]f we define a discipline as a system of rules of conduct, or as a method of practice," then architecture is not a discipline; "yet it is disciplined, codified and bounded in various ways, through the institutions that regulate it."[294] It is further argued that architecture's disciplinarity, "its version of what it is to be a discipline, is then of itself an inter-, trans-, super, even un- or a-disciplinarity."[295] Linda Groat and Sherry Ahrentzen similarly claim that architecture is 'inherently

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[291] Mark Linder. "TRANSdisciplinarity," Hunch: The Berlage Institute Report. no.9, 2005: 12.

[292] Paul Alan Johnson. "Introduction," The Theory of Architecture: Concepts Themes & Practices. New York: John Wiley&Sons, 1994: 11.

[293] C. Greig Crysler, Stephen Cairnes and Hilde Heynen. "Introduction – 1: Architectural Theory in an Expanded Field," Sage Handbook of Architecture Theory. London: Sage Publications, 2012: 14-15.

[294] Jane Rendell. "Architectural research and disciplinarity." Architectural Research Quarterly. vol 8, no 2, 2004: 143.

[295] Igea Troiani, Suzanne Ewing and Diana Periton. "Architecture and Culture: Architecture's Disciplinarity," Architecture and Culture. vol.1, iss.1, 2013: 9.

interdisciplinary' because of its broad scope.[296] However, Julie Thompson Klein, who coined the term, strongly emphasizes that "[a] wide compass alone, [] does not constitute interdisciplinarity."[297] In this line of interpretation, architecture is not considered solely as a discipline but rather an inter-, trans-, super, or a-discipline concurrently.

A contrasting approach is to be found in the book entitled "Discipline of Architecture," in which Julia Williams Robinson indicates that "[t]he field of architecture is in the process of evolving from what has been a practice, informed by other disciplines, into a discipline with its own body of knowledge."[298] As she further claims, "though the boundaries of architecture are unclear, the subdisciplines retain a segregation and integrity defined by the boundaries of their discipline of origin."[299] Robinson compiles a chart in which she illustrates that architecture has borders with twenty-one different disciplines and fields[300] and further suggests that the knowledge base of architecture is broad and fractured because each subdiscipline exists without reference to the others. (Figure 3) In another article in the same book, Andrzej Piotrowski underlines that "[a]lthough architectural knowledge is frequently

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[296] The phrase "inherently interdisciplinary" belongs to Julie Thompson Klein and she lists philosophy, literary studies, religious studies, anthropology and geography as examples without including architecture. It is Linda Groat and Sherry Ahrentzen who claim that architecture could be characterized as "inherently interdisciplinary," with reference to Klein. As cited in Julia Williams Robinson. "The Form and Structure of Architectural Knowledge: From Practice to Discipline," Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 63.

[297] Julie Thompson Klein. "A Taxonomy of Interdisciplinarity," Oxford Handbook of Interdisciplinarity. Oxford: Oxford University Press, 2010: 17.

[298] Julia Williams Robinson. "The Form and Structure of Architectural Knowledge: From Practice to Discipline," Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 61.

[299] Ibid., 72.

[300] However, Robinson does not give a clear account of how she specifies these twenty-one disciplines.

presented as interdisciplinary or crossdisciplinary, it is explicitly divided into a set of distinctive subfields, which have been constituted after, and rely on, the epistemological authority of their 'pure' models, such as physics, history, or sociology."[301]

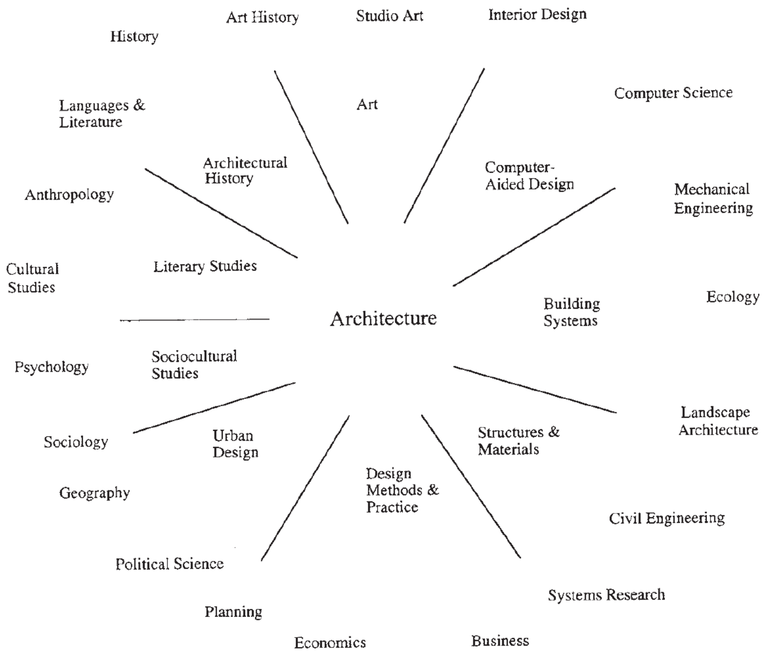

Figure 3. The relationship of architecture to other fields and disciplines [302]

Two conflicting general tendencies in defining the disciplinary status of architecture could be drawn out here. While the first approach claims that architecture's relationship with other disciplines compel it to be an inter-, trans-, super, un-, and a-discipline, according to the second approach, other disciplines strengthen the

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[301] Andrzej Piotrowski. "On the Practices of Representing and Knowing Architecture," Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 49.

[302] Julia Williams Robinson. "Form and Structure of Architectural Knowledge,". Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 70.

disciplinarity of architecture through the formation of subdisciplines. The essential point here is favoring the presence of other disciplines in establishing architecture's own disciplinarity in both approaches,[303] even though they differ in defining the impact of these relationships upon architecture's disciplinarity.

The second most fundamental reason why architecture, as a discipline, cannot stabilize itself in the whole disciplinary system is due to the differentiation between manual and intellectual labor. As a 'mechanical' art, architecture had no place in the university which was the home of the 'liberal arts' in its initial institutionalization. As Mark Wigley points out, this distinction between mechanical and liberal depends on the architectural metaphor. It follows from Aristotle's description of the theorist as an architect (*arkhitekton*) placed above the manual laborer. "It is precisely the figure of architecture that is used to exclude architecture."[304] This is still reflected in the architecture's inconsistent institutional setting in the universities.[305] Today, architecture departments could be placed "in institutes of technology, schools of art, professional schools, liberal arts colleges, and within the university in such diverse

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[303] İnci Basa also favors of the presence of other disciplines in establishing architecture's own disciplinarity. Basa builds a relationship between architecture and other disciplines through the 'objects' of architecture. As she underlines, architecture's 'objects' "do not exist in a disciplinary coherence" since "they have their intellectual roots not only in 'architecture', but also in numerous different disciplines like sociology, psychology, mathematics, engineering, philosophy, art, science." For a discussion on the reasons of the recognition of architecture as a "distinguished discipline" see İnci, Basa. Linguistic Discourse in Architecture. Unpublished PhD dissertation. METU Department of Architecture, 2000.

[304] Mark Wigley. "Prosthetic Theory: The Disciplining of Architecture," Assemblage, No. 15, 1991: 11.

[305] Architecture departments could be placed "in institutes of technology, schools of art, professional schools, liberal arts colleges, and within the university in such diverse units as liberal arts, arts and sciences, and design." See Julia Williams Robinson. "Form and Structure of Architectural Knowledge,". Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 62-63.

units as liberal arts, arts and sciences, and design."[306] This 'placelessness' "contributed to architecture's great capacity to absorb and respond to extra-disciplinary forces."[307]

Architecture could not also find its proper place in the broad categorization of disciplines,[308] i.e., natural sciences, social sciences and humanities. Even though there are recent attempts to place architecture within the tradition of humanities research,[309] there is not a consensus on which of these cultures that architecture belongs to. Necdet Teymur describes architecture as "an interdisciplinary field that comprises several major components: humanities, social and physical sciences, technology and the creative arts."[310] Jane Rendell introduces four disciplinary approaches to architectural research as "building science, social science, humanities, and art and design since architectural research can operate using different methodologies."[311] However, it should be clarified that the "[d]isputes about the nature, borders, and rationales of academic disciplines" are not specific to

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[306] Julia Williams Robinson. "The Form and Structure of Architectural Knowledge: From Practice to Discipline," Discipline of Architecture. ed. Julia Williams Robinson and Andrzej Piotrowski. Minnesota: University of Minnesota Press, 2001: 62-63.

[307] Sylvia Lavin. "Theory into History; Or, the Will to Anthology," Journal of the Society of Architectural Historians, Vol. 58, No. 3, 1999: 497.

[308] "Nowadays, the humanities can be considered as one of three "cultures" within academia: the sciences, the social sciences, and the humanities. Among these three, the social sciences are the youngest, whereas the humanities house disciplines that were already part of the mediaeval universities." See Jerome Kagan. "Three Cultures: Natural Sciences, Social Sciences, and the Humanities in the 21st Century" Cambridge: Cambridge University Press, 2009.

[309] For example, the foundation of AHRA (Architectural Humanities Research Association) could be considered as an attempt to place architecture among humanities disciplines.

[310] Necdet Teymur. "Architectural Culture and Epistemological Diversity," Architectural Knowledge and Cultural Diversity. ed William O'Reilly, 1999: 156.

[311] Jane Rendell. "Architectural Research and Disciplinarity," Architectural Research Quarterly. Vol. 8, iss.4, 2004: 142.

architecture and has "a history as long as the disciplines themselves."[312] Within this framework, this study suggests that it is necessary to decipher the concept of "disciplinarity" to determine this so-called unstable position of architecture among other disciplines.

3.2 Dissolution of Hierarchies

The positivist outlook[313] presented science as a pure and uncontaminated body of knowledge through the nineteenth century to the middle of the twentieth century, until it was challenged by the postpositivist philosophers of science pioneered by Karl Popper, Thomas Kuhn, and Imre Lakatos. Their common emphasis on the irrational side of scientific progress "leading to the extreme opposite view that disciplines are an unordered product of historical and cultural contingencies."[314]

The notion of 'progress' is inherent in the definition of science. To a great extent, the term science is reserved for fields that progress in obvious ways. This progress is generally identified with the cumulative way of producing knowledge. The expression "Copernican Revolution" was coined by Kant to describe when "a discipline becomes cumulative and "enters the sure path of a science."[315] This traditional cumulative view of science in which disciplines vertically constructing

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[312] Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," Theory, Culture & Society vol. 32, iss. 5-6, 2015: 3.

[313] This positivist outlook imposed two things: first the hierarchical ordering of the sciences and the prominence of the "objective" observation as the only method to produce knowledge. In this understanding, data is independent of knowledge, and pure not contaminated with the added "meaning" or any type of "interpretation".

[314] Fanelli D, Glanzel W (2013) Bibliometric Evidence for a Hierarchy of the Sciences. PLoS ONE 8(6):

[315] Bruno Latour. Science In Action: How to Follow Scientists and Engineers Through Society. Cambridge, Mass: Harvard University Press, 1987: 224.

their knowledge on top of each other was challenged by many philosophers of science in the 1960s and the 1970s. Since being cumulative is the mark of the sciences, the disruption of this idea transformed the whole scientific enterprise. The post-positivist turn in the philosophy of science leads to the disintegration of hierarchy between disciplines and the lateral re-organization of disciplines.

The positivist tradition was sustained by "the cumulative or accretionary view of knowledge on which natural sciences ground themselves."[316] That is why "the physical sciences had been viewed as a paradigm of knowledge, to which the rest of culture had to measure up."[317] As Zeynep Mennan further underlines:

> By denouncing the possibility of recovering the foundations of knowledge, anti-foundationalism also denounces the cumulative or accretionary view of knowledge on which natural sciences ground themselves. Interpretation thus poses a powerful threat to the grounds on which natural sciences establish themselves, specifically to the positivistic modes of inquiry. […] A series of dissolutions are then set forth: the dissolution of the distinction between subject and object; the dissolution of the disciplinary boundaries; and the dissolution of the dichotomy between the natural and the social sciences.[318]

3.2.1 Configuration of the Field of Knowledge

The current structure of knowledge, the modern 'disciplines,' as we know them today, came into being only with the breakup of natural philosophy into independent

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[316] Zeynep Mennan. "Theory on Borderlines: A Collective Experience and a Free Market." In: B. Adkins, D. Bennato et.al. eds. Shifting Borders, Negociating Places: Cultural Studies and the Mutation of Value(s). Rome: Bordighera Press: 80.

[317] Richard Rorty. Philosophy and the Mirror of Nature. Princeton: Princeton University Press, 1979: 322.

[318] Zeynep Mennan. "Theory on Borderlines: A Collective Experience and a Free Market." Rome: Bordighera Press: 80.

natural sciences at the end of the eighteenth century."[319] Before the disciplinary divisions are constructed, the first division is made between philosophy and science. As a result of this, the modern university– with its departmental structure in which each department asserting that it is the locus of a particular discipline– was born, and the faculty of philosophy is divided into "sciences" and "humanities."[320]

As Richard Rorty points out, "the eventual demarcation of philosophy from science was made possible by the notion that philosophy's core was 'theory of knowledge,' a theory distinct from the sciences because it was their foundation."[321] Rorty further claims that it was Kant, who "managed to transform the old notion of philosophy-metaphysics as 'queen of the sciences' because it was concerned with what was most universal and least material- into the notion of a 'most basic' discipline- a foundational discipline."[322] Philosophy became "primary" no longer in the sense of "highest" but in the sense of "underlying."[323] Luciano Floridi explains this shift from metaphysics to epistemology, resulting from the scientific revolution that "made seventeenth-century philosophers redirect their attention from the nature of the

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[319] David R. Shumway and Ellen Messer-Davidow. "Disciplinarity: An Introduction," Poetics Today, Vol. 12, No. 2, 1991: 203.

[320] Immanuel Wallerstein. "Historical Origins of World-Systems Analysis: From Social Science Disciplines to Historical Social Sciences," World Systems Analysis: An İntroduction. Durham and London: Duke University Press, 2004: 2.

[321] Richard Rorty. Philosophy and the Mirror of Nature. Princeton, New Jersey: Princeton University Press, 1979: 132.

