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## Renovation of social housing

*a tectonic dialogue between past and present?*

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# RENOVATION OF SOCIAL HOUSING: A TECTONIC DIALOGUE BETWEEN PAST AND PRESENT?

Stina Rask Jensen, Marie Frier Hvejsel, Poul Henning Kirkegaard,  
and Anders Strange

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## ABSTRACT

The built environment can be seen as a spatial continuum in constant alteration. When a building is renovated, we inevitably enter into a dialogue with this continuum. The motivation to alter a building may be decay and change in use or, as has been the case in Denmark in recent years, environmental and legislative demands for energy optimization. The vast majority of the existing building mass will still be in operation in 2050; and as such, the issue of energy renovation forms an important part of strategies to reduce the overall energy consumption in the building sector. However, such energy renovations dramatically influence the experience of the built environment. This calls for new strategies to articulate and maximize the spatial potential within the technical transformation process in critical dialogue with the existing construction. This article investigates whether the development of a tectonic approach to energy renovation might offer such a strategy. Methodologically, this is done by rereading the task of energy renovation through the lens of tectonic architectural theory. Specifically, Eduard Sekler's etymological distinction between structure, construction, and tectonics, together with Fred Scott's gradation of alterations, forms the basis for developing a theoretical framework for addressing the spatial implications of technical renovation initiatives. The tentative framework is applied in a comparative analysis of two case studies in order to illustrate that similar technical concepts, such as improvements of the thermal performance of the building envelope, can affect the perceived spatial quality differently depending on the applied strategy of alteration. As a conclusion, the article outlines a potential for positioning the question of spatial quality in the early design phases of energy renovation projects by means of tectonic thinking.

## KEYWORDS

tectonics, energy renovation, architectural alteration, social housing

## INTRODUCTION

‘... designers work with that of others who have preceded them, when working to alter a building, and also in precedence of those who will come after them. The work of intervention and alteration is thus collective, across generations . . .’<sup>1</sup> In this phrase, Fred Scott advocates an understanding of the built environment as a spatial continuum in constant alteration. When a building is renovated, we inevitably enter into a dialogue with this continuum.

The motivation for altering a building may be decay and change in use or, as has been the case in Denmark in recent years, environmental or legislative demands for energy optimization. The vast majority of the existing building mass will still be in operation in 2050, and as such the question of energy renovation is crucial when aiming to reduce the overall energy consumption in the building sector. This is especially relevant within the domain of social housing. In Denmark, there are approximately 600,000 social housing units. The majority of these units were built before the introduction of demands for energy performance in the national building regulations in the late 1970s. Thus, there is a significant potential for reducing the overall energy consumption in the building sector by addressing this particular typology.<sup>2</sup>

It is well recognized that the planned transformation towards a more energy-efficient building mass is likely to influence the experience of the built environment dramatically.<sup>3</sup> When a dwelling is renovated, we face a vastly different task than that which comes with building from ‘scratch’, as we inevitably enter into a dialogue with the existing and the coming.<sup>4</sup> However, recent research has identified that limited attention is being paid to the vital aspect of experienced architectural quality in contemporary energy renovation practice.<sup>5</sup> In 2015, Ulrik Stylsvig Madsen and Anne Beim carried out a comparative study of eight evaluation methodologies with relevance for the Danish building renovation industry.<sup>6</sup> Based on the study, the authors highlighted an apparent emphasis on technical, quantifiable values and advocated a need to include qualitative sociocultural values in future evaluations in order to secure a holistic approach.<sup>7</sup> This is supported by the Norwegian researchers Fernanda Acre and Annemie Wyckmans who state that ‘... the inattention to the potential of nontechnical dimensions such as spatial quality, by stakeholders involved in the energy renovation of dwellings, constitutes a lost opportunity to increase occupants’ receptiveness to energy renovation.’<sup>8</sup> Furthermore, it could be argued that inattention to the potential of spatial quality represents a lost opportunity to secure a long-term sustainable solu-

tion in which we do not look at value as something static, but rather focus on how the building can stay valuable to society and its inhabitants over time. According to Fred Scott ‘... the purpose [of altering a building] is to work the existent and the ideal together through the process of intervention, to keep the existing occupied and significant.’<sup>9</sup> In this line of thought, energy renovation can be seen as an opportunity to secure such significance and add value to the inhabitants through attention to the implications of energy-saving initiatives on the perceived spatial quality.

Yet how should this issue be approached? One suggestion is put forward in the popular science publication *Arkitektur Energi Renovering* (Architecture Energy Renovation). The authors propose a design guide for working holistically with aspects related to energy consumption, indoor climate, and ‘improved spatiality’ simultaneously.<sup>10</sup> The design guide is divided into three typologies: single-family homes, multistorey dwellings, and offices. It provides simple tools, suggestions for strategies, and cases which exemplify added value.<sup>11</sup> The format ensures a ‘hands on’ guide for practicing consultants, which to the authors of this article represents great strength in early phases of renovation projects where design freedom is still relatively high, but knowledge about the project in its entirety remains limited. However, when zooming in on softer themes, such as ‘improved spatiality’, limited elaboration of the terms are offered. As such, they still appear less explicitly articulated than their more quantifiable counterparts.<sup>12</sup>

There still seems to be a gap in the way we articulate and address technical quantifiable, ‘hard’ aspects, such as reductions in kWh/m<sup>2</sup>, to qualitative, ‘soft’ aspects related to spatial quality. In order to address this gap, the authors of the present article put forward the following research question:

*Can a tectonic approach to energy renovation help to provide a framework for articulating the potentials of technical energy-saving initiatives on the perceived spatial quality?*

The research presented in this article forms part of the national research project REVALUE (Value Creation by Energy Renovation and Transformation of the Built Environment – Modelling and Validating of Utility and Architectural Value), which is conducted by the Department of Engineering and the Department of Public Health at Aarhus University in collaboration with ten partners in the building industry. The research project is dedicated to iden-

tifying potentials for added value in building renovation. This article is built on the assumption that attention to spatial quality represents an important source of potential added value for the inhabitants.

## METHOD

The first part of the article is devoted to the development of a theoretical framework based on a rereading of Eduard Sekler's tectonic architectural theories combined with writings by Fred Scott on alterations in architecture. In this matter, Sekler's tectonic theory provides a vocabulary for articulating the relation between technical initiatives and the implication on perceived spatial quality. By combining this approach with Fred Scott's writings on renovation theory, we aim to relate tectonic theory to the domain of renovation which is by definition centred on alterations to an existing building and an understanding of our initiatives not as something final, but as a downstroke in a continuum.

In the second part of the article, the developed framework is applied in a comparative analysis of two renovation cases, namely Park Hill in Sheffield, UK, and Rosenhøj in Aarhus, Denmark. They were selected as two complementary cases related to Scott's alteration spectrum on how to approach (energy) renovation.<sup>13</sup> One represents a listed project, focusing on a combination of preservation and reinterpretation, and the other represents an approach focused on renewal. Hereby, a comparative study of the two opens up a potential to study whether or not the introduction of a tectonic lens in the context of energy renovation can help to articulate the consequences and potentials of technical initiatives on the perceived spatial quality across Scott's alteration spectrum. The housing estates were both built in the 1960s and have been renovated within the last decade.<sup>14</sup> Despite differences in scale and layout for example, they represent comparable cases in terms of typology and age. This allows for the focus on the applied renovation initiatives and how they have affected the perceived spatial quality. The case studies are based on literary references and interviews with representatives of the renovation teams.

Lastly, the article discusses perspectives and potentials for developing and implementing the tectonic analysis framework as a critical means for positioning the question of spatial quality in the early stages of renovation projects.

