



1 The front view of the Jewish Museum with the Berlin Museum on the left

2 A view of one of the voids inside the Jewish Museum

The star of David diagram is used as a way of relating ideas from different conceptual domains; here the design process is analysed following the cognitive historical method.

Conceptual diagrams in creative architectural practice: the case of Daniel Libeskind's Jewish Museum

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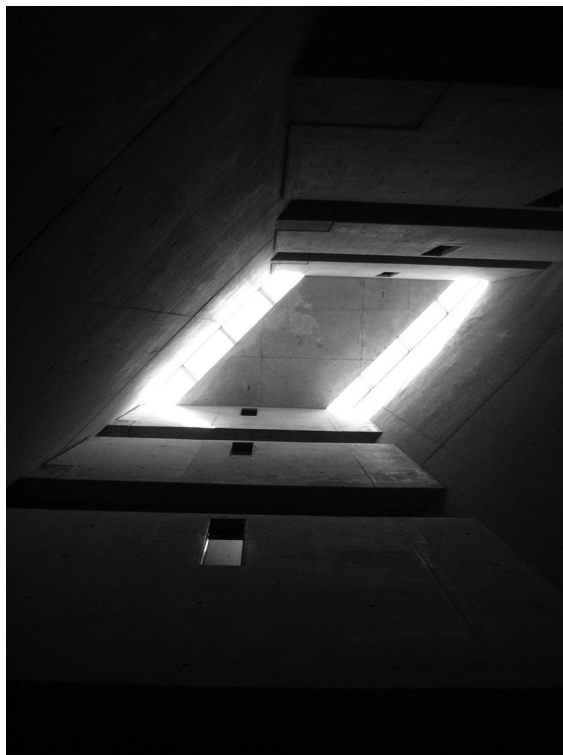
The Jewish Museum in Berlin is the first major building of Daniel Libeskind [1,2]. The project for the museum has instigated a wealth of discussions in architectural circles and achieved a rare status of attracting the attention of scholars from other disciplines.¹ Kurt W. Forster put the design for the Jewish Museum on a par with Piranesi's *Carceri d'Invenzione*, an unusual position for any building since very rarely does an architectural design '[...] bear this double burden of representing both actual buildings and mental structures, and which therefore have to submit to being measured by both standards: the durability of their ideas and the imaginative faculty of their designer.'²

In this study, we are interested in the mental structures which are instrumental in the conception of the Jewish Museum project and we will particularly look at the coupling of external representations and the designer's mental representations in the initial phases of the design. The study reconstructs the salient features of the design process of the Jewish Museum based on archival documents from the Getty Research Institute.³ The archival records, especially the large number of Libeskind's sketches, indicate that the design process of the Jewish Museum requires an in-depth inquiry commensurate with the attention that has been directed by scholars to the design of the building, its conceptual interpretations, and some of the presentation drawings.

Our study uses the cognitive-historical method of analysis, which has been used widely to enrich historical interpretation through investigating the mental processes implicated in scientific discovery and design creativity.⁴ Briefly the cognitive-historical method of analysis supposes that complex cognitive processes observed in discovery and creativity derive from and extend everyday cognitive capacities.⁵ Thus, in developing interpretations of archival records of creative processes, historians can draw insights from pertinent findings of research in the cognitive sciences. In this study, we inquire into how Libeskind represented, formulated and modified his design ideas through constructing a voluminous set of design sketches and diagrams. Our principal

claim in this inquiry is that external representations used in design processes are not simply translations of the information content of completed thoughts onto external media. Rather, they interact with only partially formed, evolving ideas in dynamic thinking processes, through which novel representations can emerge.

Libeskind specified four lines of thinking in his project, each of which relates to one aspect of Jewish culture or the position of the Jews in Germany.⁶ The significance of these is summarised as follows: the first aspect is the invisible and irrationally connected star which shines with the absent light of individual address. The second one is the cut through Act II of *Moses and Aaron* which has to do with the not-musical fulfilment of the word. The third aspect is that of the deported or missing Berliners; the fourth aspect is Walter Benjamin's urban apocalypse along the One Way Street.⁷



