The Potential of Form. Assessing the transformative potential of existing buildings in post-functional Europe

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The Potential of Form

Assessing the transformative potential of existing buildings in post-functional Europe

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Summary

The adaptive reuse of existing buildings is central to the contemporary architecture debate, in particular, under the light of sustainability. Within this debate, the concept of potential emerges as a commonly-used, but undefined term—its meaning is questionable. In buildings' adaptations, the recovery of "untapped potential" is one of the main adaptation goals. Although the use of the term potential varies in the literature, there appears to be some agreement within the adaptive reuse field that it refers to "unexpressed transformability."

To retrace and define the concept of potential in adaptive reuse, this thesis explores the concept of transformative potential under the lens of morphological features, rather than focusing on functional types, symbolic values and heritage restrictions. The present study proposes a morphological classification with the potential to replace the classical typological classifications.

The current research aims to define, decode, and assess the concept of transformative potential related to the form of existing buildings from a post-functional perspective. These adaptations include heritage buildings as well as those that are not generally labelled as equally worthy of being analyzed for their formal features.

Stemming from the roots of the contemporary preservationist debate, this thesis enlarges the boundaries of adaptive reuse by considering the relative completeness of existing and adapted buildings.

The hypothesis presented in this study addresses the transformative potential in the architectural form, considering this form a state of equilibrium between the structure of space and materials.

The thesis will investigate both the qualitative and quantitative evolution of the form—in morphology and materials—at a specific time, following diachronic and trans-scalar perspectives.

The theoretical objective of this research is to add the concept of transformative potential to the current buildings' reuse debate. This novel notion may then widen the preservation theory in evaluating the existing buildings by "tendencies" embedded in the architectural form.

The task is to express this transformative potential as an open relationship between form contingency in terms of completeness, (de)constructive actions, and embodied energy variations.

A well-established approach in adaptive reuse studies and multiple-case studies is the methodology of this work. Sixteen adaptive reuse cases within the European context during the last fifteen years are selected as 'diverse' morpho-structural types. In addition, the intensive research fieldwork enlarges the main sample to other examples and unexpected cases that place the main case studies under a broader perspective.

The thesis is structured in four chapters; the first serves as a theoretical framework based on a literature review that identifies many kinds of potentials from multiple fields of studies to architecture and adaptive reuse.

The second chapter focuses on the methodology of multiple case studies and the integration of three main methods. Firstly, the evaluation of decay stages applying a reviewed "shearing

layers" method to assess buildings' integrity in time. Secondly, the morphological analysis, which consists of a critical redrawing of original buildings by highlighting dimensional features and configurational aspects and their evolution in the urban context. Thirdly, the retroactive-embodied energy assessment, which shows the flow of primary materials in each reuse activity using an I-O simplified formula.

The third chapter analyzes the sixteen cases, ordered in four main sections according to the completeness of existing buildings: footprint, structure, shell, box.

The last chapter discusses the results on the basis of comparative tables and through the lenses of time opportunities, spatial patterns, and the energy dynamics of form.

In the end, conclusions define the transformative potential related to form *per se* as a non-measurable feature. However, findings lead to defining trajectories in buildings' adaptations. Moreover, four groups of transformative potential are outlined: "palliative," "integrative," "additive," "high-additive." These potentials are a weighted relationship between completeness, design actions, and energy flow.

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Chapter 3

Introduction

Motivation and Background

In preservation theory, cultural heritage studies, and decision-making studies, choosing what to preserve from the totality of urban legacies and how to do it is central to contemporary debate.[1] The choice of preserving something that has required the use of resources is even more relevant in considering the framework of sustainability. In the Western context, the preservation argument has recently expanded to the reuse of existing buildings, regardless of their official heritage label as a function of embracing the sustainability agenda.[2] In the past ten years, particularly in the European context, the phenomenon of reusing existing buildings has increased, and since 2010, the EU renovation market overtook the domain of new buildings.[3] Despite common agreement regarding the reuse of existing buildings as a driver of sustainability in the construction industry, this industry still has the unfortunate role of being the largest consumer of resources and raw materials.[4]

Thus, even without recognizing any heritage value in a current urban legacy, the complete demolition of any historic building to make way for new architecture still seems unthinkable.[5] However, adding, aggregating, combining, expanding, overlaying, and assembling to build something new is very effective in extending the life of existing structures; such urban architectural and landscape infrastructures are already there, and we must take advantage of them.[6]

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[1] Peter Bullen and Peter Love, "A New Future for the Past: A Model for Adaptive Reuse Decision-Making," *Built Environment Project and Asset Management* 1 (July 8, 2011): 32–44, https://doi.org/10.1108/20441241111143768; Peter A. Bullen and Peter E.D. Love, "The Rhetoric of Adaptive Reuse or Reality of Demolition: Views from the Field," *Cities* 27, no. 4 (August 2010): 215–24, https://doi.org/10.1016/j.cities.2009.12.005; Bie Plevoets and Koenraad Van Cleempoel, *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline*, 2019, https://doi.org/10.4324/9781315161440. See Appendix "Preservation Framework."

[2] Carl Elefante, "The Greenest Building Is... One That Is Already Built," *Forum Journal National Trust for Historic Preservation* 27, no. 1 (2012): 62–72, https://doi.org/muse.jhu.edu/article/494514.

[3] Yamin Saheb, "Energy Transition of the EU Building Stock—Unleashing the 4th Industrial Revolution in Europe" (OPENEXP, July 2016), 14, https://www.openexp.eu/sites/default/files/publication/files/Reports/energy_transition_of_the_eu_building_stock_full_report.pdf.