## A TECTONIC APPROACH TO ENERGY RENOVATION?

Throughout the history of architecture, the notion of tectonics has been applied as a critical means to discuss the task, role, and responsibility of the architect in bringing together technique and aesthetics. In this article, we reintroduce tectonic theory as a starting point for addressing energy renovations and establish a link between technically motivated alterations and the spatial experience of the building.

The term 'tectonic' derives from the Greek word *tekton* which signifies a carpenter or a builder. Throughout history the term has developed to signify what Kenneth Frampton refers to as 'poetics of construction', a linkage between a given construction of a space and the way people experience that space.<sup>15</sup> The notion reappeared in German architectural theory around 1850 as a response to the eclectic formal development of architecture and its relation to a possible meaningful exploitation of emerging industrial technology.<sup>16</sup> In the wake of postmodernism, the application of tectonics as a lens through which to discuss a meaningful development of architecture rooted in primordial aspects of dwelling, on the one hand, and in exploiting technological inventions, on the other, reappeared, for instance in the writings of Kenneth Frampton. In current research, this interest in tectonics seems to be increasing, lately being associated with the question of ecology as well.<sup>17</sup> This article builds upon this foundation with the aforementioned attempt at applying tectonics as a critical means of articulating the spatial potential of technical energy-saving initiatives. The article leans in particular on Eduard Sekler's etymological study of tectonics. The reasoning for doing so is that his studies represent a relatively clear theoretical framework for addressing the interrelation between technique and spatial quality. In his 1964 essay 'Structure, Construction, Tectonics', Sekler defines tectonics as 'the noble gesture which makes visible a play of forces, of load and support in column and entablature, calling forth our own empathetic participation in the experience'.<sup>18</sup> He thus establishes a link between what he refers to as the structural concept and the way it ultimately affects the experiencing subject through spatial 'gestures' once the structural principle is manifested, or realized, in concrete 'construction'.<sup>19</sup>

In the paper 'Towards a Tectonic Approach: Energy Renovation in a Danish Context', Marie Frier Hvejsel, Poul Henning Kirkegaard, and Sophie Bondgaard Mortensen propose that Sekler's terms be used as a vocabulary to articulate not only the 'visible play of forces',<sup>20</sup> but also the implications of technical interventions on the perceived spatial quality in a broader sense.<sup>21</sup>

Building on this reading of Sekler's theory, we propose that the notion of structure, construction, and gestures can be used to describe how the technical concepts are realized through certain alterations to the construction and to what degree these alterations contribute to added value for the occupants through improved spatial gestures.

The task of renovating a building differs greatly from that of building 'from scratch', as it involves an evaluation of the state or value of the existing construction and how to manage this in the renovation process. In order to relate the rereading of Sekler's tectonic architectural theory to the field of (energy) renovation, we suggest the combination of the tectonic framework with perspectives from renovation theory. Historically, changing—and even conflicting—attitudes to managing the existing built environment have been advanced. For example, the nineteenth-century French architect and author Eugène Emmanuel Viollet-le-Duc advocated an approach to renovation based on restoring the grandeur of the original building, maybe even a grandeur that has never existed.<sup>22</sup> By contrast, his contemporary, the author John Ruskin, considered such a restorative approach to be altogether deceiving and advocated an approach based on preservation and preventing interference.<sup>23</sup> The purpose of including these examples is not to initiate a thorough account of the theoretical development of the renovation field. Rather, the intention is to exemplify that there exist different views on the matter.

In this article, we also lean on writings by the architect and design theoretician Fred Scott. Based on a critical review of existing theories (the theories formulated by Viollet-le-Duc and Ruskin, among others), Scott stresses that if buildings are to stay inhabitable, they must be understood as part of a spatial continuum in constant alteration. When faced with the task of renovation, we inevitably enter into a dialogue with this continuum.

Where Sekler's tectonic theory offers a vocabulary for articulating the spatial implications of technical initiatives, Scott's writings provide a theory for understanding the initiatives not as something static or final, but as one of many alterations that the building will undergo throughout its lifespan.<sup>24</sup> His understanding of renovations as a downstroke in a constructed spatial continuum is crucial when we seek to add lasting value for the users.

Scott points out that the changes to a building alter our perception of it:

If electricity is introduced into a pre-electric building, it alters it. If central heating is put in to replace local heating via foci of heat, such as stoves and fireplaces, the building is altered spatially. Most markedly, if extensive electric lighting is introduced, the building is altered. The alteration is in the way the building is perceived: to see the spaces fully illuminated by an internal light source during the hours of darkness causes the building to be seen differently from at its inception.<sup>25</sup>

This supports the tectonic understanding that (technically motivated) interventions ultimately affect how a building is perceived and therefore constitute a spatial challenge. There are of course multiple degrees of alteration. Scott refers to wiring as an example of an alteration which can be easily concealed, whereas comprehensive changes to the spatial arrangements may cause greater 'stir'. In the case of (energy) renovation of social housing from the 1960s, we are not introducing electricity or central heating. Rather, the focus is on the energy performance of the building. In the specific case of energy renovation, research shows that one of the biggest potentials for energy reduction lies in reinsulation of the building envelope.<sup>26</sup> Furthermore, this is a commonly applied strategy in a Danish context. In order to ensure relevance for contemporary practice, we therefore focus our attention on this particular part of the building, investigating the spatial implications of altering the building envelope to be more energy-efficient.

Scott states that '[w]ork to existing buildings is of two types: either restorative or interventional'<sup>27</sup> and that a building can be altered 'in the style of the original or in contrast to it'.<sup>28</sup> As an interpretation of these statements, we introduce three concepts for articulating the degree of alteration to the building envelope: preservation, reinterpretation/accentuation, and addition/renewal. These concepts represent extremes and, as such, a building renovation could often represent an approach somewhere 'in between' or even include different approaches in relation to different building components. Nevertheless, Scott's statement serves as a reminder that different views on this matter exist and that it is relevant to articulate the implications for spatial quality in one approach over another depending on the level of existing quality in the particular project. The three concepts serve as a starting point for this articulation. Scott further distinguishes between surface and spatial changes. The former relates to alterations like colour or illumination, whereas the latter denotes alterations



of the existing spatial organisation.<sup>29</sup> In this article, we seek to combine these two aspects under the tectonic notion of 'spatial gestures', inspired by Sekler, in order to address the spatial consequence or potential of a technical alteration in its entirety, rather than separate elements. In other words, the term spatial gestures is used to denote the resulting spatial capabilities of the building envelope in the exterior and interior, spanning from how it is experienced from a distance, for example when viewing the building as part of the urban fabric, to the experience through tactile encounters on the smallest scale.

In summarizing the content of this section, it can be seen that the works of Sekler and Scott overlap in the sense that they both stress the implications of technical initiatives on the perceived spatial quality in buildings. Based on the above rereading, we introduce the following interpretation of the two theories as a point of departure for articulating the consequences and potentials of technical alterations on the perceived spatial quality in the particular context of contemporary energy renovation:

Eduard Sekler: Introducing a vocabulary to describe how *technical concepts* (such as reduction of energy losses through the building envelope) are realized through alterations to the existing *construction* and to what degree these alterations contribute to added value for the occupants through improved *spatial gestures*.

Fred Scott: Establishing (energy) renovation as a dialogue between the past, present, and future, in which we alter the existing construction to ensure the value of the building to the inhabitants over time, by *preserving* or *reinterpreting/accentuating* existing values or *adding* new values.

## INTRODUCING A TECTONIC FRAMEWORK

The ideas presented above are summarized graphically in Figure 1, which will serve as a framework for analysis in the following section. The figure visualizes the process of identifying existing spatial qualities in the building as it appears prior to renovation and laying down a strategy for alteration of the construction, that is, how to realize a *technical concept* (such as improving the thermal performance of the envelope) through alterations to the existing *construction*. Depending on the chosen strategy, the alterations to the construction can serve to 'preserve' or 'reinterpret' / 'accentuate' existing spatial qualities, or to 'add' new qualities through the *spatial gestures* they induce.