[322]

[323] Ibid.

knowable object to the epistemic relation between it and the knowing subject, and hence from metaphysics to epistemology."[324]

The separation of philosophy and science defined a hierarchical order between these two, and philosophy assumed a foundational role on which the knowledge of all other disciplines was built. With the proliferation of the new fields, it was required to describe a relationship according to this hierarchical order. In a similar manner with Rorty, Zeynep Mennan states that "both the pyramid of metaphysics and the pyramid of positivism, tapers toward theory, though through different forms of justification and construction."[325] In both of these configurations, it is rather obvious that the philosophy successfully stands apart from other disciplines by maintaining a particular position. As Mennan further states:

> […] in its attempts to displace speculative metaphysics, positivism restores a new metaphysics, a single scientific tradition, disclosed in the faith that nothing remains hidden to logical reason. Positivism falls into metaphysics; in other words it restores the pyramid it projects to dislocate. The pyramidal representation is perpetuated either in the form of a universal, a-historical, foundational philosophical knowledge {the metaphysical tradition), or in the form of a scientism idealizing natural science (the positivist tradition), […] As far as a common ground can be identified, uniting adherents under a common, transcendentalized ideal, the foundationalist representation is left intact, as well as the building of a metaphysics. [326]

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[324] "The subsequent growth of the information society and the appearance of the infosphere, the semantic environment in which millions of people spend their time nowadays, have led contemporary philosophy to privilege critical reflection first on the domain represented by the memory and languages of organised knowledge, the instruments whereby the infosphere is managed - thus moving from epistemology to philosophy of language and logic (Dummett 1993) - and then on the nature of its very fabric and essence, information itself." See Luciano Floridi. "What is the Philosophy of Information?" Metaphilosophy. vol. 33, no. 1/2, 2002: 140-141.

[325] Zeynep. Mennan. "An Interpretive framework for understanding architectural theory's self-representation," Unpublished Phd Dissertation. Ankara: METU, 1997: 92.

[326] Ibid., 64.

3.3 Dissolution of Disciplinary Borders: The Cross-Disciplinary Terminology

The main change in the nexus of disciplines since the 1970s has been the proliferation of interest and proposals for multidisciplinarity, interdisciplinarity, and transdisciplinarity of various kinds.[327] The discourse of disciplines has become "increasingly and successively differentiated and theoretically reflexive, with the introduction not only of the concept of transdisciplinarity but also of anti-disciplinarity, indisciplines, antidisciplines, postdisciplines, and de-disciplinarization."[328] "However, the three most widely used terms 'multidisciplinarity', 'interdisciplinarity,' and 'transdisciplinarity' constitute a core vocabulary for understanding "both the genus of interdisciplinarity and individual species within the general classification."[329]

The first major interdisciplinary typology[330] was compiled in the publication of an international conference which was held in 1970 in Nice, France.[331] Multidisciplinarity, interdisciplinarity, and transdisciplinarity,[332] are brought and

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[327] Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," Theory, Culture & Society vol. 32, iss. 5-6, 2015: 4-5.

[328] Ibid.

[329] Julie Thompson Klein. "A Taxonomy of Interdisciplinarity," Oxford Handbook of Interdisciplinarity. Oxford: Oxford University Press, 2010: 15.

[330] In fact, there were four terms in the publication, but pluri-disciplinarity did not gain recognition as the other three terms so it was discarded from the terminology.

[331] The conference was co-sponsored by Organization for the Economic Co-operation and Development (OECD). That is why it is sometimes referred to as OECD conference or OECD terminology in the literature. Julie Thompson Klein. "A Taxonomy of Interdisciplinarity," Oxford Handbook of Interdisciplinarity. Oxford: Oxford University Press, 2010: 15.

[332] Interdisciplinarity is considered both as an umbrella term referring to all kinds of relationships between disciplines; and also, as one of the relationship types along with multidisciplinarity and transdisciplinarity.

discussed together in that publication, and it has become a seminal point of reference since then.[333] Even though they are usually used interchangeably today, they refer to different kinds and levels of collaboration or relationship among two or more disciplines. It is important to note that this terminology is not naturally developed but rather constructed; thus, it acts "as a "terministic screen" that filters, directs, and redirects attention along some paths rather than others."[334] It could be claimed that this trilogy, then, is not a reflection of reality; but a selection and a deflection.[335]

All of these three terms are formed with an addition of a prefix to the term "disciplinarity": multi-, inter-, and trans-. The ambiguity of the term 'discipline,' as discussed above, also reflects on the definitions of these terms. In addition to that, the prefixes of each of these terms signify the differences between them as each prefix connotes different notions. In addition to the etymological roots of these prefixes, a table compiled by Julie Thompson Klein associates different keywords for each of these terms helps one characterize their distinctive features (Figure 4).

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[333] In the literature, there are different configurations of the interdisciplinary relations. Heckhausen identifies six types of interdisciplinarity as indiscriminate, pseudo-, auxiliary, composite, supplementary and unifying. Boisot, on the other hand, provides another trilogy as linear, structural, and restrictive interdisciplinarity. Kelly distinguishes between narrow and wide interdisciplinarity. This trilogy presented here, then, is not the ultimate or only categorization that we have up to this day; however, they offer a core understanding of the relationships between disciplines. See James Kelly. "Wide and Narrow Interdisciplinarity," The Journal of Education. vol.45 iss.2, 1996: 95- 113, Heinz Heckhausen, "Discipline and Iinterdisciplinarity," Interdisciplinarity: Problems of Teaching and Research in Universities. Paris: OECD, 1972: 83-89, Marcel Boisot. "Discipline and Iinterdisciplinarity," Interdisciplinarity: Problems of Teaching and Research in Universities. Paris: OECD, 1972: 89-97.

[334] Kenneth Burke. Language as Symbolic Action: Essays on Life, Literature, and Method. Berkeley: University of California Press, 1966: 45-46 as cited in Julie Thompson Klein. "Forging Theory, Practice, and Institutional Presence," Humanities, Culture, and Interdisciplinarity New York: State University of New York Press, 2005: 55.

[335] Ibid.

MULTIDISCIPLINARITY	INTERDISCIPLINARITY	TRANSDISCIPLINARITY
juxtaposing	integrating	transcending
sequencing	interacting	transgressing
coordinating	linking	transforming
	focusing	
	blending	

Figure 4. Defining characteristics in typologies of cross-disciplinarity[336] (redrawn by the author)

The prefix 'multi-' is the most evident one, which has its roots in Latin *multus* meaning 'much, many'. Multidisciplinarity specifically includes the juxtaposition of two or more disciplines, fostering "wider knowledge, information, and methods."[337] Yet, while producing a multidisciplinary work, disciplines involved in the knowledge production remain separate and retain their original identity and the existing structure.

'Inter' is an ambiguous prefix, when compared to multi-, as Geoffrey Bennington points out, it can both mean "forming a communication between and joining together, as in 'international' and 'intercourse,' and separating and keeping apart, as in 'interval' and 'intercalate.'"[338] As Joe Moran suggests, the ambiguity of the term is partly why the other terms such as 'post-disciplinary', 'anti-disciplinary,' and 'trans-disciplinary' have emerged in the first place.[339] In different definitions of the

[336] Julie Thompson Klein. "A Taxonomy of Interdisciplinarity," Oxford Handbook of Interdisciplinarity. Oxford: Oxford University Press, 2010: 16.

[337] Ibid., 17.

[338] Geoffrey Bennington "Inter," Post-Theory: New Directions in Criticism. Martin McQuillan, Graeme MacDonald, Robin Purves and Stephen Thomson eds., Edinburgh: Edinburgh University Press, 1999: 104.

[339] Joe Moran. "Introduction," Interdisciplinarity. London and New York: Routledge, 2002: 15.

term "interdisciplinarity," the emphasis is usually given to the concept of "integration." It is suggested that interdisciplinary studies draw on disciplinary perspectives and integrate their insights through constructing a more comprehensive perspective. According to this definition, there is a need for a disciplinary base to accomplish interdisciplinarity; however, some authors argue that interdisciplinarity "can also mean establishing a kind of undisciplined space in the interstices between disciplines, or even attempting to transcend disciplinary boundaries altogether."[340]

Derived from the Latin preposition '*trans*' meaning "across, to or on the farther side of, beyond, over,"[341] the term "transdisciplinarity" connotes "going across and through the disciplines, and beyond each individual discipline."[342] Such an approach naturally questions the fundamental assumptions behind the segmentation of knowledge into disciplines. As Jane Rendell asserts, "if interdisciplinarity is concerned with working in places between disciplines in order to question their edges and borders, the term transdisciplinarity is more often described as a horizontal movement, concerned with moving across disciplines, transversally."[343]

There is not only one type of transdisciplinarity, but rather we can recognize two main approaches. The first one "problem-solving" approach, which is mainly associated with the natural science disciplines that are "characterized by the refusal of formulating any methodology and by its exclusive concentration on joint problem

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340 Ibid.

341 Jane Rendell. "Architectural Research and Disciplinarity," Architectural Research Quarterly. Vol. 8, iss.4, 2004: 141.

342 David Alvargonzález. "Multidisciplinarity, Interdisciplinarity, Transdisciplinarity, and The Sciences," International Studies in the Philosophy of Science vol.25, iss.4, 2011: 388 as cited in Jay H. Bernstein "Disciplinarity and Trandisciplinarity in the Study of Knowledge," Informing Science, vol.17, 2014: 251.

343 Jane Rendell." Working Between and Across: Some Psychic Dimensions of Architecture's Inter- and Transdisciplinarity," Architecture and Culture. vol.1, iss.1, 2013: 130.

solving of problems pertaining to the science-technology–society triad."[344] This approach is presented by the book entitled "The New Production Of Knowledge," which was published in 1994.[345] As stated by Hessels and van Lente, the basic argument in the book is "while knowledge production used to be located primarily in scientific institutions and structured by scientific disciplines, its locations, practices, and principles are now much more heterogeneous."[346] This new mode of knowledge production is called the Mode 2 knowledge, and it is in contrast with traditional modes of knowledge production since it is "produced 'in the context of application' by so-called transdisciplinary collaborations."[347] Peter Osborne criticizes the claim of this book by stating that "the reduction of transdisciplinarity to 'fuzziness' of disciplinary boundaries is a serious intellectual collapse."[348] Osborne further continues:

> […] no account is taken here [in "The New Production of Knowledge"] of the fundamental transformations in the anglophone humanities since the 1970s; of their theoretical and purportedly 'scientific' nature; or of their sources in French and German philosophy and critical theory. Yet it is precisely these developments that introduced radical forms of transdisciplinary conceptual functioning into the humanities.[349]

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344 Basarab Nicolescu. "Methodology of Transdisciplinarity," World Futures. vol.70, iss. 3-4, 2014: 187.

345 Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott and Martin Trow. The New Production of Knowledge. SAGE Publications, 1994.

346 Laurens K. Hessels and Harro van Lente. "Re-thinking new knowledge production: A literature review and a research agenda". Research Policy. Vol.37, iss.4, 2008: 740.

347 Ibid.

348 Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," Theory, Culture & Society vol. 32, iss. 5-6, 2015: 15.

349 Ibid.

This type of transdisciplinarity, which Osborne refers to, is the second type, and it is mainly associated with the disciplines in the humanities and the social sciences. What Osborne defines as "the fundamental transformations in the anglophone humanities" is, for Joe Moran, a moment of 'theory,' which emerged from a reconfiguration of the humanities disciplines from the late 1960s onwards, and which "brought together diverse intellectual movements with at least one thing in common: their critical relationship to the traditional disciplines."[350] Theory, within this context, is not to be understood as in the 'scientific theory' which aims to advance knowledge within its particular discipline in an ordered, systematic way by proposing a law about the natural world which can then be empirically verified. On the contrary, theory means almost the exact opposite of what it means in the sciences.[351] Theory within the humanities disciplines, as Moran claims, is the questioning of interpretations of the world that are usually taken for granted.[352] Theory allows us to speculate about the "purpose, limits and ultimate worth" of disciplines, which are similar forms of common sense within the academia, and thus is "inherently interdisciplinary."[353]

Among these three types of relations between disciplines discussed above, transdisciplinarity seems to be the one that has gained more attention than the other two in recent years.[354] Different configurations of the term "transdisciplinarity" in

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[350] Joe Moran. "Theory and the Disciplines," Interdisciplinarity. London and New York: Routledge, 2002: 82.

[351] Ibid.

[352] Ibid.

[353] Ibid., 83.

[354] "In the decade since its launch, the 'Mode 2' concept has gained an enormous visibility in the reflection on contemporary scientific practice. The notion of 'Mode 2' is referred to in over 1000 scientific articles and seems to have influenced science, technology and innovation policies." Laurens K. Hessels and Harrovan Lente. "Re-thinking new knowledge production: A literature review and a research agenda". Research Policy. Vol.37, iss.4, 2008:741.

the broad categories of humanities and natural sciences[355] make it a more contested one than the other two. While the general tendency in architecture is to use these three terms interchangeably, few architectural scholars start to notice their differences. For instance, Mark Linder favors transdisciplinarity in the place of either disciplinarity or interdisciplinarity based on the claim that it is "a less sanguine and more overtly theoretical concept"[356] than the other two. On the other hand, Jane Rendell values inter- and trans- disciplinarity equally since "the imperative to critique disciplinary procedures remains a shared objective"[357] for both of them. This study does not aim to emphasize or prioritize any of these terms; moreover, the intention is to only provide a brief review of the scholarly literature on these terms.

3.3.1 Deterritorialization of Data

The general approach in describing knowledge production processes and typologies is based on the concept of "discipline," which is visible in terms such as anti-, omni-, multi-, inter-, and trans-disciplinarity; their meanings are all relative to the definition of the concept of 'discipline.' However, the term "discipline-less" is quite different in its essence from this disciplinary vocabulary. Even "anti-disciplinarity"

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[355] As Peter Osborne claims, "disciplinary structures play a relatively minor role in fundamental research in the natural sciences, where the general concept of 'science' and the pursuit of specific problems play the main role, often generating new disciplines." And when this generality of the concept of science transposed into the context of the humanities and social studies, it poses new problems for disciplinarity, opening up new ways for cross disciplinary knowledge production. See Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," Theory, Culture & Society vol. 32, iss. 5-6, 2015: 7.