[4] Despite the variety of approaches and views regarding reuse, Foster explains that the social, economic, and environmental output potential is largely recognized. In particular, Foster highlights the parallelism between the principles of circular economy and the approach of reuse in building by explaining the role of the reduction of total resource extraction and waste, as well as the pursuit of human wellbeing. In doing so, Foster shows that the idea of extending the lifespan of buildings has multiple advantages that positively impact the economic and social development of cities. Nevertheless, decision makers lack knowledge regarding the tradeoff between the social, economic, and environmental advantages, as well as the availability of tools in support of such decision making. Gillian Foster, "Circular Economy Strategies for Adaptive Reuse of Cultural Heritage Buildings to Reduce Environmental Impacts," *Resources, Conservation and Recycling* 152 (2020): 104507.

[5] R. Koolhaas et al., *Preservation Is Overtaking Us*, GSAPP Transcripts (GSAPP Books, 2014).

[6] Anne Lacaton and P Vassal, "La Libertad Estructural, Condición Del Milagro," *2G* no. 60 (2011): 162–71.

In this context, the role of adaptive reuse, introduced in the 1970s, has enlarged the range of approaches on existing buildings and the objects of conservation itself.[7]

Moreover, within adaptive reuse possibilities, it could be possible to include the reuse and recycling of some existing building components as well[8] along with conscious loss and decay as part of an adaptation strategy.[9] What if the capability to transform a building would encompass the dichotomy preservation-demolition, by recognizing that the field of preservation might include other conservative practices?

In fact, here, adaptive reuse is considered "the process of reusing an obsolete and derelict building by changing its function and maximizing the reuse and retention of existing materials and structures."[10] Therefore, this definition includes buildings not labelled as heritage and, as such, not acknowledged as objects of preservation in the narrow sense.[11] Consequently, this work focuses on the topic of legacy, which also accounts for heritage discourse, and enlarges the idea of adaptive reuse itself by considering the generative power of non-interventional and even destructive practices.

The search for the best way to convert a structure such that it is able to meet current needs has been traditionally linked to typologies of forms, functional typologies, or technical typologies.[12] Such traditional approaches are contingent upon which function is considered to be suitable according to the typology of the existing building[13], with a particular emphasis on specific functional types, such as industrial buildings.[14] This so-called "typological

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[7] See Appendix "Preservation Framework."

[8] Robert proposes "Recycling materials of vestiges" as an adaptive reuse intervention. P. Robert, *Reconversions, Adaptations: New Uses for Old Buildings*, Architecture Thématique (Ed. du Moniteur, 1989).

[9] A well-established body of literature evaluates the impact of demolition and building material reuse Foster, "Circular Economy Strategies for Adaptive Reuse of Cultural Heritage Buildings to Reduce Environmental Impacts"; Barbara J Thornton, "The Greenest Building (Is the One That You Don't Build!): Effective Techniques for Sustainable Adaptive Reuse/Renovation," *Journal of Green Building* 6, no. 1 (February 1, 2011): 1–7, https://doi.org/10.3992/jgb.6.1.1; Bullen and Love, "The Rhetoric of Adaptive Reuse or Reality of Demolition"; P. Crowther, "Design for Disassembly to Recover Embodied Energy," 1999. According to Chusid (1993, 17-20), buildings that are obsolete or rapidly approaching disuse and potential demolition might be a "mine" of raw materials, quantified as "urban ore."

[10] Sheida Shahi et al., "A Definition Framework for Building Adaptation Projects," *Sustainable Cities and Society* 63 (December 1, 2020): 102345, https://doi.org/10.1016/j.scs.2020.102345.

[11] The concept of adaptive reuse shares some features with other well-known concepts in preservation (i.e., refurbishment rehabilitation, remodeling, and retrofitting), thus highlighting both the lack of a specialized and agreed-upon terminology within the field, and the blurred borders between terms Plevoets and Van Cleempoel, *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline*, 2019; L. Wong, *Adaptive Reuse. Extending the Lives of Buildings* (Basel: Birkhäuser Verlag AG, 2016), https://www.ibs.it/adaptive-reuse-extending-lives-of-libro-inglese-liliane-wong/e/9783038215370; J. Douglas, *Building Adaptation* (Butterworth-Heinemann, 2006). Brand, *How Buildings Learn: What Happens After They're Built*; Douglas, *Building Adaptation.*

[12] Bie Plevoets and Koenraad Van Cleempoel, "Adaptive Reuse as an Emerging Discipline: An Historic Survey," *Reinventing Architecture and Interiors: A Socio-Political View on Building Adaptation*, 2013, 13–32.

[13] R. Machado, "Old Buildings as Palimpsest: Toward a Theory of Remodeling.," *Progressive Architecture* 11, no. Restoration and Remodeling (1976): 46–49; P. Cunnington, *Change of Use: The Conversion of Old Buildings* (London: Alpha books, 1988); Douglas, *Building Adaptation*.

[14] Matteo Robiglio, *RE-USA, 20american Stories of Adaptive Reuse, A Toolkit for Post-Industrial Cities* (Berlin: Jovis, 2017); M. Stratton, *Structure and Style: Conserving Twentieth Century Buildings* (E & FN Spon, 1997); Robert, *Reconversions, Adaptations: New Uses for Old Buildings*; Cunnington, *Change of Use: The Conversion of Old Buildings*.

approach"[15] organizes the built environment through the existing functional typologies instead of analyzing the relationship between the morphological adaptation process, the latter of which is free from functional constraints. In contrast, an architectural approach focuses mainly on the form-form relationship.[16]

However, if we assume that a theoretical framework can help us to divide contemporary practices in adaptive reuse into the fundamental categories of "typological," "architectural," "technical," and "strategic"[17], it becomes evident that there is some overlap between these categories. For instance, many authors might be represented by more than one approach.[18] Thus, focusing on the evolution of form seems to be a more promising perspective when analyzing architectural objects, especially if the original function is no longer active.