COMPARATIVE ANALYSIS OF TWO CONTEMPORARY RENOVATION CASES

In the previous section, we proposed a tectonic framework for articulating spatial quality as part of energy renovation projects through an improved mutually technical and spatial dialogue between the past and the present.

In this section, we will carry out an analysis of two cases based on the proposed framework. The cases are the social housing complexes Park Hill in Sheffield, UK, and Rosenhøj in Aarhus, Denmark. Both projects have been the subject of extensive renovation as part of the urban regeneration of the areas in which they are located. Yet they represent different approaches. The renovation of Park Hill, on the one hand, was performed in line with English Heritage’s requirements for a Grade 2 listed building<sup>30</sup> with emphasis on maintaining distinctive modernist and brutalist characteristics and reinterpreting others. In the renovation of Rosenhøj, on the other hand, which is not a listed area, the original intentions are more hidden. The cases have been included as examples of how similar technical concepts, like energy optimization of the building envelope, can be realized through different degrees of alteration to the existing construction, ultimately affecting the perceived spatial quality in distinctly different ways. The purpose of the analysis is to examine if the developed tectonic framework might help to articulate, at a deeper level, the implications of technical energy-saving initiatives on the

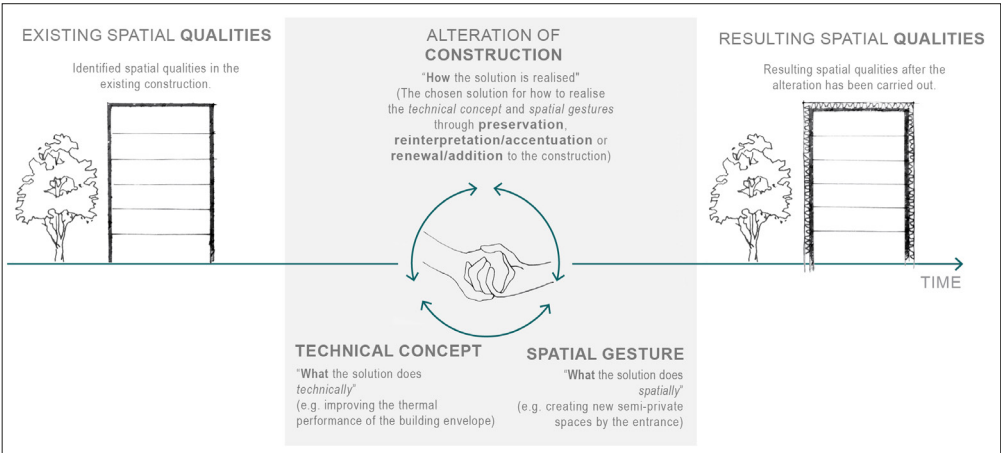


Figure 1. Proposed tectonic framework for analysis . Source: The authors

perceived spatial quality in each of these approaches. The analysis of each case includes introductory facts about the building. Thereafter, the article will focus on addressing the building envelope through a brief account of the main characteristics of the existing constructions, followed by the analysis of the completed renovation based on the proposed tectonic framework.

## PARK HILL, SHEFFIELD, UK

The residential area Park Hill was completed in 1961 with the help of architects Ivor Smith and Jack Lynn. Park Hill consisted of an astonishing number of 985 flats for rent and accompanying shared services.<sup>31</sup> The 10-metre-wide slab blocks were built in up to fourteen stories, distributed in one continuous structure across the sloping hillside. The apartments were accessed through an entrance gallery on every third floor, which was made possible by introducing a mix of one-level apartments and maisonettes with internal staircases.<sup>32</sup> The typology of the Park Hill complex differed greatly from that of the existing city and sought to break with 'the existing living-pattern of the area, which had become a notoriously blighted slum'.<sup>33</sup> At the time of its completion, Park Hill was considered an ambitious state-of-the-art project which met an urgent need for affordable housing. After approximately twenty years, the perception began to differ and the once positive attitude towards the housing complex started to fade. Characteristics, such as the large scale, the extensive use of exposed concrete, and the mono-tenure principle, have been mentioned as contributing factors to the negative development. Park Hill was facing demolition when English Heritage decided to list the building complex in 1998.<sup>34</sup> In 2004, the developer Urban Splash, in collaboration with the architects Hawkins/Brown and Studio Egret West, won a competition to renovate the housing complex. The renovation was carried out in three phases from 2004 onward, and the master plan involved changing the residential form from rental to mixed-tenure housing and including office spaces and a kindergarten, among other things.<sup>35</sup>

## EXISTING CONSTRUCTION (BUILDING ENVELOPE)

The Park Hill complex is an example of British brutalist architecture.<sup>36</sup> The structural concept is defining for the exterior expression, as is the repetitive composition of apartments.<sup>37</sup> As such, the concrete frame is a dominant characteristic in the facade. However, the rhythm of the facade is a result of the relationship between the in-situ concrete frame and its infill of precast balustrades, brickwork, windows, and balconies, which contribute to an experience of tactility and depth.<sup>38</sup> The main materials of the construction are

exposed concrete and brickwork in two colors, both materials typical for the brutalist era.<sup>39</sup> The contrast of textures in these materials and the changing depths of the infill relative to the frame serve to emphasize the latter. Another characteristic of the facade is that of the galleries on every third floor. As opposed to central corridors, these entrance decks provide air, views, and a potential for social concentration. The decks further function as pedestrian bridges, so-called 'streets in the sky,' which bind together the slab blocks and connect the streets to the ground level at one end of the sloping site.<sup>40</sup> When the renovation project began, Park Hill was in a poor state, suffering from physical decay and social problems.<sup>41</sup> As such, the aim of the renovation of the building envelope was to contribute to the revitalization of the complex and to update the construction to modern-day standards, while at the same time respecting English Heritage's requirements for Grade 2 listed buildings.<sup>42</sup>

#### ANALYSIS OF RENOVATION INITIATIVES (BUILDING ENVELOPE)

Figure 2 illustrates a section through the building complex prior to renovation. Two subsections through the building envelope are highlighted for further analysis in the following text. The objective is to analyse the tectonic interrelation between the technical concepts and resulting spatial gestures in these areas. In order to do so, we have applied the developed tectonic methodological framework as a lens through which to address the alterations to the construction.

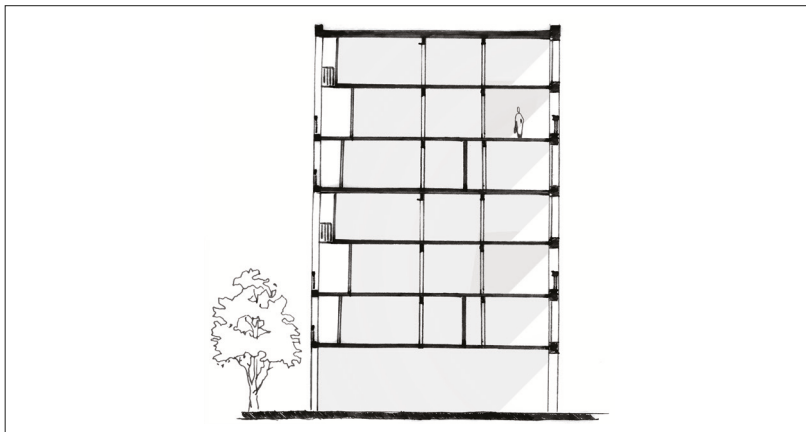


Figure 2. Section through the Park Hill complex, illustrating the area of analysis (prior to renovation).  
Source: The authors