[356] Mark Linder. "TRANSdisciplinarity," Hunch: The Berlage Institute Report. no.9, 2005: 12-15

[357] Jane Rendell. "Working Between and Across: Some Psychic Dimensions of Architecture's Inter- and Transdisciplinarity," Architecture and Culture. vol.1, iss.1, 2013: 134-135.

is included in this terminology since -anti as a prefix means "of the same kind but situated opposite." -less as a suffix, on the other hand, means "without."[358]

As Karin Knorr-Cetina claims, the notion of discipline and its cognates and the other differentiating terms used in the past were not designed to make visible the complex texture of knowledge as practiced in the spaces of modern institutions.[359] The term discipline is defined as a list of its constitutive elements, such as theory, method, tools, concepts, etc. Accordingly, the "secondary" terminology derived from the term 'discipline' must also adhere to this convention of defining itself through those units. However, when the process of knowledge production is considered without any 'disciplinary' constraints, the main elements of this process, which are data information and knowledge, should be analyzed.

The availability of diverse data and new data analytics are disruptive innovations that reconfigure how research is conducted today as they pave the way for collaboration between different domains of knowledge. Without a disciplinary base, a researcher could initiate a project by "exploring, extracting value and making sense of massive, interconnected data sets"[360] from multiple domains. This is not to argue or to contrast between knowledge-driven and data-driven science;[361] however, this study identifies a shift from knowledge to data as the unit of exchange between different domains.

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[358] The definitions are from the Merriam-Webster Dictionary.

[359] Karin Knorr-Cetina. "Introduction," Epistemic Cultures: How the Sciences Make Knowledge. Cambridge: Harvard University Press, 1999: 2.

[360] Ibid.

[361] "Knowledge-driven science, using a straight deductive approach, has particular utility in understanding and explaining the world under the conditions of scarce data and weak computation. […] the advocates of data-driven science argue that it is much more suited to exploring, extracting value and making sense of massive, interconnected data sets, fostering interdisciplinary research…" see Rob Kitchin. "Big Data, New Epistemologies and Paradigm Shifts," Big Data & Society vol.1, iss.1, 2014: 6-7.

CHAPTER 4

A FRAMEWORK FOR THE LABORATORIES IN THE SCHOOLS OF ARCHITECTURE

The epistemological crisis revolutionizes the institutional infrastructure of architecture. This state of crisis is a continuation of the perennial discussions regarding architecture's disciplinarity, yet it is argued here that there is a crucial difference. The shift in the institutional infrastructure of architecture resulted from questioning the very concept of discipline and the legitimacy of the concept to conceptualize the current processes of knowledge production.

The depiction of the whole field of knowledge is indispensable from one's characterization of the 'meaningful unit' of science as a discipline, specialty, disciplinary matrix, or a research programme since there are no canonical analytical definitions of specialty or discipline; they are all loose groupings of scientists mainly differentiated according to their scopes.[362] Specialty is a relatively small and fluid unit compared to disciplines that are more stable and more often institutionalized in the structure of universities and formal professional societies.[363] While most studies take 'discipline' as their unit of analysis, some argue that the "specialties might be more promising than disciplines."[364] Imre Lakatos offers a different terminology by specifying that "the unit of mature science is a research programme,"[365] similarly,

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[362] Harriet Zuckerman (1988) "The Sociology of Science," Handbook of Sociology. ed. Neil J. Smelser. Newbury Park, CA: Sage, 1988: 561.

[363] Ibid.

[364] Ibid.

[365] Newton's theory of gravitation, Einstein's relativity theory, quantum mechanics, Marxism, Freudianism, are all research programmes, according to Lakatos.

"Kuhn shifted his attention to 'disciplinary matrices,' smaller units than the disciplines he originally believed were carriers of paradigms."[366]

The need for a change in the unit of analysis proposed by this study is related to the exponential growth of knowledge, which causes the expansion of the frontiers of fields that creates new gaps between them and the emergence of previously inconceivable fields. In that respect, disciplinary studies must always respect the historical continuities and discontinuities since, as Kuhn argues, what is considered as the content of a single discipline today might have been distributed over a number of disciplines in the past.[367] Therefore, rather than focusing on a content-specific distribution of knowledge, such as the disciplinary one, and trying to understand the elusive and shifting boundaries of the architectural discipline and its relations with other disciplines, this study aims to decipher the current institutional setting of the field through laboratories. The objective is to decipher the working mechanisms of these laboratories to decipher how they, with their actions and practices, define and transform the field of architecture.

As also observed by Joan Ockman, the recent shift in most architecture institutions is the proliferation of 'research laboratories,' which are "the marquee items in curricular programs."[368] Ockman's argument is based on the claim that the current focus on research replaces the previous dominance of the history/theory conjunction, which appears idiosyncratic to architecture since the late 1960s or early 70s. By defining research as a "methodology rooted in science," she distinguishes the

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[366] Harriet Zuckerman (1988) "The Sociology of Science,"in Neil J. Smelser (ed.) Handbook of Sociology. Newbury Park, CA: Sage, 1988: 562.

[367] Thomas Kuhn. "Postscript—1969" in The Structure of Scientific Revolutions. Chicago: The University of Chicago Press, 1970: 179.

[368] Joan Ockman. "Slashed," e-flux Architecture. <https://www.e-flux.com/architecture/history-theory/159236/slashed/> (last accessed on 06.12.2021)

activities of research and "theoretical and critical inquiry."[369] This contrast presupposes a differentiation between "hard and soft sciences," even though Ockman declares that "research is a method applicable to work in both," she underlines that the skillset required for them differs. Although this study denies the existence of such opposition, it also argues that this duality is extended to the interrelation between the production of architectural artifacts and the production of architectural knowledge. Most of the dilemmas inherent in the discussions of the disciplinarity of architecture are rooted in this so-called distinction, which stems from the widely held view that "the act of designing itself is not and will not ever be a scientific activity."[370]

In some significant attempts to overcome this duality, the strategy was mainly to approximate the designer's activity to that of the scientist. Therefore, the focus has shifted from discipline to "research" or, more generally, the practices of knowledge production itself in those works. Since research could be characterized more analytically than that of discipline, an analytic construction has been achieved by Christopher Frayling's trilogy of research about, into, through design and in Nigel Cross's conceptualization of "designerly ways of knowing." Christopher Frayling implicitly refers to the 'context of discovery' and 'context of justification' distinction in science; and claims that "doing science" is much more like "doing design" as opposed to "post-rationalising about science."[371] In the article "Designerly Ways of Knowing," Nigel Cross handles this issue by attempting to clarify the design and science relationship and presents three different interpretations: 'scientific design,'

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[369] Ibid.

[370] Nigel Cross. "Designerly Ways of Knowing: Design Discipline Versus Design Science," Design Issues, vol. 17, n. 3, 2001: 49-55.

[371] Christopher Frayling. "Research in Art and Design," Royal College of Art Research Papers, vol.1, no1, 1993: 4.

‘design science,’ and ‘a science of design.’[372] He claims that while some of design knowledge is “inherent in the activity of designing,” some is “inherent in the artifacts of the artificial world,” and “in the processes of manufacturing the artifacts.”[373]

Here the laboratory is argued to be the institution potent with providing architecture a milieu to produce knowledge without trapping itself to this dualism. Even though a comprehensive history of the laboratory concept has not been provided yet, the existing literature suggests that it has the capacity to enable the coexistence of different kinds of labor (manual and intellectual) and diverse knowledge production practices (textual and material). The practices that take place in the laboratory to produce knowledge are not already far away from architectural knowledge production. While laboratory practices[374] are generally defined as more ‘systematic’ than the practices of knowledge production in architecture, the plurality of these practices embedded in the history of the laboratory, which will be disclosed below, shows that it is well suited for the field of architecture.

4.1 Reframing the Laboratory: A Conceptual Account

The laboratory is too multiform as a concept that, as Peter Galison contends, it is not possible to offer a transtemporal, transcultural definition of the term that would include all the spaces that are called “laboratory.”[375] “The institution has diversified

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[372] Nigel Cross. “Designerly Ways of Knowing: Design Discipline Versus Design Science,” Design Issues, vol. 17, n. 3, 2001: 49-55.

[373] Ibid., 54-55.

[374] Such as finding, collecting, organizing, documenting, categorizing, cataloging, analyzing, editing of knowledge.

[375] Peter Galison. “Buildings and the Subject of Science,” The Architecture of Science. eds. Peter Galison and Emily Thompson. Cambridge, Mass.: MIT Press, 1999: 2. As Galison lists, ‘the laboratory’ includes “all spaces from the alchemist’s secretive basement array of furnaces through the clinical research hospital to the $10 billion Large Hadron Collider outside Geneva.”

into many distinct kinds for that, and it has changed fundamentally in the past four hundred years."[376] As one of the most fundamental institutions of science, the laboratory concept is flexible enough to include too many different types within.

The laboratory is too multiform as a concept that, as Peter Galison contends, it is not possible to offer a transtemporal, transcultural definition of the term that would include all the spaces that are called "laboratory."[377] "The institution has diversified into too many distinct kinds for that, and it has changed too fundamentally in the past four hundred years."[378] The meaning of the term 'laboratory' is extended to include too many different types within. As one of the most fundamental institutions of science, the laboratory concept is flexible enough to include too many different types within.

To propose a definition that is inclusive to all virtual or physical spaces that are called as 'laboratory' is not possible. When laboratories first originated in the course of the sixteenth century, they were exclusively considered as the sites of alchemy. Therefore, it is no surprise that "one of the original meanings of the word 'laboratory' was a place where things were artificially produced or 'elaborated' from material resources."[379] Both historically and currently, the term is used to denote many different kinds of places; however, its main focus on the activity of 'production,' 'invention,' and 'innovation' specifically remains the same.

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[376] Robert E. Kohler. "Lab History: Reflections," Isis Vol. 99, No. 4, 2008: 764.

[377] Peter Galison. "Buildings and the Subject of Science," The Architecture of Science. eds. Peter Galison and Emily Thompson. Cambridge, Mass.: MIT Press, 1999: 2. As Galison lists, 'the laboratory' includes "all spaces from the alchemist's secretive basement array of furnaces through the clinical research hospital to the $10 billion Large Hadron Collider outside Geneva."

[378] Robert E. Kohler. "Lab History: Reflections," Isis Vol. 99, No. 4, 2008: 764.

[379] Graeme Gooday. "Placing or Replacing the Laboratory in the History of Science?" Isis, Vol. 99, No. 4, 2008: 792.

Henning Schmigden considers laboratories like a "metropolis in miniature," as they enable "combinations and confrontations of human and machine, body and technology, organisms and instruments occurred."[380] Laboratory space is also regarded as the site combining science, engineering, and technology. It is this amalgam of different notions that supports the co-existence of different kinds of laboratories. Even when laboratories were institutionalized into the academies and scientific societies, they still continued to be developed "in areas of commercial production and technological innovation."[381]

The current proliferation of laboratories and their ways of operating or inner working mechanisms must be considered within the specific context that we are in. Moreover, the laboratories that this study focuses on bear little resemblance to the traditional image of table-top experiments in an enclosed space[382] because of the transformations caused by the process of digitalization. Having said that, an analysis of the historical precedents of such spaces is essential in deciphering the diversity of conceptualizations in the definitions of laboratory and also to trace the continuities and disruptions of the concept throughout the ages.

The laboratory is separated from the other sites of knowledge production in their spatial design that aims to "segregate out potential contaminants" to become a "placeless space."[383] However, the laboratory is a far more complex phenomenon than its conceptualization as dispersible placeless spaces that are artificially contrived. The linguistic peculiarity of the term itself, which is derived from the

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[380] Henning Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021 <https://lps.library.cmu.edu/ETHOS/article/id/450/> (last accessed on 06.12.2021)

[381] Ursula Klein. "The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation." Isis 99, no. 4, 2008: 782.

[382] Schmidgen, "Laboratory," Encyclopedia of the History of Science. 2021.

[383] Thomas F. Gieryn. "City as Truth-Spot: Laboratories and Field-Sites in Urban Studies," Social Studies of Science. vol. 36, no. 1, 2006: 5-6.

Latin word *laborare*, meant any kind of manual work, including commercial labor, is at odds with our present understanding of "laboratories" as places of scientific teaching and research, academic or industrial, and as the privileged sites of experimentation in many different disciplines.

When the laboratory is framed as a place for experimentation, this experimental aspect should not be seen as just an empirical research method. While in the positivistic outlook, science is primarily understood as a theoretical activity in which hypotheses were first constructed then tested via experiments, post-positivism brings a reversal in this order, as Rheinberger indicates, "science is first and foremost a practical activity, although a theoretically laden one." In this study, the laboratory is not regarded as the mere space of experimentation; however, that does not signify a complete ignorance of the experimental quality of the laboratory. "Experimental" is understood here as the combination of different instruments, techniques, and knowledge to induce an innovative knowledge production rather than as mere means for checking theory. Rheinberger describes the experimental systems as "very ingenious constructions" to "capture otherwise inconceivable things" or, in other words, as "places of emergence."[384] He further defines two aspects of the experimental spirit as "materiality" and "practice-orientedness."

> If one is not immersed in, even overwhelmed by, the material, there is no creative experimentation. In the course of the interaction with the material with which one works in an experiment, the material itself somehow comes alive. […] The second aspect is related, and it has to do with the focus on science as practice, as compared with the focus on science as a theoretical system.[385]

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[384] Hans-Jörg Rheinberger. "Experiment, Research, Art" Translated transcript of the Jahreskonferenz der Dramaturgischen Gesellschaft. The Journal for Research Cultures. Iss.1 <https://rc.riat.at/issues/1/experiment-research-art.html> (accessed 10.01.2022)

[385] Hans-Jörg Rheinberger. "Forming and Being Informed: Hans-Jörg Rheinberger in conversation with Michael Schwab" ed. Michael Schwab. Experimental Systems: Future Knowledge in Artistic Research. Leuven: Leuven University Press, 2013: 199.