Here, the proposal is to explore a morphological approach through time by engaging the concept of potential. Such a shift of perspective in evaluating the existing built environment is based on what existing buildings can physically become in terms of form, despite what they originally were in functional terms. Thus, the concept of potential, which has been highlighted as crucial in adaptive reuse discourse[19], emerges as essential. This shift could be beneficial in outlining a trend embedded in existing buildings, and it might facilitate the adaptive reuse as an inclusive practice capable of fostering a transformative approach within the preservation field meant as "conservation", seeking a proper use of existing buildings, instead of protecting them from use. This novel use of dismissed buildings might be reached through (de)constructive actions, which have an impact in terms of the use of resources and sustainability.

Problem statement and rationale

As mentioned in the previous section, the reuse of existing buildings is a central issue in contemporary preservation debate and carries the power of shaping the future of our cities, both in terms of conservation of memory[20] and of sustainability. Besides, the boundaries of contemporary preservation debate are blurred, and adaptive reuse might play a crucial role in fostering sustainable conservation of the resources embedded in the urban fabric.

In the academic framework, a bibliometric analysis (conducted from 2010 to 2020) has demonstrated a growing interest in combining heritage, adaptive reuse, and sustainable development into a holistic approach to foster both conservation and development.[21] In fact,

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[15] Plevoets and Van Cleempoel, *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline*, 2019, 16.

[16] F.P. Jäger, *Old & New: Design Manual for Revitalizing Existing Buildings* (Basel: Birkhäuser, 2010); G. Brooker and S. Stone, *Rereadings: Interior Architecture and the Design Principles of Remodelling Existing Buildings* (London: RIBA Enterprises, 2004). White, *Path, Portal, Place. Appreciating Public Space in Urban Environments* (Architectural Media, 1999); Robert, *Reconversions, Adaptations: New Uses for Old Buildings*.

[17] Plevoets and Van Cleempoel, "Adaptive Reuse as an Emerging Discipline: An Historic Survey."

[18] Machado, "Old Buildings as Palimpsest: Toward a Theory of Remodeling."; Robert, *Reconversions, Adaptations: New Uses for Old Buildings*.

[19] Jean-Pierre Chupin and Tiphaine Abenia, *Du* Potential *Des Grandes Structures Urbaine Abandonnes / On the* Potential *of Abandoned Large Urban Structures* (Potential Architecture Books, 2017); Robiglio, *RE-USA, 20american Stories of Adaptive Reuse, A Toolkit for Post-Industrial Cities*.

[20] See the Appendix Preservation framework

[21] Yuan Li et al., "Research Frameworks, Methodologies, and Assessment Methods Concerning the Adaptive Reuse of Architectural Heritage: A Review," *Built Heritage* 5, no. 1 (May 4, 2021): 6, https://doi.org/10.1186/s43238-021-00025-x.

within the European context, adaptive reuse is currently one of the central subjects of several projects on the EU agenda.[22] Indeed, the increasing attention being paid to adaptive reuse in both academia and the construction industry demonstrates this topic's growing relevance in architectural theory and practice.

However, little effort has been made to assess which structures are suitable to be preserved (or not) and how from an architectural perspective; rather, the focus has been on integrating preservation studies with sustainability discourse, especially with the objective of developing a methodology not based on ex-ante "values." Despite the overall positive impact of adaptive reuse,[23] integral conservation is neither feasible in cultural, social, environmental and economic terms nor beneficial in fostering the evolution of our cities to accomplish resilience and progress.[24] Accordingly, it might be necessary to consider reuse possibilities that do not ever apply to rigorous restoration projects and/or fixed design solutions.

In architecture, the classification of buildings into typologies to analyze existing architecture and to foster eventual best practices first emerged in the classical treatises spanning from Vitruvius to Durand.[25]

In adaptive reuse theory, a well-established field analyzes existing buildings on the basis of functional classification (i.e., residential, industrial, commercial, or religious). Nevertheless, little attention has been paid to testing a morphological approach in adaptive reuse[26], especially

[22] See the Leeuwarden Declaration, which is specifically focused on adaptive-reuse. Adaptive re-use of built heritage consists of preserving and enhancing the values of our built heritage for future generations.

See Horizon 2020, Getting Cultural Heritage Work, 2020. Available at https://ec.europa.eu/programmes/horizon2020/en/news/getting-cultural-heritage-work-europe. Accessed on 06/06/2021.

See OpenHeritage – Organizing, Promoting and Enabling Heritage Re-use through Inclusion, Technology, Access, Governance and Empowerment, Available at https://ec.europa.eu/futurium/en/system/files/ged/d_1.2_mapping_of_current_heritage_re-use_policies_and_regulations_in_europe.pdf. Accessed on 06/06/2021

[23] C Langston, "The Sustainability Implications of Building Adaptive Reuse," *ERA - Engineering and Environmental Sciences*, January 1, 2008.

[24] Cornelius Holtorf, "Embracing Change: How Cultural Resilience Is Increased through Cultural Heritage," *World Archaeology* 50, no. 4 (August 8, 2018): 639–50, https://doi.org/10.1080/00438243.2018.1510340; Erin Seekamp and Eugene Jo, "Resilience and Transformation of Heritage Sites to Accommodate for Loss and Learning in a Changing Climate," *Climatic Change* 162, no. 1 (September 1, 2020): 41–55, https://doi.org/10.1007/s10584-020-02812-4; G. J. Ashworth, "Conservation as Preservation or as Heritage: Two Paradigms and Two Answers," *Built Environment (1978-)* 23, no. 2 (1997): 92–102.