### STREET IN THE SKY / COVERED ENTRANCE DECK (FIGURE 3A)

*Technical concept:* The main technical concept for the renovation of the entrance facade was to update the building envelope to a thermally efficient skin at the same time as protecting the existing concrete frame.<sup>43</sup> At the eastern facade, there has also been a focus on improving the thermal and acoustical performance of the deck between the ‘streets in the sky’ and the bedrooms in the underlying flats.<sup>44</sup>

*Construction:* The technical concepts have been realized through a hierarchical approach. Everything but the concrete slabs, walls, and columns was demolished when the process began. The original concrete elements of the grid were repaired (blue, Figures 3a and 3b). New concrete balustrades were mounted following the original scheme, however in a slightly lighter version (blue, Figures 3a and 3b). The facade between the ‘street in the sky’ and the dwellings was rebuilt with a new facade line, including a part of the old ‘street in the sky’ and with only few of the original concrete facade elements preserved. The new wall was erected as a thermally well-insulated envelope with new doors and windows (red, Figure 3a).<sup>45</sup>

*Spatial gestures:* The outer facade level with balustrades was altered as a continuation of the style of the original, both in terms of surface and spatial configuration. However, the actual building envelope (red) underwent considerable alterations, including demolishing the old wall and replacing it with new elements. The alterations allowed for new spatial gestures as the new building envelope was alternately pushed forward or drawn back to create spaces in the interior, where it added an additional storage room,<sup>46</sup> and in the exterior, where it added a shared semi-private entrance for four dwellings. The consequence of doing this was that the ‘street in the sky’ was narrowed from 3 to 2 metres. The original width was defined by the milk cart being able to pass, which today, obviously, is no longer a functional requirement.<sup>47</sup> The new layout allowed for a transition zone between the public and private realm, which has been described by a number of theoreticians as a general shortcoming in modernist housing schemes.<sup>48</sup> The surface cladding material chosen for the building envelope was wooden panels. Normally, these panels would not be able to withstand the wear and tear of the climate, but in this case the overhang allowed for protection. The finish of the joining of materials is open to interpretation, but the overall spatial gesture is that of warmth, which contrasts and accentuates the rough concrete. As part of the renovation process,

windows were added in the building envelope, which allows for a little extra daylight in the interior space, but most importantly induces a sense of security for the entrance situation.

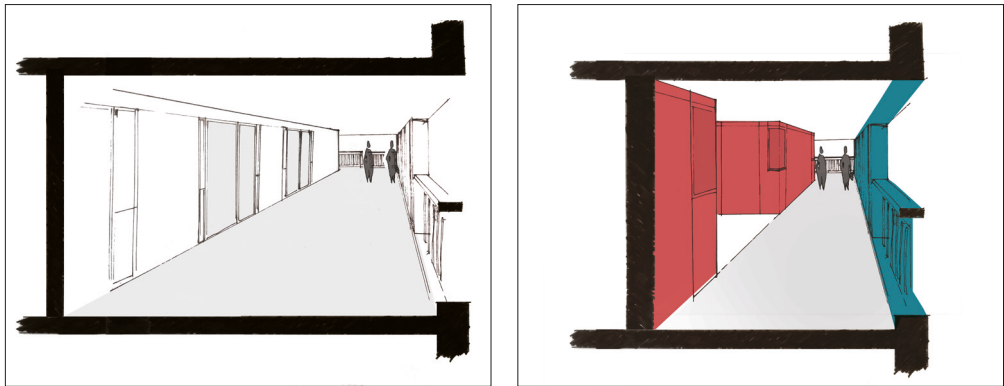


Figure 3a. Sketch of the 'street in the sky' before and after renovation (left and right respectively), preservation (repairs of concrete and restoration of balustrades) and addition of new elements.  
Source: The authors

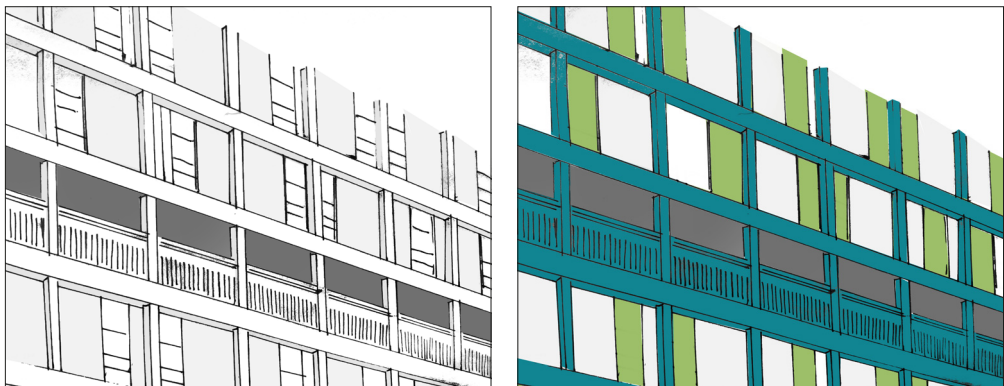


Figure 3b. Spatial sketch of the facade above the entrance deck before and after renovation (left and right respectively), ● preservation (repairs and restoration of grid and balustrades) and ● accentuation.  
Source: The authors

Figure 3. Spatial sketches of the 'streets in the sky' (3a) and facade above the entrance deck (3b) before and after renovation. Source: The authors

## FACADE ABOVE THE ENTRANCE DECK / LIVING ROOM FACADE (FIGURE 3B)

In this section, the alterations to the facade above the entrance floor, where the living rooms are located (Figure 3b), will be analysed.

*Technical concept:* As with the facade on the entrance level, the main ambition from a technical perspective was to update the building envelope to a thermally efficient skin at the same time as protecting the existing concrete frame.<sup>49</sup>

*Construction:* In the realization, this led to a hierarchical approach to handling construction elements. Everything but the concrete slabs, walls, and columns was demolished. Starting from the stripped grid, the original concrete elements of the grid were repaired (blue, Figures 3a and 3b). New energy-efficient aluminum windows and sliding doors were added, filling two thirds of the infill area as opposed to one third in the original scheme. Squares of anodized aluminum were introduced next to the windows instead of the original brick elements (green, Figure 3b).<sup>50</sup>

*Gesture:* The treatment of the original grid can be described as a preservation and continuation of the style of the original to an almost surgical degree. In this connection, it can be mentioned that the issue of thermal bridges in the concrete structure was de-emphasized in order to preserve the original expression of the grid.<sup>51</sup> By contrast, the team of consultants altered the facade elements within the grid in a more interpretive manner: the original brick elements were substituted with brightly colored aluminum as a contemporary interpretation of the graduating colours of the original brickwork. Together, the windows and the coloured elements constitute a reflecting surface which contrasts the matte surface of the concrete grid. This serves to accentuate the hierarchy of the frame and infill and indicates a step change. However, this happened at the expense of the tactility of the original brutalist brickwork.

In the interior, the alterations of the 'infill' provide increased access to daylight, which, together with partial demolition of inner walls, contributes to a spacious and light atmosphere. Furthermore, draught sealing the facades and the introduction of new sliding doors may improve the opportunity for furnishing the adjoining spaces.

## SUMMARY: TECTONIC ALTERATION OF CONSTRUCTION?

In the previous section, alterations to the building envelope in the Park Hill project have been analysed. On the entrance deck, the ‘technical concept’—energy optimization of the building envelope—has been realized through two different approaches to alterations of the existing ‘construction’. The first continues the style of the original in the concrete repairs and remaking of the balustrades following the original design, and the second contrasts the original in the redesign of the existing building envelope into a spatial element which creates a semi-private entrance area shared by four dwellings. When we analyse the resulting spatial gestures in the building envelope, the chosen strategy for alteration of the construction allows for a visual expression in line with English Heritage’s requirements at the same time as introducing new spatial qualities to the complex.