In his first book, "How Experiments End," which was published in 1987, Peter Galison was committed to introducing experiment as "another way of knowing," rather than "as a means for checking theory," which is reflected in his view of science "as composed of different communities of knowledge-making."[386] While some of the subcultures of science engage with instrument-making, some deal with experimental laboratory work, and some with the practices of theorizing. "And the interaction between them was central to how knowledge was put together."[387]

Laboratories were originally designed to create a distance between the researcher and the researched "by means of mechanization of display, observation, intervention, and inscription."[388] That is why the recent proliferation of the laboratories in domains that are not usually associated with the concept of the laboratory is seen related with the efforts to 'scientize' those fields; however, it is argued here that it is the quality of being 'placeless,' made laboratories 'dispersible' geographically and across domains. 'Placelessness' gives laboratories an opportunity to be a significant part of this emerging radically dispersed knowledge production inside and outside universities.

4.1.1 A definition of Laboratory in the Field of Architecture

> "Laboratory" becomes an operative term. It does not simply signify, but operates in various institutional ways, in different conceptual contexts, and across historical periods to denote and connote what a lab should be, what a lab must be, and what a lab might be. The lab, as a term, is an operational organization of space as much as the references, histories, and uses that include and exclude based on preference. Parts of this discourse are normative and

[386] Peter Galison, "Interview with Peter Galison: On Method," int. Winifred Elysse Newman. Technology|Architecture + Design, vol.5: iss.1, 2021: 5-6.

[387] Ibid., 6.

[388] Thomas F. Gieryn. "City as Truth-Spot: Laboratories and Field-Sites in Urban Studies." Social Studies of Science vol. 36, no. 1, 2006: 6.

> regulatory, parts negotiated, and parts contestatory or oppositional. Every time the word "lab" is applied to a new kind of hybrid space, the entire network jostles around in an attempt to accommodate or reject this new usage.[389]

The above quotation, which reflects the difficulty of providing a definition of the term laboratory, is taken from the "Lab Book." In that book, the authors propose "the extended lab model"[390] as a "checklist of aspects," which could be used as a heuristic to investigate the various places which call themselves "laboratory."[391] As the model suggests, a place could be identified as a laboratory according to its "spatial" configuration, material setting, or its deployment of specific techniques. Also, what makes a place into a laboratory could be deciphered through an investigation of how these spaces and practices are articulated by particular institutions that authorize them or through an understanding of people who are both the producers and products of these laboratories, and lastly by looking into how these places sustain various cultural mythologies of the laboratory life. Despite the authors' claim that it could be used to investigate any sort of laboratory, this study aims to provide a definition that is specific to the architecture.[392] This checklist presents a decent model to construct a generalizable definition of the laboratory in the field of architecture.

Providing a definition of laboratory within the field of architecture is even more challenging since architectural practice is itself "now a laboratory."[393] This claim

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389 Darren Wershler, Lori Emerson, and Jussi Parikka. The Lab Book: Situated Practices in Media Studies. University of Minnesota Press Open-Access Library, 2021 <https://manifold.umn.edu/projects/the-lab-book> (last accessed on 10.11.2021)

390 The space, apparatus, infrastructure, people, imaginary, and techniques comprise that checklist.

391 Ibid.

392 Since the focus of this book is particularly on the "media labs", this checklist of laboratory cannot be transferred without any alterations into this study.

393 Helene Furján. "Design/Research: Notes on a Manifesto," Journal of Architectural Education. vol. 61, no. 1, 2007: 64.

belongs to Helene Furján, who, in her article aiming to decipher design and research relationship within the context of architecture, defines the laboratory as "process-oriented and operational" and associates it with traits such as "group-oriented," "open-source," "networked," "hybrid," and "experimental."[394] As Furján argues, the experimental process in the laboratory which brings unpredictable results "is in part the production of disorder (the noise of accumulated data, records of events, and traces of inscription) and in part the process of sorting, evaluation, and pattern finding within that disorder."[395] It is this simultaneous combination of ordered and disordered practices that makes laboratory "a respected location of research in academia" aiming at innovation which is also fitting well within the university's physical and political structure. The laboratory concept is also plausible for architecture since the usual place for architectural experimentation, the studio, was not incorporated into the structure of the university very easily. Although being very similar to each other in a substantial manner, compared to the design studio, whose legitimacy as a place of knowledge production is still not provided, the laboratory is a place where architecture does not have to justify it as a place of knowledge production and yet incorporated it in a university setting.

The epistemological crisis defined at the beginning of this study in a tripartite manner as the change in the method, change in the medium, and change in the amount and nature of data is an outcome of an analysis of the whole field of knowledge. Before shifting the scale of this analysis to the field of architecture itself, it should be reminded that the terms that have been continuously referred to in this study, such as

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[394] Ibid.

[395] Ibid.

data, information, network, have an "architecture" of their own[396] which mainly refer to the operational principles and procedures of these generally intangible entities. Therefore, the incorporation of these terms into architecture or their interpretation within the field of architecture could generate some intricacies, which in the first place, make its disciplinarity problematic. In other words, while architecture gains its legitimacy by defining the figure of the architect as a person who produces drawings and not objects, and this renunciation of the material production to manual laborer provided architecture an authority, on the other hand, its materiality is continued to be used as a metaphorical tool to describe many intangible concepts at different scales, including the knowledge production practices. As Mark Wigley asserts, "the figure of architecture is used to exclude architecture from the academy."[397] In fact, many of the intricacies of architecture that Wigley writes about in most of his articles are related to this material and conceptual duality. As he states:

> The figure of the architect was constructed in the sixteenth century when Alberti and his colleagues argued that the designer is a thinker rather than a worker, producing drawings rather than objects. The institutional magic of the drawing is precisely that it is almost nothing, the lightest of traces on the lightest of materials. The permeable membrane of the paper being as little material as possible so that it could catch immaterial ideas, bringing their shadow out of the invisible world of abstract thought and into the visible, material world.[398]

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[396] "Data architecture" is the models, policies, rules, and standards that govern which data is collected and how it is stored, arranged, integrated, and put to use in data systems and in organizations. "Information architecture" is the structural design of shared information environments. "Network architecture" is the design of a computer network. It is a framework for the specification of a network's physical components and their functional organization and configuration, its operational principles and procedures, as well as communication protocols used.

[397] Mark Wigley. "Prosthetic Theory: The Disciplining of Architecture," Assemblage, No. 15, 1991: 11.

[398] Ibid.

This study proposes that "laboratory" is recently employed in the field of architecture to overcome most of these dualities, if not all. By framing laboratory as a place for "invention," "relations," and "scalar distortion," this study aims to illustrate how "laboratory" should replace the term "discipline" as the most basic unit of analysis in the field of architecture.

4.1.2 A Place for "Invention"

Architecture could never satisfy the requirements to be defined as a "proper" discipline; however, in the current knowledge production context, the urge for innovation replaces the puzzle-solving or problem-solving practices under an established paradigm within a discipline. In the field of architecture, as Michael Speaks claims, while the vanguard practices of the twentieth century relied on ideas, theories, and concepts given in advance and worked within an epistemologically stable paradigm, the post vanguard practices of the twenty-first-century innovate by learning from and adapting to instability enabled by their "unique design intelligence."[399] Speaks cites management thinker Peter Drucker's distinction between problem-solving and innovation: while the former "simply accepts the parameters of a problem given," the latter "works by a different, more entrepreneurial logic whereby rigorous analysis leads to the discovery of opportunities that can be exploited and transformed into innovation."[400] This contemporary culture of innovation in schools of architecture "requires a more fluid, interactive relationship between thinking and doing, as well as an expanded definition of what counts for architectural knowledge."[401]

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[399] Michael Speaks. "Intelligence after Theory," Perspecta.vol. 38, 2006: 103.

[400] Ibid.

[401] Ibid.

4.1.3 A Place for "Relations"

In his reading of "images of the network world"[402] produced by architects mainly in the 1950s and 1960s, Wigley argues that these architects were, in fact producing "images of their own modes of operation" or their ways of thinking. In particular, "the idea of university" diagram designed by Candilis and Woods for the Berlin Free University project in 1964 that shows "a network of overlapping dotted lines mixing different forms of "special information" to produce "general information" is "all too familiar to architects" since it was built into the architectural discipline from the start when Vitruvius insisted that the unique characteristic of the architect is the need to be familiar with all the other specialized areas of knowledge.[403] Architecture is seen to lie at the intersection of ideas. Wigley further elaborates on the networked character of architecture:

> The architect is seen as a form of synthetic intelligence. Design is understood as a form of thinking, and the space of the architect's studio is a space of pure thinking. This approach organizes architectural education, with each design studio seen as a group of people networked together in a complex pattern to address a complex problem. These studios are in turn networked together to form schools that are networked to each other in numerous ways to form an international web for architectural thinking that is interlaced with that of the profession. The result is a vast interlocked set of spaces for synthetic thinking, a thinking machine.[404]

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[402] Some of the projects Mark Wigley refers to is as follows: Cedric Price, Fun Palace project, 1964, Shadrach Woods, diagram for Berlin Free University project, 1964, Konrad Waschsmann, University Organization, 1965, Friedrich Kiesler, Morphology-Chart, 1939, Archigram, Plug-In City Network, 1964, and Louis Kahn, Philadelphia Traffic Study, 1953. See Mark Wigley. "The Architectural Brain," Network Practices: New Strategies in Architecture and Design. eds. Anthony Burke and Therese Tierney. Princeton: Princeton Architectural Press, 2007: 30- 53.

[403] Mark Wigley. "The Architectural Brain," Network Practices: New Strategies in Architecture and Design. eds. Anthony Burke and Therese Tierney. Princeton: Princeton Architectural Press, 2007: 43.

[404] Ibid.

As Wigley argues, architectural discourse is dominated by thinking about networks, and has been for an extended time, and is itself a networked way of thinking. However, in a disciplinary organization, since innovation is limited, this aspect of being in cooperation with other disciplines was seen as its weakness.

4.1.4 A Place for "Scalar Distortion"

The laboratory is generally considered as a place dedicated to work with "data" rather than the actual objects, and it is possible to manipulate the scale of the investigation in relation to the data at hand. Similarly, the material production of architecture always needs to be manipulated scale-wise in its representations. So, working across different scales or the notion of "scalar distortion" is already inherent in architecture, particularly in the design studio.[405] While the manual labor was dismissed from the "official" image of the architect in its initial configuration, the laboratory could provide architecture a milieu to reclaim its particular character as the mixture of the real and the abstract in the academy since there is no priority between intellectual and manual labor in the laboratory.

4.2 Laboratory as the Genetic Evolution of Architecture: Design Studio and 'Design Thinking'

In the field of architecture, the particular locus of knowledge production has always been the "design studio," or more precisely the locus of the "specific" knowledge of

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[405] "Research scales of construction technologies and systems usually differ from those pursued in science and even engineering. Building technology and science are typically researched in academia from the millimeter to the metric span. On the other hand, science encompasses nano and micro scales, as well as kilometer scales for regional studies." See Maria-Paz Gutierrez. "Reorienting Innovation: Transdisciplinary Research and Building Technology," arq: Architectural Research Quarterly. Vol.18, iss.1, 2014: 69-82.

the discipline is produced in the studio apart from the other more "regular" places of knowledge production such as classroom, seminar, book, and journal, etc. The working mechanism of the design studio simultaneously conforms and contradicts the norms of knowledge production in the university. As Wigley stresses, while the "project" as the outcome of the design studio, "as creative art," could not be more foreign to the university, "its public oral defence by the student is the most faithful maintenance of the oldest and most central institution of the university."[406] Thus, when first design studio in a school of architecture within the institutional context of the university was "designed" it was turned into a space of collection of "all the available fragments of architectural theories and designs to extract authorized lines of argument that can be passed on to students and thereby 'fix' architectural practice."[407] By establishing the design studio as a space filled with representations, the architect "is seen as detached from the physical space of the studio and set adrift among the conceptual space of these representations."[408] These tokens, which are the representations of something "other," something "outside" the studio, bring all of these issues "into" design.[409]

The architectural collection then spilled out into all the architectural spaces, dedicated to architectural education in the university covering every surface such as the walls of lecture rooms protecting architecture from the claim that design is not scholarly, that the prosthetic extension, in the end, does not really belong in the university. The admission of the discipline of architecture to the university in the nineteenth century was made possible only because of the dissolution of the "old

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[406] Mark Wigley. "Prosthetic Theory: The Disciplining of Architecture," Assemblage, No. 15, 1991: 22.

[407] Ibid., 14.

[408] Ibid., 15.

[409] Ibid., 20.

myth of the autonomy of the university, as a clearly defined place separate from the material world it theorizes."[410] As Wigley underlines, "the theoretical cannot be separated from the technical" in the modern university until the end of the nineteenth century.[411]

Wigley presents an episode of what he calls as the "long history of architecture's negotiation for a place as a discipline."[412] The context he focuses on is the university, and as he claims, the "disruption of the traditional limits of the university" as the sole space of "thesis" created a double opening for architecture: first to join sciences and second to join fine arts. Even though architecture schools later "detach themselves from their hosts in both the sciences and the fine arts to occupy the gap between them;" a certain discomfort remains, which also signifies that architecture has the capacity to fill the gap in "the solid foundations of the university."[413] As he further states:

> Architecture remains a prosthetic intrusion into the domain of the thesis. But as such, it cannot simply be removed. Like all prostheses, it occupies the host because there is a gap in the main body; it supplements a deficiency in the thesis, a crack in the solid foundations of the university. Suspended between art and science, academic and professional, pure and applied, theoretical and practical, it fills all the gaps that once defined the outer limits of the university but now inhabit and divide its core. Architecture incorporated itself into the institution by exploiting this convolution of the borders of the university that went unacknowledged until the nineteenth century. The old myth of the autonomy of the university, as a clearly defined place separate from the material world it theorizes, breaks down. In the modern university, the theoretical cannot be separated from the technical. Indeed, for Heidegger, the

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[410] Ibid., 22.

[411] Ibid., 15.

[412] Ibid., 11.

[413] Ibid., 22.

> modern domination of technology is precisely the dominance of the architectonic principle that organizes the production of theory.[414]

Although William Ware identified design as an "extension" of the university program in his letter to the original members of the MIT in which he proposes to include an architecture school from the start,[415] design today governs not only the university but the overall knowledge economy. The incorporation of the laboratory into the schools of architecture could be seen both as a descendent of architecture's specific ways of knowledge production that take place in the studio; but also, as a response to the shift in the focus of the university from analysis to creation, which is related to the fact that "the driving intellectual activity of the twenty-first century will be the act of creation itself."[416]

The studio is, in fact, primarily the space of the artist rather than the architect, as its dictionary definition suggests it as "a place for the study of an art."[417] While the same dictionary defines laboratory as "a place equipped for experimental study in a science."[418] The longstanding locus of architecture, the design studio, and the recently emerging laboratory culture in the schools of architecture could again be interpreted as architecture reclaiming its reconciliatory role between art and science or filling a gap in the structure of the university. However, in this study, it is claimed

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[414] Ibid.