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Here we examine Libeskind's sketches and drawings to investigate how the first and third lines of thinking made their way into the final design.⁸ When we studied the initial drawings and sketches from the design process of the museum, we found that there were a variety of rich inspirational sources from different domains, yet, the spatial configuration of the project, a zigzag, remained constant throughout the design process until one significant change was made for the final submission. The zigzag configuration of the Jewish Museum stems from a Libeskind design for an earlier exhibition project, *Line of Fire*.⁹ The final design for the Jewish Museum, however, adds a series of voids to the zigzag configuration. The voids change the spatial configuration, the experience and meaning of the space significantly.¹⁰ Through these spaces, Libeskind managed to represent the crucial idea of the invisibility of the Jewish culture in contemporary Berlin. With the inclusion of the voids, the museum as a whole, i.e., design and exhibits, captures both the significance of Jewish culture to the history of Berlin (and Germany) and the invisibility of that contribution today. As related to us by Donald Bates, who was a design associate and the main 'conduit from' Libeskind to the design team throughout the process: 'the zig-zag and the line of voids is far more potent as an architectural device [than the zig-zag alone] to tell this complex history'.¹¹

The question investigated here is: how did Libeskind introduce these voids into the design? Our analysis of the design process shows that these spaces appeared at a time when Libeskind was elaborating on the conceptual basis of his design through a series of manipulations of *conceptual diagrams*. This line of investigation was independent of his design team members, who were working on the zigzag from the *Line of Fire* project. We will show how manipulations of a diagrammatic representation – the Star of David – (hereafter called *star diagram* or *star*) [3] enabled Libeskind to bring together seemingly disparate concepts to create a semantically rich and challenging conceptual basis and translate that basis into the spatial configuration for the building. To quote Bates, the design team's '[...] job was to make the building "make sense".'

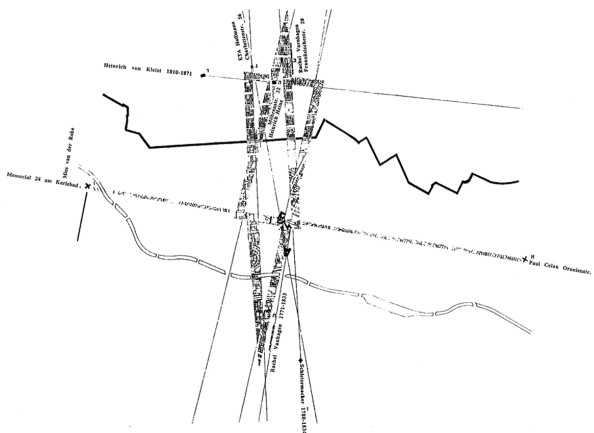
In our understanding, the star diagram was not simply an after-the-fact final presentation drawing. The creative process was facilitated through the use of the star, which we classify as a particular type of diagram and call a *conceptual diagram*.¹² Previously, we have called attention to this class of diagrams in cognitive-historical analyses of several case studies in the history of science¹³ and in the history of architectural design.¹⁴ We have argued that what is distinctive about conceptual diagrams is that they have significant correspondences with mental models that represent an early commitment to a conceptualisation of a design situation and that interactions with them constrain and facilitate the design endeavour throughout the design exploration.

Discussions in the literature related to the Jewish Museum project range from the conceptual and

inspirational underpinnings of the project, to discussions related to memory and museum space, and even further to the very notion of space and *void*. In these discussions, the building and the project have been characterised either in terms of the voids, or as a zigzag, or as a broken star.¹⁵ The voids have triggered discussions on meaning and memory in space, the experiential dimensions of space, and on the idiosyncratic nature of urban and historical conditions of Berlin.¹⁶ Libeskind himself characterised the voids as the 'central structure in the building'¹⁷ and the 'emblem where the not visible has made itself apparent'.¹⁸

Though a great number of commentators have focused on the importance of the star drawing in portraying the conceptual strength of the project,¹⁹ only few have commented on the instrumentality of the star drawing in the design process.²⁰ The archival record indicates a complex process through which Libeskind arrived at the broken star pattern. In this paper, in comparison to alternative accounts of Libeskind's design process, we articulate an account based primarily on historical archival documents. We will show that the star diagram emerged at the end of a lengthy process and almost independently of the physical topography of Berlin rather than, as has been claimed, being born at an autonomous moment²¹ or by mimetically reinterpreting '[...] the classical pattern of the Friedrichstadt with its rectangular pattern of streets and geometrical squares, the flowing lines of the Landwehrkanal, the broken and shameless line of the wall'.²² Finally, we will also discuss the implications of this case study with regard to other characterisations of the initial phases of design.