On the floor above the entrance level (the living room facade), it can be seen that the energy optimizations have been realized by altering the facade elements within the existing grid. The renovation team substituted the original brick elements with coloured glass which contrasts the matte surface of the concrete grid and thereby accentuates this feature. Whereas the spatial reconfiguration at entrance level addresses the inhabitant at a scale close to the body, the surface alterations mentioned here mainly affect our perception of the building from a cultural-historical perspective when seen from the city, as a new dialogue is initiated between the original grid and the contemporary infill of the windows and adjoining coloured panels.

Through this analysis of the Park Hill residential area, we have sought to gain a deeper understanding of the tectonic interrelation between the technical concepts and the resulting spatial gestures. It has been established that even within the same building, the technical concept of improving the thermal performance has been realized through different degrees of alterations to the existing construction in order to obtain different spatial gestures. Following the analysis, the authors conclude that the renovation of the building envelope in Park Hill is an example of a tectonic alteration to the construction as it represents a high degree of mutually technical and spatial dialogue between the past and the present. The main integrity of the original architecture is preserved and reinterpreted to secure the renewed significance of the building. In the following section, we continue with an analysis of the Rosenhøj residential area in Aarhus, Denmark. Subsequently, the results of the analysis of both cases will be compared in the ‘Discussion’ section.



## ROSENHØJ, AARHUS, DENMARK

The housing complex Rosenhøj was built from 1968 to 1970 and comprised 839 dwellings, arranged in twenty-seven four-storey apartment blocks with basements.<sup>52</sup> Rosenhøj was built as a part of the Sydjyllandspanen (South Jutland plan), which was developed and administered by the Ministry of Housing and was a plan for the support of prefabricated constructions to provide good, affordable dwellings.<sup>53</sup> The architect behind the South Jutland plan was Børge Kjær, who developed the building type in collaboration with ten housing associations. The vision was to achieve production-related advantages from developing one building type which could be mass-produced and built in a number of places across the country.<sup>54</sup> The South Jutland plan can be seen as a development of earlier decades' influences from the international modernist movement and its ideals, with the aim of providing spacious dwellings with access to green areas, air, and light.<sup>55</sup> The plan provided state-of-the-art dwellings with qualities such as large living rooms and bathrooms, modern kitchens, connections for washing machines, and an inherent flexibility and adaptability for future changes through the merging of apartments.<sup>56</sup>

The South Jutland plan is also known as one of the so-called 'crane track developments' (*kranspørsbyggeri*), which were characterized by building slabs organized in a geometrical pattern, in the case of Rosenhøj in parallel tracks. According to Jannie Rosenberg Bendsen and Anna Mette Exner, the crane track developments generally suffered from a focus on production, construction, and assembly at the expense of adaptation to local conditions and articulation of the spaces between the buildings. Other characteristics of the developments were the attention to infrastructural separation and an understanding of the settlements as independent units complete with institutions, grocery stores, and so on. Such qualities, over time, contributed to closing off the areas from the surrounding cities.<sup>57</sup>

Despite the good intentions in the original layout, the socioeconomically advantaged families gradually moved from the area, and during later years the area experienced a troublesome development. According to the housing association, the housing blocks and the area in general faced serious building damage and social issues when the recent renovation process began.<sup>58</sup> After years of preparatory work, an architectural competition was launched in the summer of 2010.<sup>59</sup> The competition was won by Viggo Madsen consulting engineers in collaboration with Arkitema Architects and EFFEKT architects.<sup>60</sup> As with the Park Hill project, the renovation formed part of a larger

master plan. In Rosenhøj, there was a specific focus on opening the area to the surroundings through the redesign of the spaces in between the buildings, densifying the area through the addition of new building types, and breaking with the monotony of the area.<sup>61</sup>

### EXISTING CONSTRUCTION (BUILDING ENVELOPE)

In accordance with the South Jutland plan, the construction of the facades was based on prefabricated elements.<sup>62</sup> This was reflected in the exterior, which was characterized by a repetitive facade expression in all of the twenty-seven blocks. Towards the south-west, the facade was dominated by large internal balconies. Towards the north-east, the entrance side, the building envelope was designed with continuous horizontal windows. These windows were separated by slender panels which emphasized the impression of an unobstructed horizontal element.

Since its completion, Rosenhøj has been the subject of a number of partial alterations. In the late 1990s, for instance, the balconies were covered with glass and the areas around the bathrooms and main entrances were reinsulated and emphasized in the facade in a characteristic postmodern way.<sup>63</sup>

When the recent extensive renovation began, the building complex was in need of a general update. There were problems with leakage, cold bridges, and mould in the construction. As such, the aim of the renovation was to perform extensive improvements of the building envelope.<sup>64</sup>

### ANALYSIS OF RENOVATION INITIATIVES (BUILDING ENVELOPE)

In the following, we engage in an analysis of the tectonic interrelation between the technical concepts and resulting spatial gestures in the renovation of Rosenhøj. As in the analysis of Park Hill, we focus our attention on alterations to the building envelope, more specifically on the north facade which is the primary entrance facade (Figure 4).

*Technical concept:* The technical intention was to update the building envelope to comply with modern-day standards for thermal insulation. In this specific case, the intention was to meet the Danish building regulations. Furthermore, the technical concept included updating the heating system and implementing a mechanical ventilation system. The alterations resulted in a reduction in energy consumption of 30–40 per cent after the renovation.<sup>65</sup>

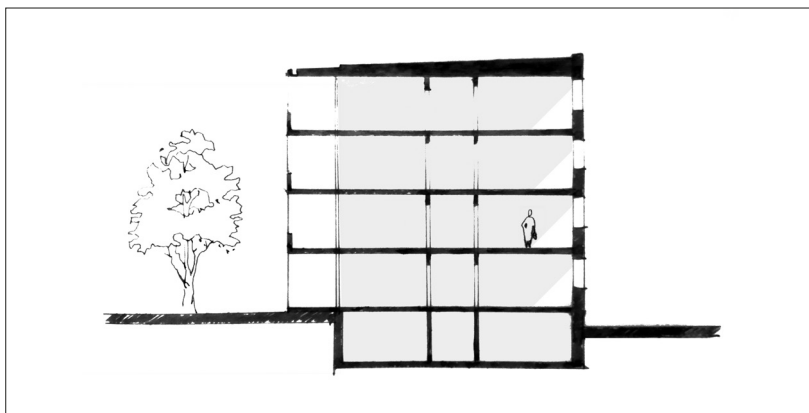


Figure 4. Section through the Park Hill complex, illustrating the area of analysis (prior to renovation).  
Source: The authors

*Construction:* In Rosenhøj, the technical concept was realized through re-insulation of the original concrete facades with 200 millimetre insulation mounted in wooden cassettes and new double glazed windows. The apartment blocks are clad in either aluminum, slate, or concrete as the main materials.<sup>66</sup> In this analysis, we focus on a building block which has been clad in aluminum.

*Spatial gestures:* The implications of the realization of the technical concepts on the perceived spatial quality are highly evident in both the exterior and the interior. Focusing on the specific section of the building envelope (Figure 4), changes in the exterior (Figure 5a) will be looked at first.

#### EXTERIOR (FIGURE 5A)

As opposed to Park Hill, it can be seen here that the majority of facade elements have been the subject of renewal (red). The building block has been dressed in a new aluminum facade which differs greatly from the original facade. The facade renovation has followed a scheme in which the blocks are 'linked' to each other in pairs around a courtyard by means of facade materiality and expression. This allows for an experience of a more differentiated area and a reduced scale. Rather than twenty-seven identical apartment blocks, they are now clustered in smaller units which define the exterior space between them. As such, the building block, which forms the outset for the present analysis, contributes to a more diverse expression in the area and to a better programming of the outdoor spaces.