[25] Jean-Nicolas-Louis Durand and Jacques Guillaume Legrand, "Recueil et parallèle des édifices de tout genre anciens et modern, remarquables par leur beauté, par leur grandeur, ou par leur singularité, et dessinés sur une même échelle," 1801, https://doi.org/10.11588/diglit.1608; J.N.L. Durand, *Précis Des Leçons d'architecture Données à l'école Polytechnique*, Précis Des Leçons d'architecture Données à l'école Polytechnique, v. 1 (L'imprimerie de F. Didot, 1809); C.H. Krinsky, *Cesare Cesariano and the Como Vitruvius Edition of 1521*, 1989.

[26] Dafna Fisher-Gewirtzman, "Adaptive Reuse Architecture Documentation and Analysis," *Journal of Architectural Engineering Technology* 5 (January 1, 2016), https://doi.org/10.4172/2168-9717.1000172.

with respect to the integration between a form-form relationship [27] and a more practical approach within morphological studies. [28]

In the field of restoration, building types might be seen as modes of building that have evolved across history and are now stabilized, according to a pattern and form. Besides, these types are the result of tradition and situations by archeological remains, which includes geomorphological configuration of the site, climate, the technical evolution of building and constructive habits and the presence of the raw materials for construction. [29]

Therefore, a novel perspective in architecture could be unrelated to either fixed typologies or historical values by considering the transformation of existing buildings in terms of "potential," while spatial capabilities to evolve are explored within existing morphological and material conditions. [30]

Research Aim and Objectives

This research aims to introduce and define the concept of "transformative potential" of existing buildings through a post-functional perspective in the European context. Specifically, the thesis defines existing buildings—both heritage listed and not—in terms of "potentials." The research focuses on the only physical aspects of buildings. In doing so, the impact of functional purpose and symbolic values are not considered. Purposely, the eventual status of heritage-listed buildings is not taken into account. The choice to place this research in "post-functional Europe" refers both to the geographic-cultural context of this analysis and to the object of analysis. Specifically, "post-functional" means uncharacterized by its original functional purpose. In other words, the scope of this research is within the European context of contemporary intervention on buildings that are not (anymore) characterized by a stable functional purpose. This "post-functional" condition is undeniable in the case of dismissed buildings , that are eventually adapted to accommodate new uses.

The building's form is therefore investigated, regardless of legal, normative, heritage, symbolic value, and functional concerns.

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[27] Brooker and Stone, *Rereadings: Interior Architecture and the Design Principles of Remodelling Existing Buildings*; White, *Path, Portal, Place. Appreciating Public Space in Urban Environments*; Jäger, *Old & New: Design Manual for Revitalizing Existing Buildings*. This so-called form-form relationship has been outlined by Plevoets, Bie, and Koenraad Van Cleempoel in Plevoets, Bie, and Koenraad Van Cleempoel. *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline*. London: Routledge, 2019. https://doi.org/10.4324/9781315161440.

[28] R.H. Clark and M. Pause, *Precedents in Architecture: Analytic Diagrams, Formative Ideas, and Partis* (Wiley, 1985); F.D.K. Ching, *Architecture: Form, Space, and Order*, 1st ed. (New York: Van Nostrand Reinhold, 1979).

[29] P. Marconi, *Il Recupero Della Bellezza*, Architettura: Saggi (Skira, 2005).

[30] In the "Atlas of Novel Tectocnics," Reiser and Umemoto (2006) describe Goethe's essential plant in terms of potential (63). They further define the meaning of "potential" in architecture by quoting Aldo Rossi's *Autobiografia Scientifica*. Here, Rossi evokes the concept of potential as a latent power embedded in a building's materials: "The mason was stuck by the fact that expanded energy does not get lost; it remains stored for many years, never diminished, latent in the block of stone until one day it happens that the block slides off the roof and falls on the head of passerby… in architecture this search is also undoubtedly bound up with the material and its energy; and if one fails to not take note of this, it is not possible to comprehend any building, either from technical point of view or from a compositional one. In the use of every material there must be an anticipation of construction of a place and its transformation" A. Rossi, *A Scientific Autobiography*, Oppositions Books (MIT Press, 1981).

Evaluating a built structure in terms of potential means shifting the approach from asking "what does it mean" to "what does it do."[31] Here, the proposal is to deconstruct the classical typological classification and put a morphological framework in its place, assuming the questionable role of the new building over the sheer amount of built stock in the present.

As Goethe's essential plant is presented in terms of potential, where elements comprise a complex system, it might be defined through capabilities to evolve instead of using deductive reasoning to categorize it a priori.[32]

To embrace an inductive approach, this research attempts to first explore the theoretical concept of potential; although it has been widely applied within the narrative surrounding adaptive reuse studies, it still has a nebulous meaning.

Many authors refer to the concept of "potential" in general terms, where the "untapped potential" in existing buildings is an unstated value waiting to be released.[33] However, the act of rescuing such an "untapped potential" of dismissed buildings emerges as an adaptation goal. By referring to post-preservation and counter-preservation theories, as well as non-intervention practices, the concept of potential is embedded with the meaning of unavoidable change by not-architects, nature, and time.[34]

The hypothesis addresses this transformative potential in the architectural form by considering such a form as a state of equilibrium between the structure of space and materials.[35] This "equilibrium" changes, evolves through time under decay processes and through architectural interventions. The work intends to define this potential in terms of an operative view through its elements in the architectural realm. At first, dismissed buildings are considered post-functional vessels of memory free from function constraints and valuable in terms of their inherent qualities.[36] Second, time is deemed a proper physical dimension of architecture that actualizes itself through the decay of the material that makes up the building.[37] Finally, through the assumption of an ideal-type model, schematizations of reality simplify such a complex system, which is otherwise not transmissible in design applications.[38]

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[31] Reiser and Umemoto, *Atlas of Novel Tectonics*, 23.