[415] Ibid., 13-14.

[416] James J. Duderstadt. "Preparing for the Digital Age," Positioning the University of Michigan for the New Millennium: A Case Study in University Transformation. Ann Arbor, Mich., 1999: 344.

[417] "studio," Merriam-Webster Dictionary <https://www.merriam-webster.com/dictionary/studio> (accessed 10.01.2022)

[418] "laboratory," Merriam-Webster Dictionary <https://www.merriam-webster.com/dictionary/studio> (accessed 10.01.2022)

that it is more likely related to the recent innovation culture constructing a knowledge economy which prioritizes the notion of design thinking.

The current era has been dominated by "design thinking." There is an ongoing fascination with the notion of "design thinking" in many different components of the knowledge economy, with the expansion of innovation's terrain.[419] The idea of design thinking, in Tim Brown's reading, is a lineal descendant of the tradition of Thomas Edison's research and development laboratory in Menlo Park, New Jersey,[420] in which Edison made innovation "a profession that blended art, craft, science, business savvy, and an astute understanding of customers and markets."[421] In this "design thinking" model, design refers to every "courses of action aimed at changing existing situations into preferred ones"[422] and conceiving artifacts to enable such changes.[423] The lateral mode of operation is embedded in design thinking since it inherently connects and relates individual elements, actions, and activities and relies on both art and science methodologies.[424] As Laura Lee claims, design knowledge becomes "the most valued "commodity" of our age," and therefore, "our actions demand the interplay between the arts, humanities and science, and between education, practice and research."[425]

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[419] Tim Brown defines design thinking as "using the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity." See Tim Brown. "Design Thinking," Harvard Business Review, June 2008: 1-9.

[420] Tim Brown. "Design Thinking," Harvard Business Review, June 2008: 1.

[421] Ibid., 2.

[422] Herbert Simon. The Sciences of the Artificial. Cambridge, Mass.: MIT Press, 1996: 111.

[423] Laura Lee "Integrated Design Strategies for Innovation: Educating Architects towards Innovative Architecture," EAAE Transactions on Architectural Education. no 50, 2010: 31- 43.

[424] Ibid.

[425] Ibid.

4.3 Media Lab as the Precursor

The MIT Media Lab is considered as the precursor for the current laboratories in the schools of architecture that this study focuses on.[426] The institution's naming as the "Media Lab" indicates a desire to position it free of any disciplinary implications, as the co-founder Nicholas Negroponte claimed 'media' belongs to no discipline.[427] Indeed, the term 'media' could be interpreted as widely as "something that is used for particular purpose" or "a way of communicating 'information.'"[428] Even though the area eventually developed into a full-fledged discipline[429] as "media studies" with growing institutional apparatus such as departments, annual conferences, and journals, the concept of "media" cannot be confined to the limits of a single discipline.

Media is a very wide notion signifying a way of communicating 'information' or giving it a physical form. Founding the lab around a 'medium' rather than a field of study or a discipline, or the generality of the concepts of 'media' and 'information' provided the Media Lab the capability of staying "relevant" for the last four decades. This generality brings complexity through the coexistence of diverse types and kinds of research practices. When founding the lab, Negroponte "predicted a massive convergence that would jumble all of the disciplines together and connect arts and

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[426] Besides that, "The MIT Media Lab paved the way for a broader transformation of American education. The Lab and its MIT predecessor, the Architecture Machine Group, were at the very forefront of transforming how university research happens, what counts as research, and how it's funded."

[427] But, in 1985, when Media Lab founded, "media" belong to no discipline in particular.

[428] The singular version of the term "media", medium is defined as "a way of communicating information" and as "something that is used for a particular purpose" by the Oxford Learner's Dictionary. <https://www.oxfordlearnersdictionaries.com/definition/english/medium_2>

[429] Darren Wershler, Lori Emerson, Jussi Parikka. The Lab Book: Situated Practices in Media Studies. Minneapolis: University of Minnesota Press, 2022. <https://manifold.umn.edu/projects/the-lab-book> (last accessed on 05.10.2021)

sciences together as well."[430] Therefore, Media Lab's academic degree program under the School of Architecture and Planning is called "Media Arts and Sciences." As Joi Ito, the former director, explains in the book "Whiplash: How to Survive Our Faster Future":

> The culture isn't so much interdisciplinary as it is proudly "antidisciplinary"; the faculty and students more often than not aren't just *collaborating between disciplines*, but are *exploring the spaces between and beyond them* as well.[431] (italics mine)

The previous literature on multi-, inter-, and transdisciplinarity presupposes that knowledge production only happens within a disciplinary setting or the spaces between disciplines and their intersections. Antidisciplinary research, encouraged by the Media Lab, explores areas of research that "cannot be addressed by simple disciplinary intersectionality."[432] This "antidisciplinary" outlook aims to create a milieu for the research that does not fit into any existing field of study which includes both disciplines and their intersections.[433] To better convey it graphically, Ito describes this antidisciplinary space as such:

> When I think about the "space" we've created, I like to think about a huge piece of paper that represents "all science." The disciplines are represented by a line of widely spaced little black dots. The massive amounts of white space between the dots represent antidisciplinary space.[434]

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[430] Joi Ito and Jeff Howe. Whiplash: How to Survive Our Faster Future. E-book. 2016.

[431] Ibid.

[432] Joi Ito. "The Practice of Change," Unpublished PhD dissertation. Keio University, 2018: 32.

[433] As Joi Ito states, "if you can do what you want to do in any other lab or department, you should go do it there; come to the Media Lab only if there is nowhere else for you to go. We are the new Salon des Refusés." See Joi Ito. "The Practice of Change," Unpublished PhD dissertation. Keio University, 2018: 232.

[434] Joi Ito and Jeff Howe. Whiplash: How to Survive Our Faster Future. E-book. 2016.

In this "antidisciplinary" environment, each research group and each unit has the freedom to interpret the "lab culture" in their own way; therefore, the Media Lab is impossible to map, but there is a certain compass everyone is heading to.[435] In Ito's words, "If the system were mappable, it wouldn't be as adaptable or as agile." This "impossibly complex but very vibrant and, in the end, self-adapting system" in fact resembles the properties of an ecosystem, which are like many biological systems, are emergent phenomena meaning that they are more than the sum of their parts and cannot be understood when disassembled into their component pieces.[436] This ecosystem metaphor also implies that small changes can bring about large effects which can only be observed in the system as a whole since ecological perspectives are inherently non-reductive, concerning relationships, not things.[437]

4.3.1 The Antidisciplinary Hypothesis at the MIT Media Lab

Ed Boyden, a former member of MIT Media Lab, describes the lab's approach as omnidisciplinary rather than antidisciplinary,[438] which according to Jeff Howe, could lead to the reconstructing of the sciences entirely or even pioneering an approach that eschews disciplines altogether."[439] Another prominent member of the Media Lab, Neri Oxman also claims a transition to a age of entanglement with the advent of "antidisciplinarity" at the dawn of the millennium; in which it is not possible to "understand how the world works by breaking it down into loosely-connected

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[435] Ibid.

[436] PostRational. (2019). "Entangled Flourishings: Ideas in Conversation with Resisting Reduction," Journal of Design and Science. March, 2019.

[437] Ibid.

[438] Isabel Barnet. "Watch, perturb, and map: A multifaceted approach to studying the human brain and condition" The Tech Newspaper. Feb. 28, 2019. <https://thetech.com/2019/02/28/lab-spotlight-boyden>

[439] Joi Ito and Jeff Howe. Whiplash: How to Survive Our Faster Future. E-book. 2016.

parts."[440] By contrasting this age to the age of enlightenment which has the *L'Encyclopédie* as its "signpost"[441] that secured the concrete boundaries between the disciplines by the act of cataloguing,[442] Oxman aims to "establish a tentative, yet holistic, cartography of the interrelation" between the domains of art, design, science and engineering, "where one realm can incite revolution inside another; and where a single individual or project can reside in multiple dominions."[443]

Oxman defends "the antidisciplinary hypothesis: that knowledge can no longer be ascribed to, or produced within, disciplinary boundaries, but is entirely entangled."[444] Since the disciplinary model operates as a cognitive tool to reduce the complexity by diminishing the differences, defining boundaries, and creating a clear-cut system; the flexibility required by the constant disruptive shifts cannot be responded to by the rigid disciplinary institutional setting; therefore, this could only be acquired through the laboratories. The current infrastructure of laboratories enables complexity to exist.

In this era of constant change in which "the periods of stability have grown shorter, and the disruptive shifts to new paradigms have come with greater frequency," the focus of the lab shifts with the developments in the information technologies, while in the late 1980s and 1990s, the Lab "focused on personal computing, interfaces, and

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[440] Danny Hillis. "The Enlightenment is Dead, Long Live the Entanglement," Journal of Design and Science, iss.1, 2016.

[441] Oxman claims that every age has a relic such as a loom, an automobile, the PC, a 3D printer. L'Encyclopédie was the signpost for the long eighteenth century. See Neri Oxman. "Age of Entanglement." Journal of Design and Science, iss.1, 2016.

[442] Neri Oxman. "Age of Entanglement." Journal of Design and Science, iss.1, 2016.

[443] Ibid.

[444] Ibid.

displays," later it moved from them into email and networks, and eventually into big data and social physics.[445]

4.4 Laboratory in the Field of Architecture

Despite the diversity of the usage of the term laboratory, how it is appropriated in the field of architecture has not yet been disclosed.[446] One of the most recent attempts in that regard is the "Lab Cult" exhibition at the Canadian Centre of Architecture, in 2018, curated by Evangelos Kotsioris, which "investigates the concept of the laboratory as a pervasive and recurring metaphor for experimentation in both science and architecture."[447] By regarding the laboratory only as "a place for the conduct of rigorous research," this exhibition implicitly strengthens the so-called discrepancies between architectural and scientific research, even though it claims to have "a more symmetrical narrative" between these two fields rather than "reinforcing any preconceived hierarchies."[448] The method used in the exhibition is to juxtapose case studies from science and architecture to suggest "a history of close-knit relationships and mutual exchanges."[449]

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[445] Joi Ito and Jeff Howe. Whiplash: How to Survive Our Faster Future. E-book. 2016.

[446] Along with the CCA exhibition, a recent study on architectural laboratories is Bechara Helal's dissertation in which he aims to access the complex nature of the architectural laboratory. See Bechara Helal. "Les laboratoires de l'architecture: enquête épistémologique sur un paradigme historique" Unpublished PhD dissertation. Université de Montréal, 2016.

[447] "LAB CULT: An unorthodox history of interchanges between science and architecture," Press Release for the exhibition Lab Cult at The Canadian Centre for Architecture. 23 March- 2 September 2018. <https://www.cca.qc.ca/cca.media/files/11516/10426/LabCult_PressEN.pdf> (last accessed on 05.12.2021)

[448] Ibid.

[449] Ibid.

The motivation of the exhibition is to demonstrate the claim that "scientists strongly rely on architectural concepts, representations and material means to stage and communicate sophisticated set-ups of rigorous investigation," to a similar extent to that of architects' attempts of "borrowing, transforming (or even misappropriating) scientific ideas, tools, and working protocols" "to systematize the intuitive aspects of the creative process."[450] The exhibition presents six mutual themes between science and architecture or scientific research practices in laboratories with several "architectural experiments."[451] Themes are "designing instruments, measuring movement, visualizing forces, testing animals, building models and observing behaviour."[452]

The definition of 'science' in this exhibition relies on a particular understanding of scientific research, which has been challenged as inadequate by the post-positivist philosophers. One of the fundamental observations of the exhibition, as the curator Kotsioris points out, is the employment of both terms, architecture and laboratory, as 'metaphors,' 'analogies,' or 'allegories' for scientific knowledge production. It is claimed in the exhibition that "the laboratory has become an unquestioned dogma," "[i]n its ubiquity as metaphor, physical space, and visual aesthetic."[453] While the metaphorical usage of the term architecture to define the scientific knowledge

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[450] Ibid.

[451] Ibid.

[452] The exhibition is organized under six themes: "Designing Instruments, "Measuring Movement," "Visualizing Forces," "Testing Animals," "Building Models," and "Observing Behaviour." "Each of these themes is presented by pairing one historical case study from science with one from architecture. Ranging from the late nineteenth century to the early 1980s, these case studies identify the ways in which working concepts, methods and protocols have been exchanged across different time periods between scientists and architects of diverse disciplinary backgrounds, such as architecture, psychology, engineering, physiology, mathematics, industrial design, computer science and others."

[453] Ibid.

production was employed to "exclude, subordinate, and control architecture,"[454] within the institution of the university by creating a distinction between mechanical and liberal, it could be speculated that the recent appropriation of the laboratory could reappropriate architecture within the university.

The exhibition is founded upon the observation that the "laboratory has become an omnipresent term in architectural education, practice, and theory."[455] However, the presented cases illustrate what Jussi Parikka terms as the "twentieth-century art and design education's laboratorization of the experiment."[456] When the laboratory is considered solely as a space of experimentation, the diversity of both historical and current types of laboratories is undermined. Parikka points out the practices of speculation in media and design laboratories, which are "the contemporary places of recreation, imagination, technological practice, and activism."[457] To avoid such stereotypes about knowledge and creative practices, such as "tensions between regularity versus unexpected outcomes; experimentation versus standardization; creativity versus routine,"[458] which was also posed by the Lab Cult exhibition at the CCA, as Parikka asserts, critical maps of laboratory practices are needed.

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[454] "There is no place for the study of architecture within this institution. As a "mechanical" art, it has no place in the home of the "liberal" arts. But this distinction between mechanical and liberal depends on the architectural metaphor." See Mark Wigley. "Prosthetic Theory: The Disciplining of Architecture," Assemblage, No. 15, 1991: 11.