Looking more closely at the facade, traces of the original horizontal window strips (green) are evident. The impression of a horizontal band is obtained through the use of wooden lamellas which visually connect the windows. The wooden elements also add a level of tactility to the surface. However, most dominantly, it can be seen that on every second storey, the horizontal

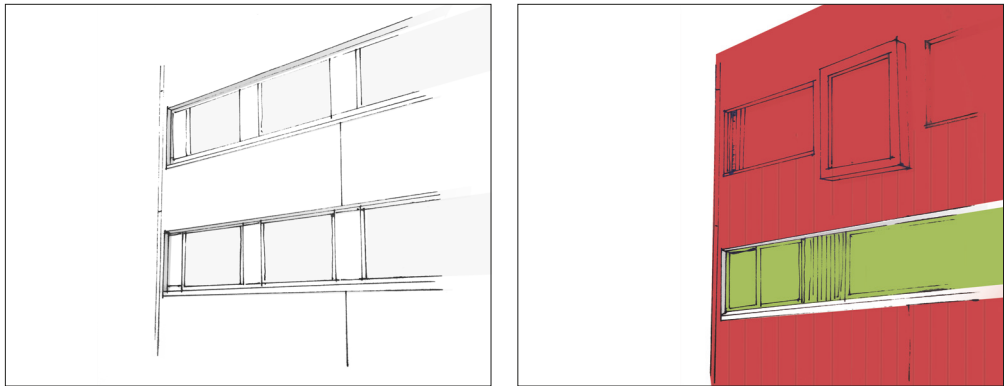


Figure 5a. Sketch of the exterior before and after the renovation (left and right respectively),  
● accentuation and ● addition/renewal. Source: The authors

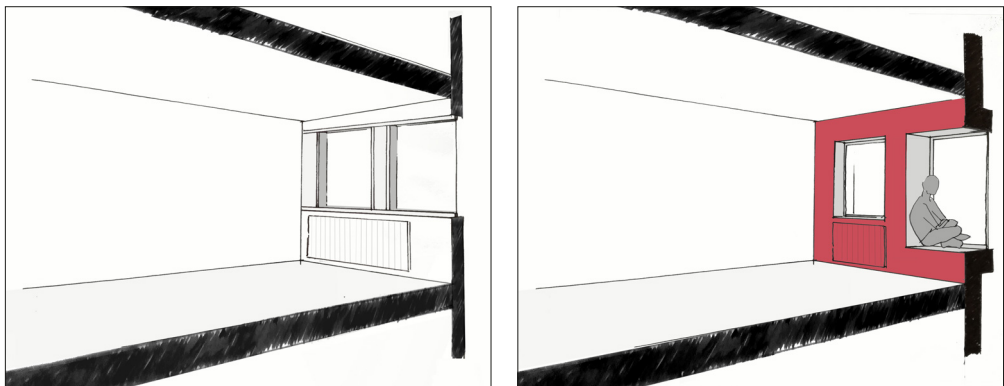


Figure 5b. Sketch of the interior before and after the renovation (left and right respectively),  
● renewal of the facade. Source: The authors

Figure 5. Spatial sketches of the facade from the exterior (5a) and interior (5b) before and after renovation. Source: The authors

windows have been supplemented with new bay windows (red). The introduction of the bay windows fundamentally breaks with the original layout and adds to the overall impression of a completely altered expression, in which only few links to the original surface articulation remain.

#### INTERIOR (FIGURE 5B)

In the interior, the extensive alterations to the facade create a distinctly altered experience in the adjoining spaces (Figure 5b). Most distinct are the aforementioned bay windows, which utilize the extra depth of the walls to create a sitting niche. According to the engineer Søren Nielsen from Viggo Madsen consulting engineers, the tenants have responded positively to the alteration, especially as a place for sitting in connection to the kitchen area.<sup>67</sup> This utilization of the additional depth of the wall due to re-insulation creates a new spatial gesture which was not there before.

#### SUMMARY: TECTONIC ALTERATION OF CONSTRUCTION?

In Rosenhøj, the building blocks have undergone extensive renovation including re-insulation, changing window formats, and applying new facade materials. In the exterior, the technical concept—namely to optimize the thermal performance of the building envelope—has been realized in the manner of focusing on renewal of the existing construction. This, to a degree, where the original expression (which reflected the technical concept of mass production and assembly), is almost hidden. The impression of a renewed facade is further strengthened by the introduction of bay windows which constitute a new formal motif in the area. However, traces of the original horizontal window bands, which are interpreted and accentuated through the use of wooden lamellas, can be found. The resulting spatial gestures in the exterior may be described through the ability of the building envelope to contribute to a new narrative in the area, focusing on differentiation and reduction of the experienced scale.

In the interior, the alteration of the construction—the re-insulation of the building envelope and the introduction of bay windows—is utilized to create new sitting niches. In the exterior, the pairs of blocks help to define exterior courtyards. As such, the chosen way of realizing the technical concept provides new spatial gestures which were not part of the original scheme.

In summary, it can be stated that the approach presented in Rosenhøj differs greatly from that of the Park Hill project. By focusing on renewal as the main

alteration strategy, the dialogue between the past and the present has a distinctly different character. It can be argued that by hiding the original intentions with a new 'overcoat', we are renouncing the fact that the original facade is of any value. Yet the intention of this article is not to pass judgement on either of the two approaches presented here, but rather to articulate how similar technical concepts can be realized in vastly different manners depending on the state or value of the original building. It can, however, be concluded that in relation to the building envelope, there is a limited dialogue with the past. Rather, there seems to be a focus on breaking with a somewhat shady reputation at Rosenhøj through extensive changes in architectural expression. The new facade cladding is contributing to this with more than a 'facelift', as it defines new spatial gestures in the interior and the exterior. In this light, the alterations can be viewed as tectonic.

## DISCUSSION

In the previous section, two case studies, Park Hill in Sheffield, UK, and Rosenhøj in Aarhus, Denmark, have been analysed. The purpose of the analysis has been to examine if and how a tectonic approach to energy renovation might help to provide a framework for articulating the implications of energy-saving initiatives on the perceived spatial quality. This section is devoted to a discussion of the application of the suggested tectonic framework.

The consequences of reinsulating the building envelope on the overall expression of a building has been mentioned in a number of publications.<sup>68</sup> Especially in the case of historical buildings, the facade expression may require alternative means of energy optimization in order to not disturb the qualities of the facade.<sup>69</sup> This is the case in the Park Hill project, in which concerns related to thermal bridges in the concrete grid have been de-emphasized in order to preserve the characteristic grid structure. However, as seen in the case of Rosenhøj, there may be buildings in which the focus is on the renewal/addition of qualities rather than on preserving existing ones. Both cases, however, require tectonic insight in order to maximize the potential for added spatial value. The tectonic framework serves to nuance the discussion, so that it is possible to articulate the degree of alteration and address the potential for increased spatial quality relative to the chosen strategy.