[32] J.W. von Goethe, *Versuch Die Metamorphose Der Pflanzen Zu Erklären* (Ettinger, 1790).

[33] Douglas, *Building Adaptation*; P. Oswalt, *Urban Catalyst: Strategies for Temporary Use* (Actar-D, 2008); Chupin and Abenia, *Du* Potential *Des Grandes Structures Urbaine Abandonnes / On the* Potential *of Abandoned Large Urban Structures*.

[34] J. Hughes and S. Sadler, *Non-Plan: Essays on Freedom Participation and Change in Modern Architecture and Urbanism* (Architectural Press, 2000); Daniela Sandler, *Counterpreservation*, ed. Peter Uwe Hohendahl, 1st ed. (Cornell University Press, 2016), www.jstor.org/stable/10.7591/j.ctt1d2dnjg; Caitlin Desilvey, *Curated Decay: Heritage Beyond Saving* (University of Minnesota Press, 2017).

[35] A. Borie, P. Micheloni, and P. Pinon, *Forme et Déformation Des Objets Architecturaux et Urbains*, Eupalinos (Marseille: Parentheses Eds, 1978), https://www.editionsparentheses.com/forme-et-deformation-des-objets; Reiser and Umemoto, *Atlas of Novel Tectonics*; Rossi, *A Scientific Autobiography*; Ching, *Architecture: Form, Space, and Order*.

[36] Alessandra Latour, "Remarks, 1965," in *Louis Kahn: Writings, Lectures, Interviews*, Rizzoli (New York, n.d.), p.197-219.

[37] Desilvey, *Curated Decay: Heritage Beyond Saving*; D.M. Abramson, *Obsolescence: An Architectural History* (University of Chicago Press, 2016); S. Cairns and J.M. Jacobs, *Buildings Must Die: A Perverse View of Architecture*, Mit Press (MIT Press, 2014); S. Brand, *How Buildings Learn: What Happens After They're Built* (Penguin Publishing Group, 1995); Francis Duffy, *The Changing Workplace* (London: Phaidon Press, 1992).

[38] (Weber, Shils, and Finch 1949; Moles 1951, 1958)

Research Methodology (Overview)

This work relies on a multiple case study analysis, which combines three methods from a diverse field of studies (morphology, adaptive reuse, environmental engineering) and intensive fieldwork documented through a digital atlas of examples.[39]

In the field of architecture, a case study methodology is a well-established approach in the adaptive reuse field.[40] Starting with Durand's planches, case studies within academia have become a scientific methodology.[41] This study reviews sixteen well-known cases of adapted buildings that emerged in the European context within the last fifteen years.

The cases were not selected based on the functional classification of existing buildings or on historical time and heritage labels. On the contrary, the selection process considered original buildings from diverse epochs and multiple functional types. The selection criteria included the stage of decay of the existing structure at the time of adaptive reuse design and the variety of dimensional and structural articulations.

Such a morpho-structural variety follows the logic of the Weberian *idealtypus*,[42] which represents an unreal conceptual framework that serves as a template or a scheme of reality that discloses its significant elements. Such a draft classification ex-post of existing buildings as morpho-structural types could lead to the expansion of future findings to the whole category.

Considering morphological and structural conditions crucial in delivering adaptation projects,[43] the case study selection process encompassed various intervention theory approaches[44] and included minimal intervention and ruination[45] as a design possibility. Thus, the cases include adaptation projects with interventions ranging from radical to minimal that started from a diverse stage of decay of the original building.

To explore these cases without losing a broad perspective, an intensive 40-day fieldwork session around Europe was conducted during the summer of 2021. This research journey was motivated not only by the desire to explore the case studies but also due to the intention of collecting a high number of examples of building adaptation (more than 40) and several unexpected cases (more than 20) to build an open atlas with geo-references and tags.[46]

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[39] See the ongoing project *Atlas of* Potential started by the author in July 2021. Available online at https://www.atlasofpotential.com/.

[40] Plevoets and Van Cleempoel, *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline*, 2019; Dan Barasch, *Ruin and Redemption in Architecture*, Phaidon, 2019; Robiglio, *RE-USA, 20american Stories of Adaptive Reuse, A Toolkit for Post-Industrial Cities*; Wong, *Adaptive Reuse. Extending the Lives of Buildings*; Jäger, *Old & New: Design Manual for Revitalizing Existing Buildings*; Brooker and Stone, *Rereadings: Interior Architecture and the Design Principles of Remodelling Existing Buildings*.

[41] For Durand, classification into typologies is finalized to allow for a critical replication (J. N. L. Durand 1809). However, from the nineteenth century, architectural research was recognized as a scientific product because of the application of a "scientific method" (Caballero Lobera 2017). This rationalist-based architecture often employs inductive reasoning based on the observation of a particular phenomenon.

[42] Weber, Shils, and Finch, *The Methodology of the Social Sciences*.

[43] Douglas, *Building Adaptation*.

[44] White, *Path, Portal, Place. Appreciating Public Space in Urban Environments*; Brooker and Stone, *Rereadings: Interior Architecture and the Design Principles of Remodelling Existing Buildings*; Jäger, *Old & New: Design Manual for Revitalizing Existing Buildings*; Robert, *Reconversions, Adaptations: New Uses for Old Buildings*; Wong, *Adaptive Reuse. Extending the Lives of Buildings*.