[455] "LAB CULT: An unorthodox history of interchanges between science and architecture," Press Release for the exhibition Lab Cult at The Canadian Centre for Architecture. 23 March- 2 September 2018. <https://www.cca.qc.ca/cca.media/files/11516/10426/LabCult_PressEN.pdf> (last accessed on 05.12.2021)

[456] Jussi Parikka. "The Lab Imaginary: Speculative Practices in Situ," Across and Beyond: Post-Digital Practices, Concepts, and Institutions. eds. Ryan Bishop, Kristoffer Gansing, Jussi Parikka and Elvia Wilk. Berlin: Sternberg, 2016: 80.

[457] Ibid.

[458] Ibid.

The history of the laboratory illustrates the multifaceted nature of it contrary to its conceptualization as the sole place of experimentation. As a consequence of its multiple predecessors, from the kitchen to atelier, workshop, and alchemist's workplace, the laboratory preserves this multiplicity until this day. As Peter Galison underlines, the laboratory is, in different times in history, "a chamber of magic, a parliament, a home, a cottage industry, a factory, a monastery, a networked web."[459] Galison further explains this shifting identity of the laboratory:

> The laboratory, in a sense, begins in the lower regions, in the basement in secret spaces that restrict and isolate from the outside, that bring it closer to earth. This was the alchemists' lair. Laboratories moved in the early modern period to gentleman's quarters, somewhere between the well-run household and a miniature parliamentary chamber. This is where my interest in laboratories starts, in Victorian England, when the laboratory mutated yet again to a form of workshop, a craft-dominated late-nineteenth century factory where glass was hand-blown, tools were machined by hand, and the world in some sense was to be gathered in from the extremes of the empire, as physicists strove to imitate storms, electrical discharges, glaciers and volcanoes. Thick, immovable walls built to isolate sound and other vibrations from the precision work within also served, symbolically, to isolate and render permanent the dominion of the experimenter. Then came the laboratory of the Second World War and the postwar years, the laboratory as a centralized factory of largescale production. In the last few decades of the twentieth century, the laboratory was dispersed in various complex ways, through networks of institutions, personnel, equipment, and data flows. The isolated, centralized laboratory of physics has begun to dissolve, at least in large-scale experimentation.[460]

The re-appropriation of the notion of the laboratory as a place for experimentation for the last two decades should be investigated from a broader perspective in which laboratory is considered as "independent of natural order time scales and conditions"

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[459] Peter Galison et al., "Peter Galison interviewed by Oladélé Ajiboyé Bamgboyé, Okwui Enwezor, Kobe Matthys and Barbara Vanderlinden," Laboratorium, ed. Hans Ulrich Obrist and Barbara Vanderlinden Antwerp: Dumont; Antwerpen Open; Roomade, 1999: 97.

[460] Ibid.

since they “rarely work with objects as they occur in nature.”[461] Laboratories “work with object images or with their visual, auditory, electrical traces, with their components, their extractions, their simulations,” and this “enculturation and reconfiguration of natural objects” creates a distinction between an uncontrolled outside and a controlled inside which appoint laboratories as sites for “consequence-free research.”[462] A laboratory, therefore, as indicated by Marc Thompson and Mathis Schulte, is a “site of provisional, contested and emergent knowledge.”[463]

The definition of the laboratory has been extended in the last two decades to incorporate the recent forms of knowledge production practices outside of the natural science domain. The “living laboratory” concept was used by William J. Mitchell from the MIT Media Lab and School of Architecture in 1995 to “define an innovative research approach aimed at developing and testing new technologies and strategies to cope with complex social problems.”[464] The recently founded laboratories such as “Innovation Labs,” “Urban Transition Labs,” “Change Labs,” “Real World Labs,” “Policy Labs,” “Challenge Labs,” “Social Labs,” and “Public Innovation Labs”[465] demonstrates that laboratories are also “sites for addressing complex social change problems such as inequality, the climate crisis, unemployment, affordable housing,

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[461] Karin Knorr Cetina “Metaphors in the Scientific Laboratory: Why are they there and what do they do?” Metaphorical Point of View: A Multidisciplinary Approach to the Cognitive Content of Metaphor, ed. Zdravko Radman. Berlin and Boston: De Gruyter, 2015: 334.

[462] Michael Guggenheim. “Laboratizing and De-Laboratizing the World: Changing Sociological Concepts for Places of Knowledge Production,” History of the Human Sciences. Vol.25, iss.1, 2012: 101.

[463] Marc Thompson, and Mathis Schulte. "The Laboratization of Change: What Is It with Labs and Change These Days?" Research in Organizational Change and Development Vol. 29, 2021: 33.

[464] Giorgia Nesti “Co-production for innovation: the urban living lab experience,” Policy and Society, vol.37, iss.3, 2018: 310-325.

[465] Ibid.

access to healthcare, education, and so on."[466] "Many urban designers also use the term "lab" or "laboratory" [] indicating their study of the chaotic and random creative processes of experimentation in the city."[467] Moreover, in recent years, "an increasing amount of humanities and media institutions have pitched themselves as 'labs' in design, creativity, and even a sort of imaginary work, or at least a media archaeological sort of reverse-engineering of technologies and cultural narratives about technology."[468]

Michael Guggenheim also investigates the following recent uses of the term laboratory.[469] The first use of laboratory as collaboration is "a way of doing collaborative work on similar topics across different institutions" "by creating a small network called a laboratory."[470] The second use is the empirical extension of the laboratory space to the whole of society, framing society as a laboratory itself.[471] In its third usage, the laboratory is seen as "a generic notion for places of research."[472] In this regard, the city or a country is a laboratory for economists, sociologists and planners. The last one is the laboratory "as a container to test unique things or, in a

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[466] Ibid.

[467] Hanna Katharina Göbel. "Introduction," The Re-Use of Urban Ruins: Atmospheric Inquiries of the City. New York and London: Routledge, 2015: 18.

[468] Parikka. "The Lab Imaginary: Speculative Practices in Situ," 2016: 79.

[469] The recent uses are listed by Guggenheim as such: lab as collaboration; empirical extension of lab space (society as laboratory/real-world experiments); lab as a generalized notion for spaces for knowledge production: and lab as a container to test objects. See Michael Guggenheim. "Laboratizing and De-Laboratizing the World: Changing Sociological Concepts for Places of Knowledge Production," History of the Human Sciences. Vol.25, iss.1, 2012: 99-118.

[470] Guggenheim. "Laboratizing and De-Laboratizing the World: Changing Sociological Concepts for Places of Knowledge Production," History of the Human Sciences. 2012: 110.

[471] Ibid.

[472] Ibid., 111.

more general sense, the laboratory as the workspace of designers."[473] "A laboratory in this sense would be a space, where professionals manipulate models, drawings, signs and texts that refer to the outside world."[474] Guggenheim compares the architectural office to laboratory since the office also creates a distinction between an inside and an outside, where the object, the building, is under "full control of the architect."

This study aims to offer a bottom-up definition of the laboratory in the field of architecture that originates from the analysis of these laboratories. As stated above, the concept of laboratory has been differentiated and diversified with each area that it is extended since its inception in the sixteenth century. With its expansion to different domains, new traits are added, and some attributes are left behind as laboratory becomes part of their knowledge production processes. Therefore, the definition of the laboratory concept in architecture must also be specialized in itself. It is argued here that the laboratory phenomenon in architecture cannot follow the general discussions around the extension of the laboratory concept to fields that are not mainly associated with the laboratory culture.

As Willem de Bruijn notes, it is only, in the last two decades, that "the use of the term laboratory or 'lab,' as it is often abbreviated to, has become widespread in both the profession and in education," in the field of architecture.[475] In de Bruijn's interpretation, this recent development has placed laboratory as "the very paradigm of conceptualizations of practice and research in architecture."[476] De Bruijn attributes this 'lab phenomenon' to "a renewed interest in the notion of experiment

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[473] Ibid., 112.

[474] Ibid.

[475] Willem de Bruijn. "Writerly Experimentation in Architecture: The Laboratory (not) as Metaphor," Writingplace, vol. 1, 2018: 48.

[476] Ibid.

and the spaces of experimentation."[477] Therefore he points out to the *Bauversuchsplatz* (building laboratory) of Bauhaus, as the origin of the architectural laboratory in the domain of design education which was conceived as "a large-scale experimental studio where practical workshop problems may be addressed in both the technical and formal senses, under the direction of a highly qualified practicing architect."[478]

Placing the notion of the experiment as the basis for the recent proliferation of laboratories in architecture institutions is similar to the "scientification" arguments in the current "humanities literature" with the introduction of digital humanities laboratories.[479] This study dissociates itself from this line of argumentation and claims that to think of the laboratory as simply as an 'experimental space' is to ignore the multifaceted nature of the term 'laboratory.' Even though there were specific periods in the history of architecture that witnessed such efforts to "scientize" the field, the proliferation of laboratories is viewed here from a broader perspective. Considering the laboratory's historical development and current formation, it is visible that the laboratory is neither only a "placeless space" where scientific knowledge is produced, nor only a space of technological innovation related to manual labor. Moreover, it is not possible to limit its existence only to the industrial or scientific context. Even though they share some certain characteristics, there are no strict specific criteria that the places called laboratories in this study share other than their self-attribution as laboratories.

There is a certain flexibility with the concept of laboratory that stems from the multiplicity of its predecessors from workshop to kitchen, enabling the laboratory to

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[477] Ibid.

[478] Ibid., 50.

[479] See Urszula Pawlicka "Data, Collaboration, Laboratory: Bringing Concepts from Science into Humanities Practice," English Studies, vol.98, iss.5: 526-541.

be a common denominator for different contexts such as industrial, scientific, educational, and so on. Another aspect of "laboratory" which contributes to its distribution among different milieus is their quality of being "placeless," which enables them to spread globally and on a large scale. Laboratories, in this sense, are also well-suited in this complex network age.

When the laboratory concept is reconsidered within the specific conditions of architecture, several observations should be underlined. The knowledge production in architecture is dependent mainly on the context, while laboratories are attributed with "placelessness," allowing context-free production of knowledge. The word "labor," which is interpreted in this study as "practical work"[480] or "productive activity,"[481] is essential for the definition of the laboratory. It is not to claim that every labor-intensive work at the laboratory involves physical effort aimed at material production. Still, creation, by all means, is in the center, including technological innovation, even when the outcome is not in the form of a material product. Similarly, for architecture, every attempt to produce knowledge does not aim to construct an architectural artifact; however, material production is still at the very center of the field. With this emphasis on "production," laboratory is dispersed to different contexts such as scientific, industrial, educational, and technological. Architecture also cannot be imagined separately from these contexts.

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480 "labor," Cambridge English Dictionary. <https://dictionary.cambridge.org/dictionary/english/labor> (last accessed on 14.12.2021)

481 "labor," Collins English Dictionary. <https://www.collinsdictionary.com/dictionary/english/labor>(last accessed on 14.12.2021)

4.5 Method: A Framework for the Laboratory Types in the Schools of Architecture

This study follows Lakatos's understanding of scientific research programmes to conceptualize and then categorize the laboratories in the schools of architecture. Lakatos's typical descriptive unit of science, the research programme has three components: first, a characteristic hard core stubbornly defended, second a more flexible protective belt of auxiliary hypotheses, and third, a "heuristic," a "powerful problem-solving machinery," that defines what paths of research to avoid (negative heuristic), and what paths to pursue (positive heuristic).[482] As Lakatos explains:

> The negative heuristic specifies the 'hard core' of the programme which is 'irrefutable' by the methodological decision of its proponents; the positive heuristic consists of a partially articulated set of suggestions or hints on how to change, develop the 'refutable variants' of the research-programme, how to modify, sophisticate, the 'refutable' protective belt.[483]

This formulation offered by Lakatos could also be regarded as a scale from tradition to innovation. While the hypotheses composing the 'hard core' are irrefutable, sustaining the tradition, the protective belt is the part that is 'refutable' or could be developed. Furthermore, the reason behind the adaptation of Lakatos's account in categorizing laboratories is because it does not rely on the concept of 'discipline.' The intention here is to analyze these laboratories on the basis of how they operate

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[482] Imre Lakatos. "Introduction: Science and pseudoscience," The Methodology of Scientific Research Programmes: Philosophical Papers. eds. J. Worrall and G. Currie (Eds.), Cambridge: Cambridge University Press, 1978: 4.

[483] Ibid., 50.

rather than their field of study. Based on their self-descriptions, I classify them into three main types according to Lakatos's account.[484]

Lakatos defines progress as the capacity of making novel predictions of the research programme, while hard-core remains enacted. When modifications only protect the hard-core from refutation but do not predict new phenomena, then the programme is degenerating, and the rational scientist abandons it. Regardless of the choice of "descriptive unit" as a hypothesis, discipline, specialty, or research programme, the theme of progress is inherent in all of the characterizations of knowledge production. Since knowledge is inexhaustible, the production of new knowledge always gives rise to the production of knowledge. There is always a balance between tradition and innovation. Sustaining the hard-core is only acceptable when there is a certain degree of innovation. To maintain the hard-core alone shows that the program is degenerating. Similarly, Kuhn's conceptualization of convergent and divergent research, describes the essential tension of science, emphasizes this balance. Kuhn states that the extended periods of convergent research are the necessary preliminary to revolutionary shifts, and the convergent research ultimately results in revolution.[485] Therefore, for innovative laboratories to exist, there must always be laboratories that sustain hard-core.

These laboratories, in their self-descriptions, still use cross-disciplinary terminology, although somewhat confusingly, to highlight their differences from the disciplinary production of knowledge. There is no doubt that they all have connections and

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[484] It should be noted here that the three components of this framework are not categorically same. While hard-core and protective belt is described as a set of hypotheses; as fundamental and auxiliary respectively, the heuristic, on the other hand is the mechanism controlling the conduct of the research programme. Therefore, the proposed classification does not have a direct correspondence with the framework, rather the overall conceptualization is influential in this study.

[485] Thomas S. Kuhn. The Essential Tension: Selected Studies in Scientific Tradition and Change, Chicago: University of Chicago Press, 1978. 141.

interrelations with other fields, and these interrelations are interpreted in this study with the concept of a networked web. When the focus is shifted from disciplinary or its derivate cross-disciplinary terminology to the notion of "innovation," the discussion is directed to the processes of knowledge production themselves rather than the relations between fields.