In the analysis of Park Hill and Rosenhøj, we have focused on chosen details related to alterations of the building envelope. We have analysed if and how technical concepts are realized in a manner which contributes value to the

inhabitants by offering spatial gestures identifiable as a tectonic approach to alteration of the construction. In the Park Hill project, it has been shown how technical concepts related to energy optimization have been realized in a manner that accentuates the existing concrete grid (preservation/accentuation) and adds new spatial values to the building by introducing changes such as semi-private entrance spaces at the entrance levels (renewal/addition). In Rosenhøj, it has been highlighted how the similar technical concepts related to the building envelope have been realized in a manner which favours addition/renewal over preservation. In this case, the tectonic exploitation of the building envelope is strengthened as the new facade (renewal/addition) induces spatial gestures in both the interior and the exterior, which the original facade failed to do and which may have been a contributing factor in its declining reputation amongst the users. Through the application of the tectonic framework in the two case studies, we have attempted to move beyond the somewhat ambiguous notion of 'spatial quality' put forward in contemporary renovation discourse, towards a more nuanced vocabulary for articulating the spatial consequences and potentials of the technical renovation initiatives. Using 'technical concept', 'construction', and 'spatial gesture' as guiding principles, the question of spatial quality has been positioned in direct relation to technical alterations to the construction. We hereby stress the importance of considering reinsurance not as a mere technical cladding, but as an architectural element that lends itself to strengthening existing spatial qualities or to adding new ones through critical assessment of renovation alternatives.

The tectonic approach opens up the discussion about the relation between technical and spatial concerns. However, an understanding of spatial quality in the context of social housing necessarily prescribes an understanding of cultural and socioeconomic matters. Such matters are crucial in both the case of Park Hill and the case of Rosenhøj<sup>70</sup> but have only been addressed indirectly in the tectonic framework presented here. As such, there is room for further development of the framework to encompass such concerns as part of a tectonic approach to energy renovation of social housing.

## FROM ANALYSIS FRAMEWORK TO PROCESS TOOL

Presented in this article is a framework for analysing the implications of technical initiatives on the spatial quality of a dwelling. The perspective of the research is to further develop the tectonic framework, aiming not only to analyse completed projects, but also to articulate potentials in ongoing

projects. The hypothesis is that the tectonic lens can help to position the question of spatial quality in the early design phases of renovation projects in which the outline of the project is drawn and design freedom is still relatively high. If the framework is to be developed as part of contemporary process tools or design guides, it would be natural to employ a different sequence starting with mapping the intended technical concept and spatial gestures and subsequently discussing how different construction alternatives support these aspects in a tectonic manner. Further development of the framework would involve moving from a theoretical lens to a more hands-on format.

The development of the tectonic approach to energy renovation will be based on further theoretical studies and empirical studies: the latter through investigations of how occupants in social housing complexes perceive the spatial implications of energy renovations in their dwellings.

## CONCLUSION

In this article, we have addressed the architectural challenges related to energy renovation of social housing. The focus of the article has been to investigate if a tectonic approach to energy renovation might help to provide a framework for articulating and maximizing the potential of technical energy-saving initiatives on the perceived spatial quality. Since re-insulation of the building envelope represents an important focus area in many contemporary projects, the present article has focused on initiatives related to this particular part of the building.

Through a rereading of Eduard Sekler's studies of tectonic architectural theory, we have proposed a simplified tectonic framework for analysis of renovation initiatives in relation to the building envelope. This has been linked to Fred Scott's understanding of the act of renovation as a dialogue between the past, present, and future—as a way to target the domain of renovation and the specific challenges related to this discipline.

In continuation hereof, we have applied the framework in the analysis of two case studies of social housing projects which have undergone renovation within recent years: Park Hill in Sheffield, UK, and Rosenhøj in Aarhus, Denmark. Both complexes were built in the 1960s and represent two different approaches to the degree of alteration of the original. As such, they have been included as examples of how similar technical concepts can be realized in distinctly different manners depending on the state or value of the original



building. In the analysis, we have applied the framework as a means to articulate if and how the constructional realization of technical concepts related to the building envelope contributes to spatial gestures in the interior and the exterior, leading to increased spatial quality for the inhabitants rather than providing 'mere' additional cladding. Based on the analysis, we see a critical potential to explore the framework further as a lens through which to position the tectonic question of spatial quality in the early design phases of energy renovation projects.

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## NOTES

<sup>1</sup> Fred Scott, *On Altering Architecture* (New York: Routledge, 2008), preface.

<sup>2</sup> The Danish Government, *Strategi for energirenovering af bygninger: Vejen til energieffektive bygninger i fremtidens Danmark*, Danish edition, 2014, p. 56.

<sup>3</sup> Fernanda Acre and Annemie Wyckmans, 'Spatial Quality Determinants for Residential Building Renovation: A Methodological Approach to the Development of Spatial Quality Assessment', *International Journal of Sustainable Building Technology and Urban Development* 5 (2014), pp. 183–204; Ulrik Stylsvig Madsen and Anne Beim, *Værdiskabelse i Bygningsrenovering: en minianalyse af udvalgte koncepter for vurdering af egenskaber og kvaliteter i byggeri* (Copenhagen: CINARK [Kunstakademiets Arkitektskole], 2015); Marie Frier Hvejsel, Poul Henning Kirkegaard, and Sophie Bondgaard Mortensen, 'Towards a Tectonic Approach: Energy Renovation in a Danish Context', *Nordic Journal of Architectural Research* 27 (2015), pp. 35–60; Ole Michael Jensen, *Virkemidler til fremme af energibesparelser i bygninger* (SBI 2009:06) (Hørsholm: SBI, 2009), <http://www.sbi.dk/miljo-og-energi/energibesparelser/virkemidler-til-fremme-af-energibesparelser-i-bygninger/virkemidler-til-fremme-af-energibesparelser-i-bygninger> (all URLs accessed in May 2019).

<sup>4</sup> Scott, *On Altering Architecture*, preface, p. xv.

<sup>5</sup> Madsen and Beim, *Værdiskabelse i Bygningsrenovering*.

<sup>6</sup> Ibid.

<sup>7</sup> Ibid., p. 39.

<sup>8</sup> Fernanda Acre and Annemie Wyckmans, 'Dwelling Renovation and Spatial Quality: The Impact of the Dwelling Renovation on Spatial Quality Determinants', *International Journal of Sustainable Built Environment* 4 (2015), pp. 12–41, esp. p. 12.

<sup>9</sup> Scott, *On Altering Architecture*, preface, p. xviii.

<sup>10</sup> Rob Marsh, Lise Mansfeldt Faurbjerg, and Signe Kongebro, *Arkitektur, energi, renovering: designguide for energi-, dagslys- & indeklima-renovering* (Copenhagen: SBI, 2013), <https://sbi.dk/Assets/Arkitektur-Energi-Renovering/arkitektur-energi-renovering-1.pdf>.

<sup>11</sup> Ibid.

<sup>12</sup> Ibid., p. 5; Hvejsel et al., 'Towards a Tectonic Approach', p. 37.

<sup>13</sup> Scott, *On Altering Architecture*.

<sup>14</sup> David Levitt, *The Housing Design Handbook: A Guide to Good Practice* (New York: Routledge, 2010), p. 220; Aarhus Omegn, *Et historisk overblik* (Aarhus: Aarhus Omegn, 2017), <https://www.aarhusomegn.dk/om-aarhus-omegn/historie.aspx>.

<sup>15</sup> Kenneth Frampton, *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture* (Cambridge, MA: MIT Press, 1995), p. 3.

<sup>16</sup> Gottfried Semper, *The Four Elements of Architecture and Other Writings*, trans. Harry F. Mallgrave and Wolfgang Herrmann (1851; repr., Cambridge: Cambridge University Press, 1989); Carl Bötticher, *Die Tektonik der Hellenen*, 2 vols. (Potsdam: Riegel, 1852).

<sup>17</sup> Kenneth Frampton, 'Rappel à l'ordre: The Case for the Tectonic', *Architectural Design* 60 (1990); Frampton, *Studies in Tectonic Culture*; Ulrik Stylsvig Madsen and Anne Beim, *Towards an Ecology of Tectonics* (Copenhagen: Edition Axel Menges gmbh, 2014).