[45] Plevoets and Van Cleempoel, *Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline*, 2019.

[46] See more on the online map of the *Atlas of* Potential, available at: https://maps.mapifator.com/places/FGNNhKFJhsyvsW6Nt5xE.

The method used is based on multiple investigation methodologies that integrate architecture-related studies on building morphology with adaptive reuse studies and explore the possible application of embodied energy in existing buildings. This integrated approach underlies a certain degree of simplification of the individual disciplines involved, with the awareness that the limitations are derived from a cross-disciplinary approach and might affect the separate disciplines' results in a strictly monodisciplinary context.

The research methods integrate 1) decay stage evaluation, 2) morphological analysis, and 3) retroactive-embodied energy assessment.

The first method of decay evaluation involves "shearing layers";[47] here, the method is intended to assess the building integrity in time, starting from how many layers are in place before and after the adaptive reuse intervention. Such a method constructs and investigates four families of cases. This analysis assumes that decay influences the presence of shearing layers and their relative completeness and that not all these layers may be required to define a "building."

The second method, morphological analysis, consists of the critical redrawing of original buildings and highlights the dimensional features and configurational aspects.[48] The building, in its urban context, is analyzed through schemes, which propose a simplification of reality that makes the physical evolution that takes place through a design project evident.[49]

The third method, embodied energy analysis, retraces the preserved, added, removed, or displaced materials during the reuse activity.[50] The embodied energy assessment applies the survey model of Input-Output analysis for the primary structural materials by employing a simplified formula.[51]

Scope and Limitations

As previously introduced, this thesis's theoretical scope is to propose the concept of "transformative potential" within the reuse of existing buildings in the European context. Furthermore, this novel notion may shift the approach to the existing legacy by adopting a post-functional perspective in evaluating existing buildings according to a "tendency," and as a "space of possibilities."[52]

Therefore, the task of this thesis is to express the transformative potential as a relationship between the decay rate, dimensional features, and embodied energy, which will then allow for a pattern to be outlined between existing features and adaptive reuse interventions that may help future interventions into dismissed buildings. Such a transformative potential may unfold

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[47] Brand, *How Buildings Learn: What Happens After They're Built*; Duffy, *The Changing Workplace*.

[48] Ching, *Architecture: Form, Space, and Order*; Clark and Pause, *Precedents in Architecture: Analytic Diagrams, Formative Ideas, and Partis*.

[49] Borie, Micheloni, and Pinon, *Forme et Déformation Des Objets Architecturaux et Urbains*.

[50] Mike Jackson, "Embodied Energy and Historic Preservation: A Needed Reassessment," *APT Bulletin: The Journal of Preservation Technology* 36, no. 4 (2005): 47–52; D.N. Benjamin, *Embodied Energy and Design: Making Architecture Between Metrics and Narratives* (Columbia University GSAPP, 2017).

[51] Advisory Council on Historical Preservation, "Assessing the Energy Conservation Benefits of Historic Preservation: Method and Exeples," January 1979.

[52] M. DeLanda, *Intensive Science and Virtual Philosophy*, Series Editor (Bloomsbury Academic, 2002).

the traditional classification by original functions. In particular, the integrated method proposed is itself a novel methodological tool in evaluating the existing buildings to unveil the transformative potentials related to form through a comparative perspective. This tool needs to be adapted to specific situations and the unicity of each urban and historical context and does not represent a set of unique answers for preexistences or a ready solution to deliver effective projects on existing buildings. To do so, this work represents the first step in proposing this concept, testing it on a number of case studies, and drawing some conclusions to be expanded according to weaknesses and limits that have emerged.

Nevertheless, this work has some limitations. First, this investigation explores the relationship across three main features that comprise the physicality of the building (time, space, and matter), which constitutes a conscious partial reading. The role of functional purposes is not considered, and neither is the symbolic value of these legacies. This choice is driven by the scope of this analysis, which wants to unveil the features of architectural form that drive some kind of transformations in morphological terms. However, this kind of transformative potential does not exclude the relevance of other narratives and layers of analysis, and in fact, does quite the opposite by recognizing its partial nature and encouraging integration with the social, economic, and normative framework to provide an overall analysis in the adaptive reuse practice. A second problem might be that the scope of this thesis may be too broad; nevertheless, this work is intended to serve as an exploratory test of a novel approach, and according to the conclusions, further research to expand the depth of this topic is therefore suggested. Finally, the proposal of applying the integrated method as a tool represents an extreme simplification of the issues concerning the adaptive reuse of existing buildings by evaluating a relatively small sample of adaptive reuse projects. However, this study aims to be applied to a larger set of cases in further research applications.

The supplemental work of the "Atlas of Potential" represents a potential source of European cases of building adaptation, which might be useful for university students and researchers as a repository of potential case studies and to display the adaptive reuse a widespread phenomenon. Furthermore, its open structure allows for the continuous expansion of information and places to provide a larger sample of analysis in the following years.

The ideal user to test the output of this research would be a public administrator more than a developer. Indeed, municipalities, regions, and national governments need to delineate a broad strategy to preserve a high building stock with scarce resources. The methodological approach and the concept of transformative potential as proposed aims to help these users carry out comparative analysis on their existing buildings stock. It is important to remark that any index or closed formula is proposed. On the contrary, the methodological approach wants to set the basis for analyzing the impact of eventual adaptive reuse by including minimal interventions strategies and the impact of interventions in terms of sustainable use of resources. This research could provide a methodological base to be tested further to homogeneous spatial assets in terms of existing morphology.