The archival materials investigated for this study include Libeskind's sketchbooks (nineteen in total), final competition drawings and other drawings, letters and additional textual materials from Libeskind's office.²³ In addition, for information about the design process we contacted Donald Bates.²⁴ His responses to the twenty-four item questionnaire we provided him with were important for understanding the work dynamics of the design team and the development of the principal components of the design scheme, as well as for corroborating some of our interpretations.²⁵



The design task

The stated aims of the competition were twofold. First, the Jewish Museum Department, which was part of the Berlin Museum, was to be 'enlarged and fully integrated into the Berlin Museum'. Second, the Berlin Museum itself needed more space. The former, however, was the main task of the competition. The most important information provided by the competition brief was its description of the desired nature of the relationship between the Jewish Department of the museum and the museum itself. The brief described the Department 'as an autonomous department' of the Berlin Museum, yet also integrated with it.²⁶

The dilemma for the competing architects was to find a scheme in which the two main departments of the museum would be housed so

as to remain integrated while the Jewish Department kept its autonomy. The nature of the relationship between the two departments as described in the document would, in principle, reflect the interaction between Jews and the City of Berlin throughout its history. Bates describes the challenge of the competition as follows:

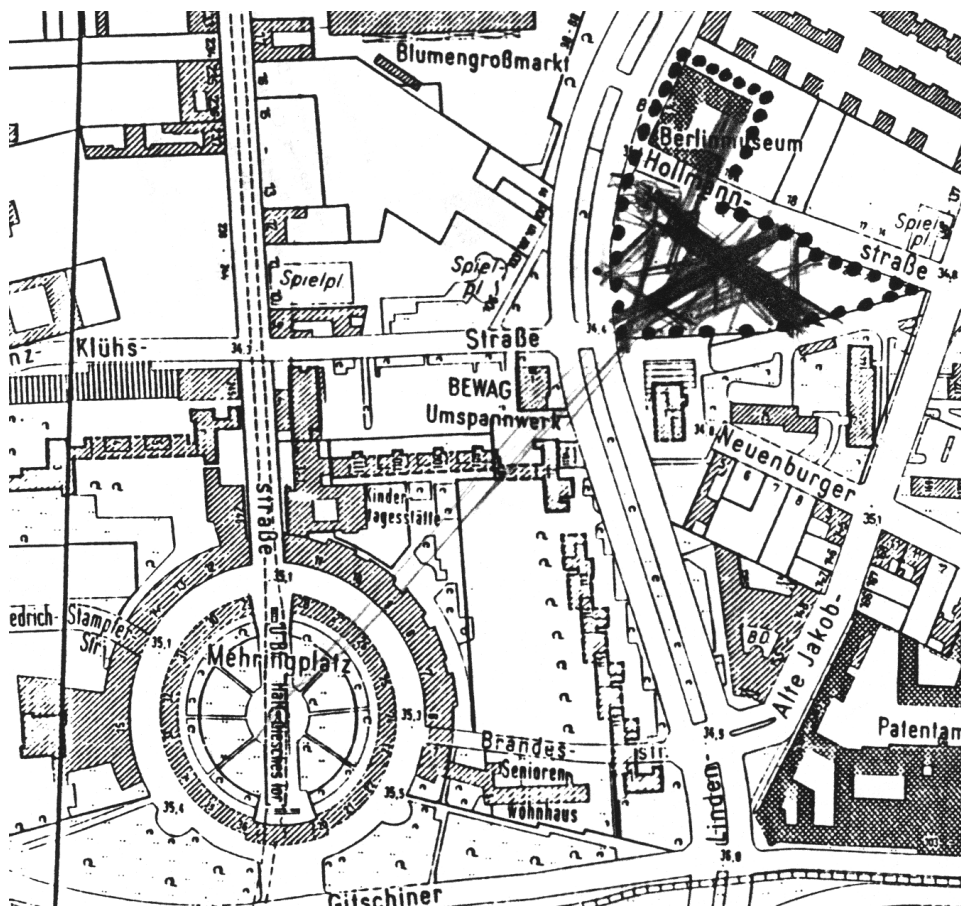
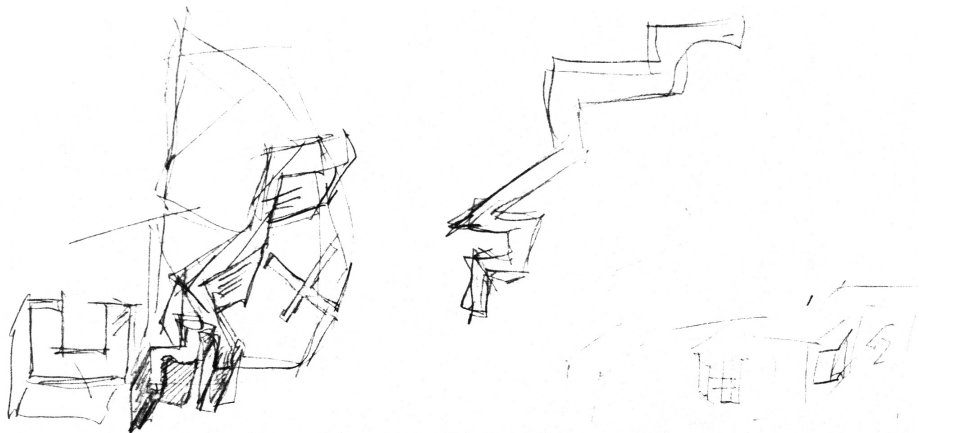
It was clear from the beginning that the competition presented a spatial/programmatic paradox: how to give presence and visibility to a Jewish collection, but also to see it as inextricably enmeshed with the history of Berlin itself – that is, that Berlin history was only possible in the context of the Jews who were also Germans.