<sup>18</sup> Eduard F. Sekler, 'Structure, Construction, Tectonics', in *Structure in Art and in Science*, ed. Gyorgy Kepes (New York: George Braziller, 1965), pp. 89–95, esp. p. 93.

<sup>19</sup> Ibid., pp. 89 and 93.

<sup>20</sup> Ibid., p. 93.

<sup>21</sup> Hvejsel et al., 'Towards a Tectonic Approach', p. 43.

<sup>22</sup> Eugène Emmanuel Viollet-Le-Duc, *Dictionnaire raisonne de l'Architecture*, vol. III (Paris, 1854–68), cited in Scott, *On Altering Architecture*, pp. 45 and 59.

<sup>23</sup> John Ruskin, *The Seven Lamps of Architecture* (New York: J. Wiley & Sons, 1866), p. 161 (XVIII).

<sup>24</sup> Scott, *On Altering Architecture*.

<sup>25</sup> Ibid., p. 92.

<sup>26</sup> Jensen, *Virkemidler til fremme af energibesparelser i bygninger*.

<sup>27</sup> Scott, *On Altering Architecture*, p. 64.

<sup>28</sup> Ibid., p. 95.

<sup>29</sup> Ibid., pp. 92ff.

<sup>30</sup> Levitt, *The Housing Design Handbook*, pp. 221–22.

<sup>31</sup> Peter Blundell Jones, 'Reframing Park Hill', *The Architectural Review* 230, no. 1376 (October 2011), pp. 83–93, esp. p. 84; Levitt, *The Housing Design Handbook*, p. 220.

<sup>32</sup> Jones, 'Reframing Park Hill', p. 86.

<sup>33</sup> Reyner Banham, *The New Brutalism* (London: Architectural Press, 1966), p. 132.

<sup>34</sup> Levitt, *The Housing Design Handbook*, p. 220; Christophe Egret, 'Interview with Christophe Egret about the renovation project "Park Hill" on January 25th 2017', video conference, Aarhus, Denmark, and London, UK, 2017.

<sup>35</sup> Egret, 'Interview with Christophe Egret'.

<sup>36</sup> Banham, *The New Brutalism*, p. 132.

<sup>37</sup> Reyner Banham, 'Park Hill, Housing, Sheffield', *The Architectural Review* 130, no. 778 (December 1961), pp. 403–10, esp. p. 404.

<sup>38</sup> Jones, 'Reframing Park Hill', p. 90; Banham, *The New Brutalism*, p. 132.

<sup>39</sup> Jones, 'Reframing Park Hill', p. 90.

<sup>40</sup> Ibid.

<sup>41</sup> Egret, 'Interview with Christophe Egret'.

<sup>42</sup> Levitt, *The Housing Design Handbook*, pp. 220ff.; Egret, 'Interview with Christophe Egret'.

<sup>43</sup> Levitt, *The Housing Design Handbook*, p. 222.

<sup>44</sup> Egret, 'Interview with Christophe Egret'.

<sup>45</sup> Ibid.

<sup>46</sup> Jones, 'Reframing Park Hill', p. 92.

<sup>47</sup> Egret, 'Interview with Christophe Egret'.

<sup>48</sup> For example, Niels Bjørn, *Sådan lykkes forandringen af Gellerup: Fra udsat boligområde til velfungerende, attraktiv og socialt balanceret bydel* (Aarhus: Aarhus Kommune and Brabrand Boligforening, 2015); Jan Gehl, *Livet mellem husene: udeaktiviteter og udemiljøer*, 5th ed. (Copenhagen: Arkitektens Forlag, 2003).

<sup>49</sup> Levitt, *The Housing Design Handbook*, p. 222.

<sup>50</sup> Egret, 'Interview with Christophe Egret'; Jones, 'Reframing Park Hill', p. 92.

<sup>51</sup> Egret, 'Interview with Christophe Egret'.

<sup>52</sup> Aarhus Municipality, Aarhus Omegn, and Viby Andelsboligforening, *Konkurrenceprogram – Projektkonkurrence om fornyelse i Viby Syd*, 2010, <https://docplayer.dk/3283294-Konkurrenceprogram-projektkonkurrence-om-fornyelse-i-viby-syd-24-september-2010-aarhus-kommune-aarhus-omegn-viby-andelsboligforening.html>, p. 15.

<sup>53</sup> Aarhus Omegn, *Et historisk overblik*.

<sup>54</sup> Claus Bech-Danielsen, Jesper Ole Jensen, Inge Mette Kirkeby, Søren Ginnerup, Anne Clementsen, and Martin Ø. Hansen, *Renovering af efterkrigstidens almene bebyggelser* (SBI 2011:22), 1st ed. (Hørsholm: SBI, 2011), <https://sbi.dk/Assets/Renovering-af-efterkrigstidens-almene-bebyggelser/sbi-2011-22-www-pdf.pdf>, pp. 16–17.

<sup>55</sup> Jannie Rosenberg Bendsen and Anna Mette Exner, *Rammer for udvikling – almene boligbebyggelsers bevaringsværdier* (Copenhagen: Landsbyggefonden, 2017), p. 29.

<sup>56</sup> For example, Carl H. Bechmann, 'Sydjyllandsplanen', *Boligen* 31 (1963), pp. 377–79, esp. pp. 377–78.

<sup>57</sup> Bendsen and Exner, *Rammer for udvikling*, p. 32.

<sup>58</sup> Anita Kurowska Larsen, *Energirenovering af almene boliger – en erfaringsudveksling hen over Øresundsbroen*, 2015, <https://docplayer.dk/12214653-Energirenovering-af-almene-boliger-en-erfaringsudveksling-hen-over-oeresundsbroen.html>, p. 58.

<sup>59</sup> Aarhus Municipality, Aarhus Omegn, and Viby Andelsboligforening, *Konkurrenceprogram*.

<sup>60</sup> Rasmus Gregersen, *Vinderprojekter for Viby Syd afsløret*, 2011, [https://www.building-supply.dk/article/view/60840/vinderprojekter\\_for\\_viby\\_syd\\_afsloret](https://www.building-supply.dk/article/view/60840/vinderprojekter_for_viby_syd_afsloret).

<sup>61</sup> Renover.dk, *Nyt Rosenhøj*, 2019, <https://renover.dk/projekt/nyt-rosenhoej/>.

<sup>62</sup> Aarhus Municipality, Aarhus Omegn, and Viby Andelsboligforening, *Konkurrenceprogram*.

<sup>63</sup> Gunni Petersen, *Rosenhøj: 40 år på bagen* (Aarhus: Boligforeningen Aarhus Omegn, 2008), p. 8; Claus Bech-Danielsen and Mette Mechlenborg, *Renovering af almene boligområder: Evaluering af fysiske indsatser gennemført i perioden 2014–2016* (SBI 2017:11), 1st ed. (Kongens Lyngby: SBI, 2017), <https://sbi.dk/Assets/Renovering-af-almene-boligomraader/SBI2017-11.pdf>, p. 108.

<sup>64</sup> Bech-Danielsen and Mechlenborg, *Renovering af almene boligområder*.

<sup>65</sup> Søren L. Nielsen, interview with Søren L. Nielsen, engineer at Viggo Madsen consulting engineers about the renovation project 'Rosenhøj' on 10 April 2017 in Aarhus, Denmark.

<sup>66</sup> Ibid.

<sup>67</sup> Ibid.

<sup>68</sup> For example, Jensen, *Virkemidler til fremme af energibesparelser i bygninger*; Marsh et al., *Arkitektur, energi, renovering*; Hvejsel et al., 'Towards a Tectonic Approach'.

<sup>69</sup> Jensen, *Virkemidler til fremme af energibesparelser i bygninger*, p. 9.

<sup>70</sup> Egret, 'Interview with Christophe Egret'; Jensen, 'Renovering af Rosenhøj'.