Research Structure

This thesis is divided into four main chapters: the first focuses on a critical literature review, the second explains the integrated methodology applied, the third reports the case study

analysis, and the fourth discusses the findings. In the end, the conclusions highlight a broad classification in terms of transformative potentials and further applications in the adaptive reuse practice. Moreover, a glossary of key terms will support the reading of each chapter. The chapters consist of three or four subchapters and several thematic paragraphs. Moreover, an Appendix on preservation aims to provide an overview of the current Western preservation theories that embrace change.

In Chapter 1, the interdisciplinary literature review starts from an etymological survey across time and then explores the notion of "potential" in post-structuralist philosophy.[53] It then underlines prominent theories in math and physics that shaped the potential as a secular concept,[54] including the idea of potential in the social sciences and evolutionary biology.[55] However, some features of potential emerge as a set of behaviours that are shared between diverse disciplinary contexts. Then, this chapter critically reports the primary metaphorical and analogical references to the concept of potential in architecture and urban studies as "incomplete," "indeterminate," "loss," "chance," "latency" and "capability to change."[56] To conclude, the last sub-chapter reviews the literature in the adaptive reuse field,[57] where among several kinds of potential*s*, the transformative one emerges as central in the context of buildings' evolution. In conclusion, the research sets its focus on developing the idea of transformative potential that relies on the physical features of existing buildings that have faced an adaptive reuse intervention. In particular, this chapter proposes the transformative potential as a metric of building form evolution, both qualitative and quantitative, and in terms of morphology and materials, at a specific time according to diachronic and trans-scalar perspectives.

Chapter 2 illustrates the methodological framework applied in this work. First, a brief introduction focuses on the multiple case study technique employed as the lead methodology. Then, case study selection is argued on the basis of decay stage acknowledgement and the classification of a morpho-structural type. Second, the chapter explores modes and the contribution impact of the intensive fieldwork conducted to support this research and create an atlas of contemporary adaptive reuse examples in Europe. Moreover, other sources and materials involved and their application within the work are critical arguments. To conclude, the three methods (decay evaluation, morphological analysis, and embodied energy assessment) are explained in depth.

In Chapter 3, each case study is examined with the use of an analysis form. Cases are organized into four subchapters: "footprints," "structures," "shells," and "boxes." This articulation follows the layers' completeness of each building at the moment before the adaptive reuse intervention started and represents the first step of decay stages analysis.

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[53] DeLanda; Françoise Jullien, *Traité de l'efficacité*, Biblios Essais (Grasset, 2002).(DeLanda 2002; Jullien 2002)

[54] Richard P. Feynman, Robert B Leighton, and Matthew L. Sands, *The Feynman Lectures on Physics*, Reading, Mass (Addison-Wesley Pub. Co., 1963).

[55] A. H. Maslow, "A Theory of Human Motivation.," *Psychological Review* 50, no. 4 (1943): 370–96, https://doi.org/10.1037/h0054346; Niles Eldredge and S. Gould, "Punctuated Equilibria: An Alternative to Phyletic Gradualism," in *Models in Paleobiology*, vol. 82, 1971, 82–115; Stephen Jay Gould and Elisabeth S. Vrba, "Exaptation-A Missing Term in the Science of Form," *Paleobiology* 8, no. 1 (1982): 4–15.

[56] See 1.2.1 and 1.2.2 in References

[57] Douglas, *Building Adaptation*; Brand, *How Buildings Learn: What Happens After They're Built*.

Chapter 4 discusses the findings by employing a cross-comparison between the cases through the lens of de(constructive) actions, both in quantitative and qualitative terms. Moreover, the selected cases are compared in terms of interventions to the examples visited during the fieldwork journey and other well-established cases in the literature. The findings lead to the development of trajectories of form evolution across time, in terms of adaptive reuse interventions that modify the space and the matter of existing buildings. A set of "transformative potential*s*" are proposed on the basis of case studies analysis: "palliative potential," "integrative potential," "high additive potential," "additive potential." Such transformative potentials are expressed in terms of equilibria between completeness of exiting building, design actions, and sustainability.

The conclusion shows how conscious decay approaches and radical design projects may show a transformative potential that is worth to be considered in terms of relative balance. The conclusion includes some remarks on how the concept of transformative potential might help support interventions in buildings that lost their original purpose.

Conclusions

This thesis frames the concept of transformative potential related to buildings' form, by considering the form as a stage of equilibrium between space and matter. This equilibrium is explored through a novel multiple case studies analysis that joins three main methods: the decay analysis through the shearing layers theory, the morphological analysis through a critical redrawing procedure, and the assessment of materials flow through the embodied energy evaluation. As happened in the biological evolution of forms, existing form changes under a set of specific actions and triggers, defining new morphologies that were not originally planned.[766]

The literature review has demonstrated that the concept of potential allows to embrace a paradigm shift that evaluates the essential feature of architecture based on what this item is capable of doing rather than how it has traditionally been characterized and the embedded energy as a malleable stage of matter and space.[767] These buildings, not defined by their symbolic value or functional use, are worthy to be analyzed in forms' transformation only.

Here, these adaptive reuse projects are explored in terms of physical transformations only. The literature review has provided a broad perspective on the concept of potential itself. This ex-post analysis highlighted a mutual set of relationships between time, space, and matter across adaptive reuse processes. Applying a phenomenological approach, this potential is mainly explored in the moment before the adaptation and at the times of (de)constructive actions.

This analysis does not explore the other kinds of potentials but does not exclude the high relevance of these other potentials to influence the adaptive reuse processes.