The competition brief also emphasised the problem of missing materials because of the systematic elimination of Jewish artefacts after 1933. The brief suggested a flexible chronological organisation for

3 Star Matrix. A distorted version of the Star of David superimposed on the map of Berlin with the black line across the star showing the Berlin wall and the grey line showing the Landwehrkanal (Roll 39)

4 The zigzags drawn on the back of the Berlin Museum pamphlet (Box 26 Folder 2)

5 The distorted star on the site indicating the footprint of the building (Box 26 Folder 2)



the available materials, instead of a sequential one.

The competition documents were issued on 27 December 1988. The organisers accepted questions in writing by 20 January 1989 and arranged an inquiry colloquium held on 6 February 1989, which Libeskind attended with Bates. The deadline for 1:200 and 1:500 architectural drawing submissions was 28 April 1989 and, for the model, 12 May 1989. The competition jury deliberations continued from 2 May 1989 to 15 June 1989, and the jury announced the results on June 25.²⁷ There were 165 entries to the competition, and Libeskind's entry was given the first prize.

Overview of the design process

Libeskind received an invitation letter from the Berlin Senate Department for Building and Housing on 29 November 1988. Along with general information about the competition and its deadlines, the letter included a 1:5000 site plan and pamphlet containing brief information about the Berlin Museum.

On the back of the Berlin Museum pamphlet Libeskind drew six distorted and eight partial stars, suggestive of the Star of David. On the second page of the pamphlet, Libeskind drew fifteen more stars, and on the back of the second page he drew an axonometric drawing of a zigzag adjacent to the existing Baroque building housing the Berlin Museum [4].²⁸ This first drawing is surprisingly similar to the final project but only in form. Bates reported that in the initial period the team searched through all of Libeskind's previous projects 'at different scales', 'in different arrangements', and decided on the zigzag of the *Line of Fire* project as the basic plan layout for the Jewish Museum. According to Bates, this project 'made sense' and 'worked on the site'.

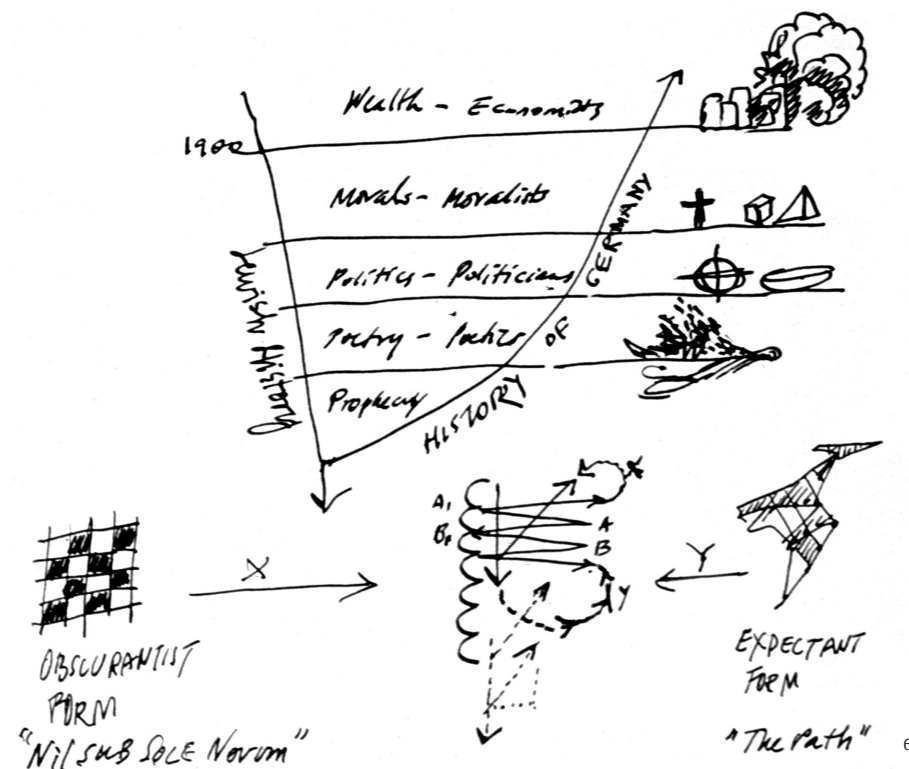
On the site plan attached to the invitation letter, Libeskind sketched a preliminary layout for his building and its relation to Mehringplatz, a nearby public circle [5]. These drawings indicate that from the outset both the distorted star and the zigzag configuration, though yet unrelated conceptually, were present in Libeskind's thinking as generic potential spatial configurations for the Jewish Museum.