First, by juxtaposing the first fifty universities in the QS rankings, which offers the subject of 'architecture and built environment' with the first fifty universities of Times Higher Education rankings again offering the subject of 'architecture,' a list of eighty-four universities is obtained. Despite the discussions around the objectivity of these ranking systems, they provide the necessary information to have an overall list of the leading schools of architecture in the world. The specific rankings of selected schools in these lists are irrelevant for the study. These rankings are only employed here to achieve a list of leading architecture schools rather than a random selection.[486] From that list, twenty-one schools that incorporate the "laboratory culture" to their structure are selected for the analysis. Eliminating a lot of schools in this step is related to the lack of research activities in universities that offer only undergraduate education in architecture.[487]

Schools included in this study are mainly located in the United States, but there are also schools from Australia, Canada, Finland, Singapore, Hong Kong, and China.

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[486] The selection criteria preclude the inclusion of the department where this thesis has been conducted. However, an analysis of the laboratories in the department of architecture at METU is provided in appendix C.

[487] For instance, Stanford University is placed as the 34th architecture school in the QS rankings, however, the Architectural Design Program at Stanford University is a part of the department of Civil and Environmental Engineering and it is only an undergraduate major which grants a degree of bachelor of science in engineering with a specialization in architectural design. Therefore, there is no institutional structure to house the research activities.

In addition to that, some schools do not provide well-documented websites for their research practices, and some schools only provide information in their national language.

Due to the wideness of the geographical scope of the selected schools, it was not possible to physically conduct 'on-site' research, but by compiling the self-descriptions of these laboratories on their websites, three different clusters are self-assembled.

This study aims to demonstrate that disciplinary analysis is not the only possible way to discuss and decipher the field of architecture. Architecture claims from the very beginning that it has extensive connections with the other fields due to its broad scope and epistemological instability.[488] The exchanges between disciplines have been widely discussed and turned into a concrete reality. Therefore, it is not viable for architecture to establish its specificity through the abundance or the nature of its relations with other fields. It can position itself more precisely in the whole field of knowledge through an understanding of the existing knowledge production practices. Therefore, this study offers a new tool to understand the current knowledge production in architecture through the concept of "laboratory," replacing the notion of discipline and its elements (theory, models, paradigms) as the only tools to examine the knowledge production practices of a single field of knowledge.

A simple acceptance that discipline is not a uniform concept and includes many different types indicates that we need to reconsider our commitment to the discipline concept and the multi-inter-trans-disciplinary literature based on it. There is a discrepancy between the representation of the field of knowledge and the knowledge production processes. There were knowledge production practices even before the disciplinary divisions were created, and these practices were attempted to be integrated into the disciplinary system. Then, the idea of cross-disciplinarity arose with the claim that these practices do not fit the disciplinary definition of knowledge

[488] Which is indeed ironic considering the fact that architecture itself helps create the metaphor of stability that is the foundation.

production. The point of change, in fact, is the transformation of the knowledge production practices; that is why the changes in the terminology are not sufficient.

Kuhn's philosophy of science is directed to the historical understanding of scientific practice; it does not point out the dissolution of the positivist understanding from a certain point in the history of science; rather, it illustrates that the practices of knowledge production have always followed a non-linear logic. The examples he gave to explain his theory of "paradigm change" date back to the seventeenth century. Therefore, the practice turn is understood here as a return to knowledge production practices and as a means of reconsidering the definitions that dominated the past.

This study considers the symptomatic change in knowledge production practices in the last twenty years as the increasing digitalization of knowledge and exponential change in the amount of information. This change in the amount of information has also induced the emergence of new fields of knowledge. Contrary to the representation of the knowledge field in a tree diagram, new fields are not only formed by branching away from the previously existing knowledge fields or by their combination. These new areas have never been thought of before or cannot be reconciled with existing fields. To incorporate and integrate these unprecedented fields of knowledge into already existing fields, this study considers 'laboratory' as a mediator to extend our set of available tools to increase our capacity to comprehend the current practices of knowledge.

Each laboratory included in this study refers to established disciplines while describing themselves, but mainly they express themselves through the knowledge production practices. A three distinct set of actions and practices emerge from an examination of the briefs of the laboratories on their websites, which is then appropriated as three laboratory types in the schools of architecture. (Figure 5) The categorization is free from the conventions of disciplinary terminology; it solely focuses on the degree of innovation in their knowledge production practices. Each of these laboratories included in this study attempts to innovate at different scales.

TYPE 1		TYPE 2		TYPE	
address	expand	bridge	generate	activate	invent
advance	explore	catalyze	integrate	change	model
analyze	focus	challenge	map	co-craft	pioneer
apply	identify	combine	navigate	envision	propose
contribute	improve	confront	redesign	formulate	push
develop	promote	craft	respond	ignite	re-imagine
emphasize	reveal	create	shape	implement	reconceive
enhance	support	establish	synthesize	innovate	revisit
evaluate	test	facilitate	unite	inspire	transform

Figure 5. Set of actions associated with different types of laboratories[489]

Before giving a detailed description of these three types of laboratories, the adaptation strategy of Lakatos's framework as a means to categorize these laboratories must be explained. The first type of laboratories defined here share some characteristics with Lakatos's definition of "hard-core" since they mainly conduct research for an in-depth exploration of the existing knowledge, aiming at an overall enhancement of their field of studies. The second type of laboratories exceed the hard-core, as they mainly operate as a facilitator for different components of the field of knowledge work together; they do not only enable a connection between different fields but also between institutions, people, industries, and other research communities besides the ones in universities. The flexible character of this type of laboratory is reminiscent of Lakatos's description of a "protective belt"; since these laboratories aim to expand the reach of their respective field of studies even to redesign some of its aspects. This type of laboratory could be considered the "heuristic" mechanism for architecture since they define new research paths to

[489] Compiled by the author according to the self-descriptions of the laboratories in their web pages.

pursue.[490] The third and last type of laboratories aim to re-imagine the field or rethink its conventions and pioneer new modes of research. [491]

4.5.1 Type 1 Laboratories: Sustaining the Hard-Core

The operational principle of the first type of laboratory that this study offers is to sustain the hard-core of the field of architecture. These laboratories do not question the conventions of the knowledge production practices since they are situated at the "hard core" of the field of architecture and have no intention to go beyond it. Their aim is to provide an in-depth understanding of the built environment by investigating and examining its elements and exploring its effects. They also provide in-depth, detailed, and sometimes methodologically innovative research on issues that have been already studied to a certain degree. Instead of originating new fields of study, this type of laboratory brings some of the preestablished issues into focus again. They also use already existing or emerging technologies to better understand and address complex problems of the field.

This type of laboratory also manufactures material artifacts using machinery or, more generally, aims at repetitive production without any attempt to innovate. Together with "the advances in material science at microscopic scale, and the availability of

[490] These paths later could be relinquished, in the manner of Lakatos's negative heuristics.

[491] While this study focuses mainly on how these laboratories operate rather than what they produce, the diversity of the outputs of these knowledge production practices should be briefly mentioned here. Besides the outputs which are mainly in the written format such as a journal article, or a book, these laboratories also produce and develop prototypes, computational tools and methods, simulation tools, and new algorithms. The outputs of these laboratories range from creating innovative and thought-provoking projects such as short films, documentaries, architectural earworms, simulation tools, and VR pamphlets to producing speculative spatial propositions and data projections.

specialist tools to customize materials,"[492] material production processes within architecture have transformed drastically. This type of laboratory has replaced the factory as the principal place for industrial production with the advancement of digital tools.

4.5.2 Type 2 Laboratories: Enabling Collaboration

The second type of laboratory operates as a heuristic mechanism for architecture and endeavors to improve the field by enabling an international network and creating the 'community' of researchers and projects. They provide a research infrastructure for researchers to collaborate. Their goal is to describe the patterns of thinking and the way of the growth of knowledge. Laboratories in this category conduct cutting-edge research, but the research outcome could later be transformed into new inquiries worth following but not necessarily. They challenge some of the established practices of knowledge production, but they do not aim at a complete reorganization of the field. The most critical role they play in the field of architecture is to synthesize frameworks between diverse areas and to enable broad applications of newly developed technological advancements.

The following set of actions identifies this type of laboratory: introducing new digital methods and new modes of knowledge, bringing the architect's way of operating to new fields of culture, and also applying insights and theories from different areas such as biology, robotics, and computer science to the design, fabrication, and production of architectural artifacts. By integrating different methodologies and generating new ones, these laboratories aim to go beyond the traditional research trajectories and sometimes even challenge architecture's epistemological capacities.

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[492] UCL Bartlett School of Architecture Website. <https://www.ucl.ac.uk/bartlett/architecture/programmes/postgraduate/march-architectural-design> (last accessed on 15.12.2021)

These laboratories develop alternative models, technologies, and processes intending to understand specific issues in the field of architecture in previously unexplored ways.

4.5.3 Type 3 Laboratories: Discipline-less Innovation

The third and last type that this study focuses on is the "discipline-less" laboratories that fully aim at innovation without adhering to any disciplinary convention or limitation. These laboratories are established to create a radical break with the previous practices of knowledge production through the convergence of previously apart methods, techniques, fields. Based on their self-descriptions, a set of actions could be listed to define the kind of knowledge production these laboratories conduct. The goals and ambitions of some of these laboratories span from changing current architectural practice to creating innovative and thought-provoking projects at the intersection of architecture and other fields such as design, science, and engineering.

I define three different kinds of innovation laboratories within this third type of laboratory: data-centric, production-oriented, and, lastly, laboratories that innovate the knowledge production practices themselves. Data-centric laboratories respond to the abrupt change in the amount of data, which is one of the most fundamental developments that has transformed the knowledge production processes in the last two decades. Despite a great deal of research on how big data is changing and transforming architectural design practices,[493] there has not been much discussion of how it triggers a transformation in knowledge production practices in architecture.

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[493] An inquiry into how information processing informs and is informed by architecture could be found in the book "Architecture in Formation on the Nature of Information in Digital Architecture" edited By Pablo Lorenzo-Eiroa, Aaron Sprecher. See Pablo Lorenzo-Eiroa, and Aaron Sprecher. Architecture in Formation: On the Nature of Information in Digital Architecture. London: Routledge: 2013.

The number of laboratories classified as data-centric is much less than other types; however, the specific ways laboratories use the big data is decisive whether or not they are included in this classification. Rather than a basic application of big data in a conventional manner, the laboratories in this category either create data using novel methodologies or produce data-driven answers. In addition to that, big data laboratories are not usually incorporated into architecture schools; they are commonly more independent and feed every part of the university. On the other hand, production-oriented laboratories associate innovation with material production, that is to say, the materialization of their knowledge through production. The set of actions of the last kind of laboratories, which innovate the knowledge production processes, includes challenging and re-imagining the process of architectural practice and also changing how people think about certain matters. These laboratories also aim to develop alternatives to current practices.

4.6 Discussion on the Framework

The graphic produced from the framework offered in this study to conceptualize the laboratories in the selected schools of architecture illustrates the consistency between the sets of actions assigned for each type of laboratory and the proposed classifications. (Figure 6) There are very few laboratories placed at the intersection of different sets of actions.[494]

[494] For instance, the action "activate" intersects with "advance" for The Circular Construction Lab; however, this particular laboratory, in fact, "advances the paradigm shift from linear material consumption towards a circular economy within an industrialized construction industry." While the dictionary definition of the word "advance" is very similar to other actions which belong to the same type, such as "develop" and "improve," the dictionary definition is entirely altered in this particular use. See The Circular Construction Lab website. <http://ccl.aap.cornell.edu> (last accessed on 27.01.2022)

The first question to be asked about this framework is how these laboratories produce knowledge differently from the disciplinary way of knowledge production and how three distinct types illustrate those aspects in particular. First, the laboratories are more flexible in their organizational structures than disciplines. While disciplines need to sustain the continuity of their established structures, laboratories could easily be formed, dissolved, and transformed into something new. This flexibility is also visible in the scopes of these laboratories as they do not need to identify themselves with reference to specific disciplines that are mainly distinguished according to their subject matters, which is inevitably provisional because of the constant reconfiguration of the field of knowledge. A discipline is an individual body of knowledge that must be evaluated in relation to the larger system of knowledge, which can be described as an infrastructure that holds these separate bodies of knowledge together by organizing their interrelations. This flexibility in structure and freedom in scope enables these laboratories to establish fresh perspectives in the production of knowledge. This is one of the underlying reasons these laboratories are freer to construct and transform their customizable approaches to knowledge production.