In the end, some trajectories of transformative potential*s* are represented. Such trajectories are relatively exclusive but not univocal in absolute terms. These trajectories show realized tendency of existing buildings, embedding the exclusion of other potential trajectories. The transformative potential is therefore displayed as a set of trajectories of architectural forms' evolution. These trajectories show that deconstructive approaches are mostly carried. Existing buildings are partially demolished, some elements are removed, not for being replaced but to allow the insertion of other grafts.

Considering the potential in comparative terms, four groups of transformative potential*s* are proposed: 1) palliative potential, 2) integrative potential, 3) additive potential, 4) high additive potential. These groups represent a transition from linear to non-linear causation by not only considering the capacity to impact but by including another capacity to be affected,[768] bringing together existing completeness, (de)constructive actions, and embodied energy impact in a comparative perspective. Completeness is expressed in terms of shearing layers, design

[766] Gould and Vrba, "Exaptation-A Missing Term in the Science of Form," 6.
[767] Rossi, *A Scientific Autobiography*.
[768] For instance, shifting the focus from the load's ability to push to a specific materials tendency to be pushed. DeLanda, *Intensive Science and Virtual Philosophy*.

interventions in terms of weighted actions, and energy impacts in terms of weighted embodied energy impact between old and new.

These transformative potentials are equally worth being considered, according to their strengths and weaknesses. The "palliative potential" requires minimal (de)constructive actions and embedded energy starting from uncompleted buildings in terms of layers. This potential is not actualized through the completeness of the existing, on the contrary, it delineates morphologies that are open to hosting a wide range of further design actions. Similarly, in terms of open-end transformations that happen in the cases of the "integrative potential," minimal actions from buildings' fragments are integrated through the high use of weighted energy. In other words, these transformations have relatively high energy embedded in added materials and the design of a novel morphology from scarce remains through a minimal layer addition. On the other hand, the additive potential is distinguished by a strong engagement in de(constructive) actions despite relative initial completeness and a low influence of weighted embodied energy. Then, the high-additive potential is characterized by the entire completeness of the original building and a significant increase of added elements over existing ones, both in terms of layers and embodied energy.

These types of transformative potentials would require to be explored further, especially in terms of the relationship with the existing and adapted morphology, and always intended as complementary to others potentials.

Along with this research, several additional inputs have emerged:

First, changes are not just realized through the constructive process, because they usually require deconstructive phases instead, and stages of relative completeness are equally relevant in buildings' adaptation. Most cases have shown deconstructive phases. However, it is a matter of fact that with fragments of existing buildings, any adaptive project has applied high deconstructive approaches, both in terms of layers and materials. Starting from fragments, these projects always tend to conserve what is presented.

Second, decay stages in terms of layers completeness have shown a strong correlation to design actions only if such actions are considered to be related to a specific morphology. In the sample analyzed, the morphologies are too heterogeneous to delineate general assumptions in terms of transformative potential. The attempt to define cross-relationship between old and new to be generalizable would need a larger sample. In fact, the additional "examples" and "unexpected" prefigurate a further in-depth analysis.

However, a series of existing/transformed morphologies has emerged in each case: 1) urban enclosure/open urban box; 2) isolated track/platform circuit; 3) spine walls/urban nook; 4) foundation/ideal frame; 5) platform/elevated box; 6) container frame/caged cylinder; 7) shed frame/open canopy; 8) round plates/panoramic exoskeleton; 9) clustered slab/incremental stripe hub; 10) grid block/infilled modular box; 11) court active ruin/ ruin shell; 12) under-demolition pavilion/multilayer square; 13) rotunda/multilevel ring; 14) tripartite shed/ interior panoramic shelf; 15) polygonal box/ overflowing building; 16) polymorph court block/permeable court block. These morphologies might be explored in-depth applying the same methodological approach of this thesis but focusing on analogous existing morphologies to highlight a more accurate pattern in deformations.[769]

[769] See Figure 343) Schemes of Examples and Unexpected.

Third, embodied energy and materials play a crucial role in defining the potential for transformation under the light of sustainable use of resources. In fact, some transformations are more sustainable than others. Assuming that the concept of potential is for definition linked to a future prefiguration, this potential might retrace trajectories more sustainable than others. This sustainable use of resources is not only in terms of addition and demolitions required to adapt a building,[770] but also in assessing a hierarchy of conservation of existing buildings. Some buildings, even if they have lost their functional purpose, might be worth being conserved in terms of energy embedded in their original materials still *in situ*.[771]

The methodological approach of this research is willing to be applied to further comparative analysis between a sample more homogeneous. Assuming a layers' completeness not always to be reached through adaptive reuse projects, the integrated methodology proposed here aims to be functional of being tuned and specified in adaptive reuse theory and have an eventual influence in the evaluation of existing buildings to foster the acceptance of a broader range of design solutions.

The transformative potential as framed in this research would be quantifiable in comparative terms only, by being tested on a large and morphologically homogeneous sample and establishing a scope of this potential.

Further research to expand the depth of this topic is therefore suggested, following three complementary directions: 1) enlarging the sample 2) analyzing similar morpho-structural types 3) assuming a goal-oriented approach.

To conclude, this research is the first step towards an integrated approach that aims to evaluate the existing building stock transformed in terms of form to highlight both best practices according to decay levels assumed as unavoidable in the existing building fabric. In doing so, this novel approach proposes a shift from a typology framework to a morphology one as it is able to foster a sustainable approach in building adaptations by working on transformative patterns instead of the dichotomy between old and new.

[770] See Figure 350) Constructive actions in terms of embodied energy impact, and Table 10) Deconstructive actions in terms of embodied energy.

[771] See Table 8) Embodied energy absolute values in MJ.