Libeskind's sketch of distorted star on the site might appear to indicate the footprint of the building, i.e., the star appears to designate the building itself. In subsequent phases of the design process, however, the star was not used as a spatial configuration for the building. Rather, it was used as a means to conceptually explore different threads of German-Jewish relations and to weave together a coherent conceptualisation that both gave meaning to the zigzag configuration and satisfied the competition's requirements for the building.

In the final version of the star diagram [3], the star represents an imaginary projection extending across the cityscape of Berlin beyond the boundaries of the museum and even the site. Libeskind changed the scale of the star to cover a very large area in Berlin so as to convey a network of connections he had envisioned in his exploratory sketches linking addresses of Berliners, some of whom were Jews. The points in this larger star designate those addresses.

Libeskind explained the network of connections represented by this star as follows:

At the same time, I felt that the physical trace of Berlin was not the only trace, but rather that there was an invisible matrix of connections in relationship. I found this connection between figures of Germans and Jews; between the particular history of Berlin, and between the Jewish history of Germany and of Berlin [...] So I found this connection and I plotted an irrational matrix which was



6 Libeskind's sketch of the Jewish and German lines of history (Box 6 Sketchbook 1)

7 Libeskind's sketch of the Berliner Luft – the air across Berlin – and 'the spiritual search' for form within the Berliner Luft (Box 7 Sketchbook 2)

in the form of system of squared triangles which would yield some reference to the emblematics of a compressed and distorted star: the yellow star that was so frequently worn on this site, which today is green.²⁹

Conceptual elaboration

To deal with the design challenge Libeskind drew many sketches representing a range of issues. Some of these issues seem to be very esoteric while others relate to the design challenge more directly. Here we can only summarise the main conceptual issues that Libeskind dwelt on in his sketchbooks, namely, the oneness of Jewish and German cultures, Jewish-German history, the invisibility of Jewish culture in contemporary Berlin, relationships between the city of Berlin and the Jewish Museum, and relationships between Jewish and German Berliners. These issues can be grouped under two headings: explorations regarding fractured historical relations and explorations regarding present-day invisibility.

Explorations of fractured historical relations between Jews and Germans

Libeskind considered Jews 'inseparably both German and Berliners' and German and Jewish culture as 'one'. His extension to the Berlin Museum 'would manifest that fact, clear across the abyss created by the Holocaust'.³⁰ One theme represents this historical relationship as a beam split apart along a zigzag line, with annotations as J and G and the words *interlocking* and *split fiber*. Next, in a more schematic representation of back-to-back fractured beams, Libeskind uses the words *gap* and *rift*.

The theme of the separation of Germans and Jews shows itself in another set of drawings that explore the historical relationship between the two groups. In one particular drawing [6] Jewish and German histories are depicted as lying between two converging/diverging lines representative of their close interaction. The Jewish history line points into the past, whereas the German history line branches out of the Jewish line and points into the future. This suggests that Libeskind envisioned Jewish