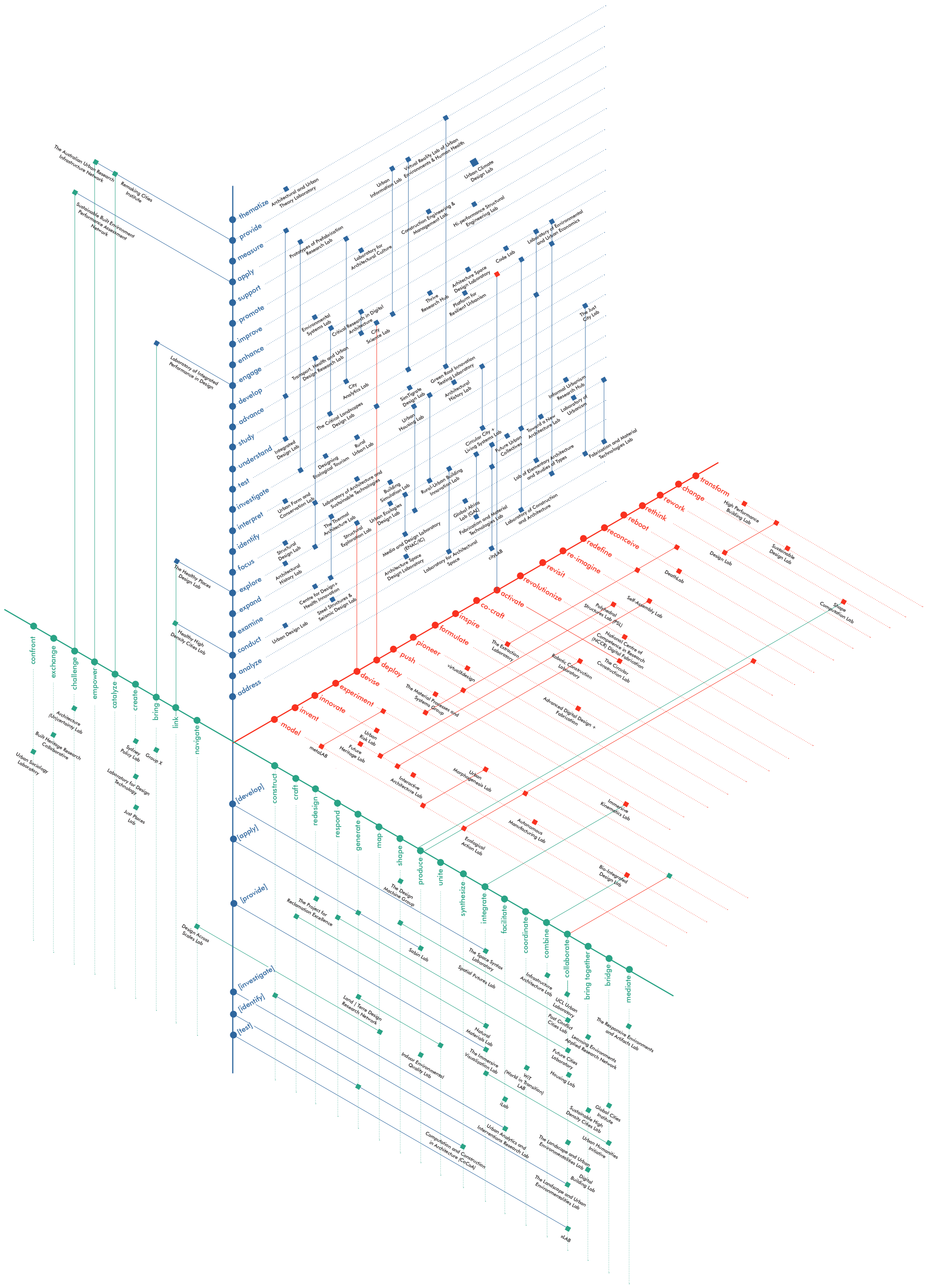

Figure 6. A Graphic Exploration of the ‘Set of Actions’ (produced by the author)

The framework also has the potential to bring forward a renewed perspective to some of the perennial discussions in architecture. One of them is the legitimacy of the knowledge produced through design studio works, defined as design research or research by design. The questionable scientificity of the design studio in the positivist outlook is due to the supremacy of science to other forms of knowledge production;[495] however, science no longer offers a model of rationality that could be applied to other domains of human life in the current postpositivist context. Since science ceased to be a model of rationality, one expects to see a transformation within the overall system of knowledge in which other types of knowledge gain more value.

The notion of design research is emerged to posit the claim that "design practice constitutes a distinctive form of knowledge production and intellectual inquiry,"[496] which marks "a shift from 'critical practices' to 'innovation' and the adjunct promises of positioning architecture as a 'projective' or 'material' practice."[497] As Christopher Hight argues, "design research is symptomatic of a broader epistemological transformation," and in this new epistemological context, "the privileged status of architecture as the metaphor for systematic reason has been displaced because architectonics of knowledge seem themselves less empirically accurate as ways of understanding the production of knowledge even in the natural sciences."[498] The laboratories included in this study, particularly those in the third type, are not afraid to claim a post-positivistic scientificity. However, it could be stated that architecture still favors the positivist model of laboratory to claim

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[495] These other forms of knowledge are not limited to academic context; the production of knowledge in artisanal and artistic practices, or even in the industrial context are also included.

[496] Christopher Hight. "One Step towards an Ecology of Design: Fields of Relations and Bodies of Knowledge," Design Innovation for the Built Environment: Research by Design and the Renovation of Practice. ed. Michael U. Hensel. London and New York: Routledge, 2012.

[497] Ibid.

[498] Ibid.

scientificity through them, and the coexistence of three different laboratory types supports this statement.

CHAPTER 5

CONCLUSION

This study contributes to the field of architecture by providing a framework which is defined through the practices of knowledge production in architecture, free of the conventional terminology of 'disciplinarity.' The conceptual basis for this study is constructed by deciphering the implications of the disruptions in the whole field of knowledge and extending it into the field of architecture. By challenging the already established definitions of notions such as 'discipline' and 'laboratory,' this study provides an original approach to the conceptualization of the field of architecture.

This thesis defines a set of actions emerging from the knowledge production practices in the laboratories in the schools of architecture with the conviction that the idiosyncratic nature of architecture could be best captured through a framework generated within the field itself. While architecture is used as an analytical tool for various abstract concepts, including the ones used to describe the configuration of the whole field of knowledge, architecture has always reached to its outside to find the means to analyze itself.

Far from being an unintentional act, this is a conscious strategy for architecture to separate itself from its practice so that its theory is mobilized and could operate simultaneously in multiple fields which are considered more robust than architecture. As thoroughly discussed in the study, architecture has always seen as an 'extension,' a 'misfit' when placed in relation to other fields of knowledge. 'An overarching theoretical construct' was needed to legitimatize architectural practice, which is not contaminated by the contingencies of the real world. The invention of theory as distinct from practice enabled architecture to be codified as a discipline.[499] In order to be defined as a discipline, architecture had to distance itself from its practice. Therefore, it is not possible to comprehend the totality of the field of architecture through the lenses of 'disciplinarity.'

The intention here is to assert that the 'disciplinary' analysis is not the only possible way to investigate, question, or assess the field of architecture. Such dependency on a term that lacks an analytical definition in organizing the entire field of knowledge results in confusion, since each attempted definition of the term is simply an interpretation of an abstract concept. Furthermore, the concept of discipline is also problematic in the context of the university, because of its primary function of "constraint" that contradicts with the notion of "free inquiry, on which the self-image of the modern research university is based."[500] As an alternative to 'discipline' as the unit of analysis, this study offers 'laboratory' with the assumption that it could reflect the current state of the field of architecture more precisely.

Although this strong emphasis on the concept of the laboratory is likely to create a perception that this thesis tries to approximate architecture closer to the scientific discourse, such direct association between science and laboratory is based on a limited understanding of the term 'science.' This study, in fact, acknowledges the inherent plurality of the term 'science,' which comprising a set of different practices, and actions that take place in various kinds of spaces, which has only been conceded with the recent practice-turn, replacing the terms' connotation of singular positivist understanding of the empirical sciences. Laboratory studies, which aimed at deciphering the laboratory as a locus of production of knowledge, had a significant

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[499] Stan Allen. "PRACTICE vs PROJECT." PRAXIS: Journal of Writing Building. vol. 1, 1999: 114.

[500] Peter Osborne. "Problematizing Disciplinarity, Transdisciplinary Problematics," Theory, Culture & Society vol. 32, iss. 5-6, 2015: 8.

impact on the shift towards scientific practice in the philosophy of science. This turn to post-positivism illustrates that the humanities, social sciences, and natural sciences, which are previously considered as fundamentally separated from each other, in fact, converge on several levels when knowledge production practices themselves are taken into consideration.

Despite the firm belief in some periods in history that the field of knowledge is divided by very sharp and unquestionable boundaries, certain practices, traditions, and loci of knowledge production have always been shared by these different fields which caused a discrepancy between how knowledge is actually produced and how its production is represented in its idealized 'image.' This proposition seems accurate with regard to both the knowledge production practices of architecture and the laboratory. Architecture had to separate its practice to define itself as a strong discipline. Similarly, the reason why laboratories are neglected as an object of study is because "laboratory practices and techniques have always differed in substantial ways from their official description."[501] So while laboratory was seen as the emblematic space of the positivist natural science at the outset, it was, in fact, simultaneously housing such "contested" forms of knowledge production since its inception.

The "practice turn" disrupted the understanding of science as composed of practices rather than theories. This also provided architecture the freedom to embrace its own particular knowledge production practices. There is no direct "borrowing" or "imitation" from either side because, in fact, the initial image of both the sciences and architecture is inaccurate, as stated above. Furthermore, the fact that the investigation of knowledge production practices in the field of architecture refers

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[501] Darren Wershler, Lori Emerson, Jussi Parikka. The Lab Book: Situated Practices in Media Studies. Minneapolis: University of Minnesota Press, 2022. <https://manifold.umn.edu/projects/the-lab-book> (last accessed on 05.10.2021)

back to laboratories shows how significant the laboratory is as a place of knowledge production.

The notion of the laboratory has been subjected to "transformations" since its implementation in the field of architecture in the 2000s. The particular aspects of these laboratories in the schools of architecture should be identified without constructing dualities between art and science, academic and professional, pure and applied, theoretical and practical. These laboratories do not seek to create a superficial scientific outlook by bringing architecture closer to the scientific practice; they are the very products of the fact that science no longer organizes itself in its idealized image; in fact, laboratories enable architecture to return to its nature. The intersection of architecture and laboratory practices demonstrates this as well. Since the particular context that this convergence realized is the schools of architecture, this study needed to take academic institutions as its basis for analysis as they are the "necessary hosts for the erosion of established structures of power" while simultaneously being "perceived as mechanisms for the reproduction of existing systems of domination."[502]

These similarities between knowledge production practices in laboratories and architecture are, in fact, most evident in the learning by doing tradition in the design studio that imposes a project-based pedagogical setting in the university. The studio could be considered as an archaic model resembling the structure of a research laboratory in architecture. It should be noted that certain key aspects of the laboratory concept have invoked architecture to redefine or reproduce its own knowledge production practices in this new locus of knowledge. The previously dispersed loci of knowledge production in architecture such as the classroom, studio, office, field, construction site, etc. was re-conceptualized as laboratories without losing their

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[502] Beatriz Colomina. "Towards a Radical Pedagogy," Andrew Carnegie Lecture Series, Lecture. Edinburgh College of Art, Sculpture Court, 20.11.2014.

original qualities as the concept of the laboratory could easily allocate those. Therefore, the proliferation of laboratories in the schools of architecture is considered more as an evolution than a revolution for the field of architecture.

These laboratories transformed the institutional infrastructure of architecture by enabling collaborations between many different levels. The first level is the collaborations between researchers in the same laboratory, and in the second level, research laboratories are connected to each other in the same school. Moreover, these laboratories do not remain within their institutions, they are also networked with each other in different universities. This network also reaches to the industry since some laboratories have close connections to the construction practice. This collaborative way of knowledge production does not suggest that architecture is in the process of becoming a science, or it attempts to "scientize" itself, however, the similarities between architectural and scientific practices sustained through laboratories should be acknowledged without posing a dichotomy or a comparison between science and architecture.

The analysis presented in this study has been maintained at three different scales: the field of knowledge, the discipline of architecture, and laboratory practices. The similarities and continuities disclosed at these scales are taken as an indication that architecture could organize its own practices more effectively through these research laboratories, as they are founded upon the urge for innovation. The reason why the laboratory is so intertwined with the concepts of invention and innovation is due to its fundamental characteristics, which are already specified in the thesis, such as combining the material and conceptual knowledge production practices, embracing both the production and the representation of knowledge, and providing lateral network relations to enable knowledge exchange across different areas. While these aspects could be listed as the main reasons why the laboratory is considered as innovative, these could as well be the reasons why architecture does not comply with the definition of discipline.

It is possible to interpret this current configuration of the field of architecture as a period of crisis, or as a proto-paradigm period that will stabilize in the near future, or as the new paradigm that emerged after the crisis of the discipline. There is certainly a crisis, a rupture in the field of architecture, as has been the case in many periods of its history. Architecture inevitably produces those crises because of its innovative character, which is supported by its practice. Architecture cannot sustain its innovative identity in a disciplinary setting since discipline needs to limit the urge for innovation for its survival.

The framework that is used to analyze the production of knowledge in this study is developed mainly with reference to Thomas Kuhn and Imre Lakatos' theories of epistemology. Therefore, this current order generated by the recent crisis should be evaluated according to the scientific community's commitment to it. A new order then is a move away from previous conceptualization of the field, and based on the claim that the laboratory phenomenon comes from the genetic lineage of architecture, this study considers this new order as a more fitted way to produce knowledge for architecture.

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APPENDIX

A. Research Laboratories at the METU School of Architecture

There are eight laboratories in the department of architecture at METU, most of which were established in the first decade that the school was founded. [503] Two of the more recent laboratories are Building Simulations Lab and Digital Design Lab, which are both founded after the 2000s. The latest addition is the Building Materials Library, and as the name suggests, it mainly operates as an archive. Similarly, the Model Making Workshop is also listed as a laboratory, even though it lacks the term laboratory in its naming. The educational focus of the graduate programs at the department is visible in the self-descriptions of these laboratories, as they strongly emphasize their role in the school's educational activities. For instance, the Model Making Workshop is defined as a facility by the department which aims to sustain the "half-a-century-long tradition of extensive summer practices" of the school. [504] Similarly, the Digital Design Lab aspires to be the "core of computational design education,"[505] and the Photogrammetry Laboratory aims to provide training for undergraduate and graduate students.

This list of laboratories at METU department of architecture demonstrates the plurality of the laboratory concept that has been highlighted prominently in the study. Some of these laboratories organize themselves as exhibition space, library, workshop, or info-locus. However, it could be claimed that the aspect of the research has been given secondary importance since the term 'research' itself has not been utilized in the descriptions of these laboratories very often. When the term is used, it

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[503] The department of architecture at METU was founded in 1956.

[504] Metu Department of Architecture Website. <https://archweb.metu.edu.tr/en/laboratories> (last accesed 25.12.2021)

[505] Ibid.

is generally accompanied by the notion of “cutting-edge,” which indicates that the urge of “innovation” has not yet penetrated into the operations of these laboratories. Therefore, it is not pertinent to analyze these laboratories within the framework offered by this study which is based on the level of innovation of the laboratories. Indeed, the intention here is not a direct comparison with the laboratories included in this study to the laboratories in the school of architecture at METU. Such a comparison should incorporate an investigation of various issues at many different levels that

CURRICULUM VITAE

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EDUCATION

Degree	Institution	Year of Graduation
M.Arch	METU, Department of Architecture	2015
B.Arch	Gazi University, Department of Architecture	2012
High School	Atatürk High School, Ankara	2007

WORK EXPERIENCE

Year	Institution	Position
2013-2022	METU, Department of Architecture	Research Assistant

PUBLICATIONS

Acar, Zuhal. The Problem of Categorization in Design Research," Impact by Designing, Architectural Research European Network Association Third Annual Conference Proceedings, 2017: 125- 132.

FOREIGN LANGUAGES

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