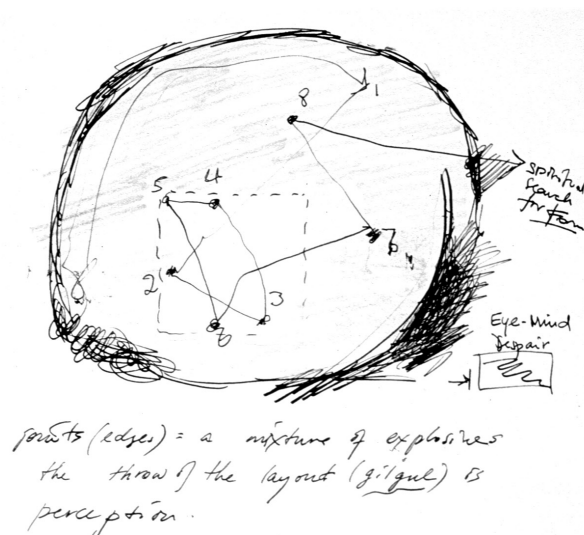
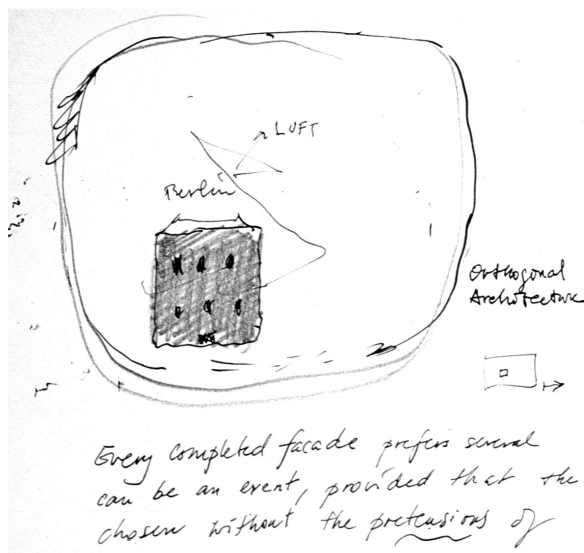
history as rooted in the past from which German history has emerged.

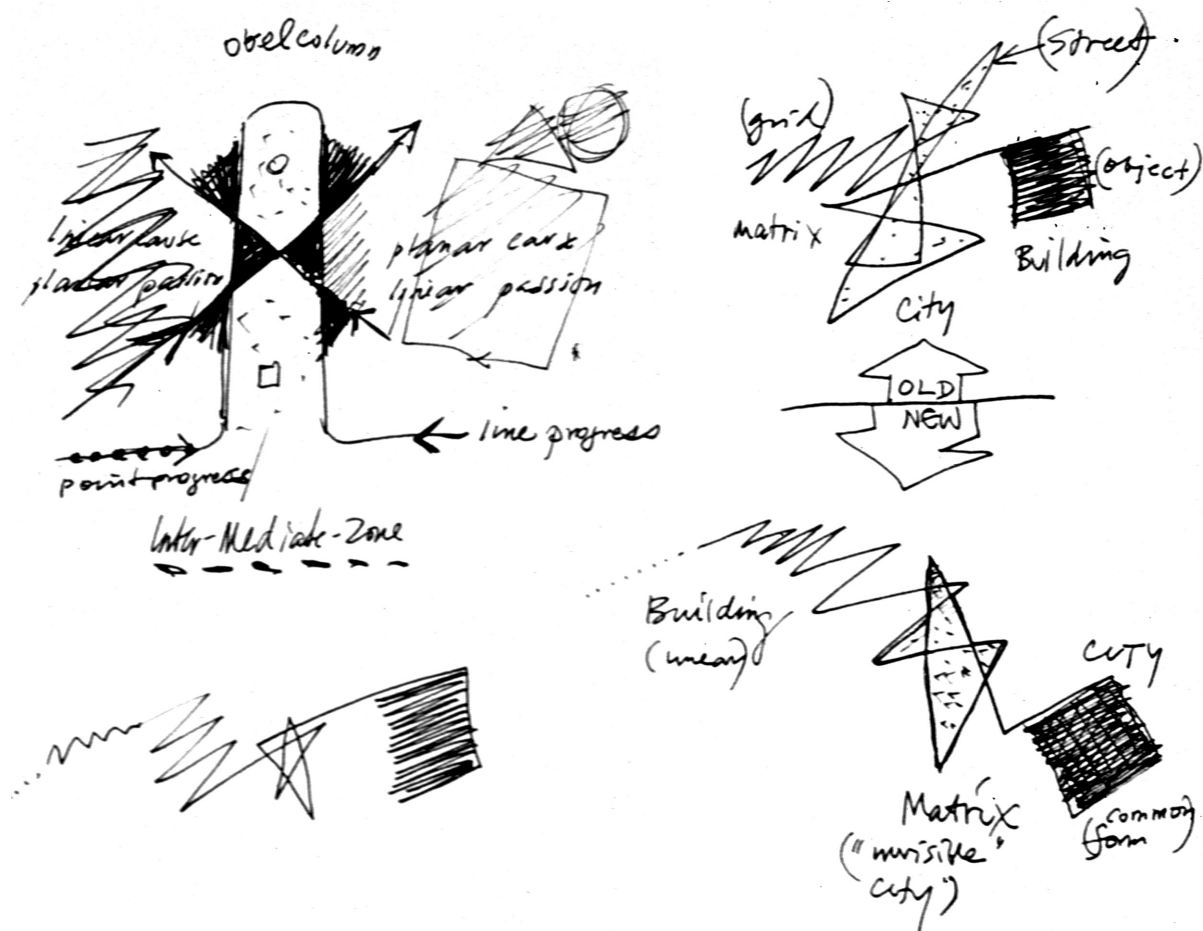
In a smaller drawing in this set, Libeskind abstracted the relationship of Germans and Jews in a rudimentary force diagram in which Jewish history is represented by a downward line and German history is shown as a diagonal line branching off the Jewish line. A sinusoidal line weaves between a series of points (AA, BB) on the two history lines. The conception of *integrated* history in these drawings is represented by a double helix-like historical progression of two intertwined lines, which refers to the merging and parting of the two histories and also their complex and convoluted historical relationship. In a related series of drawings Libeskind drew numerous trajectories between two points (A and B) representing the individual biographical trajectories of citizens of Berlin. Again the trajectories are not linear. Rather, they are all convoluted lines that crisscross each other, symbolising the complex network interactions among these inhabitants of Berlin.

Exploration of the visible/invisible nature of Jews in Berlin

The other significant, related theme Libeskind focused on in his preliminary sketches was the invisibility of Jewish culture in present-day Berlin and Germany. In his architectural report for the competition Libeskind stated that the underlying idea of his project was to render visible what is invisible, i.e., 'the past fatality of the German-Jewish Cultural relation in Berlin'.³¹ To begin addressing the invisibility of the Jews he introduced the notion of *Berliner Luft* [7], later explained as 'the air across Berlin which mixes with the air of history to shape the city'.³²

In this set of drawings Libeskind depicted what he meant by an invisible order behind what is visible. Over a rendering suggestive of the Berlin Museum [7, left side] and labelled *Berlin*, Libeskind started to draw a zigzag, labelled *Luft*. This suggests that Libeskind was trying to connect the zigzag spatial configuration to an underlying pattern for the city of



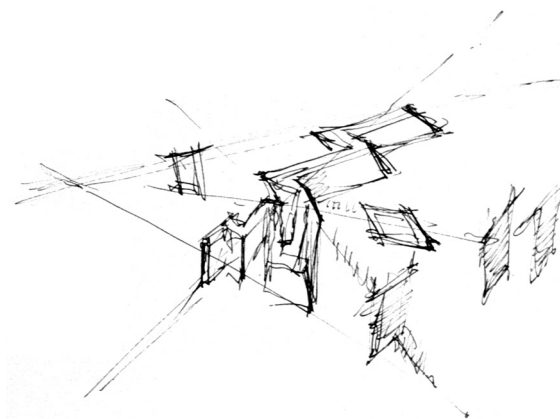


Berlin. On the facing page, he extended a zigzag line outwards, breaking the form of the star. Libeskind labelled this line *the spiritual search for form*. This drawing indicates that Libeskind conceived of the star as an underlying pattern or structure over the city of Berlin which, though not visible, might be traceable through plotting points (noted on diagram) and connecting them to one another. In the series of sketches following these, Libeskind explained further how he saw the invisible *spiritual organisation* in his building, with respect to the plan configuration and the facade. What is most significant about the star in these drawings is that Libeskind began to use it to create a pattern of meaningful integrations along various dimensions of the conceptual space, some of which we outline below.

Integrations

1. City and Building

The series of drawings in Figure 8 depict the connection between building and city, using the star diagram as a mediator. The geometry of the star in these drawings is manipulated so that it can denote underlying structures that connect a generic *building* representation to a representation of the overall city pattern. In these drawings the city is a continuation of buildings shaped according to an invisible, distorted star pattern. Libeskind labelled one drawing of the star the *Matrix* ('invisible city'), further emphasising its role as the pattern underlying the visible city fabric. In a subsequent drawing he put the matrix between the city and architecture and

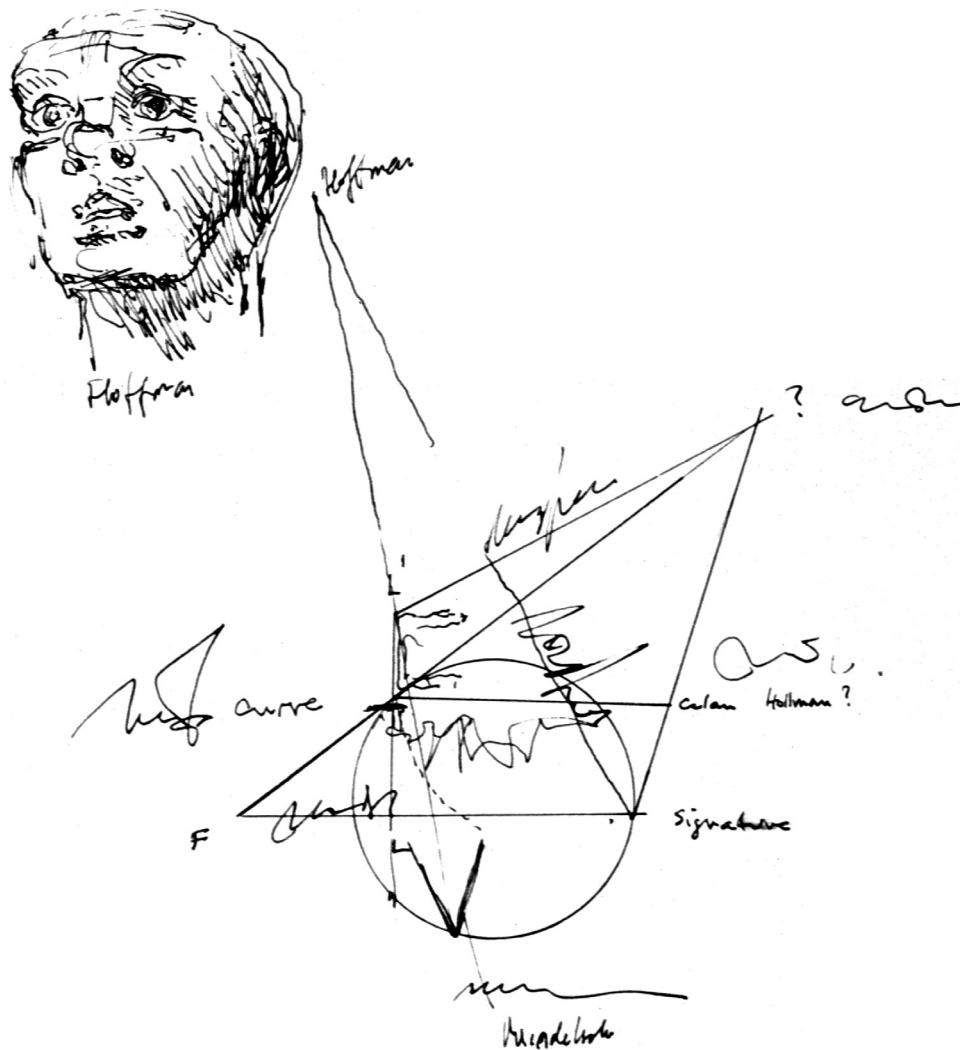


labelled it the *ghost*, again emphasising the invisible mediation of the star.

2. Places

In another sequence of drawings Libeskind used the Star as a connecting element among places, including his Jewish Museum. One drawing plotted a star over and beyond the Berlin Wall, connecting specific buildings and places, including the Berlin Museum, Erich Mendelsohn's Metal Worker's Union Building, Libeskind's own City Edge Project, Oranienstrasse and Mehringplatz. He also included the names of Schinkel, Celan, Ossietzky and Hoffman on the drawing and included an axis over the Star, which he labelled as the *Jewish Cultural Intermarriage* to depict integration between Jews and non-Jews. Most interestingly, when a star configuration is used

- 8 Libeskind's sketch of a Star as a mediating structure between the building and the city (Box 8 Sketchbook 2)
- 9 Libeskind's sketch of the building's form stretching between the two edges of the Star (Box 6 Sketchbook 1)
- 10 Libeskind's sketch of the Star connecting people with their signatures. The Jewish Museum building is one among other signatures (Box 6 Sketchbook 1)



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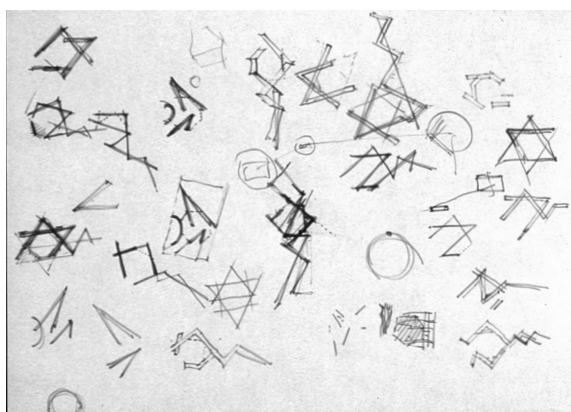
to connect places, the position of the Jewish Museum building with respect to the star changes. Sometimes the building is in the centre, sometimes it is aligned along one of the edges, and sometimes it is at one of the corners of the star. Figure 9 provides an example in which the museum building stretches from one edge of the Star to the other, as if the two sides of the star are held together by means of the Jewish Museum itself.

3. People

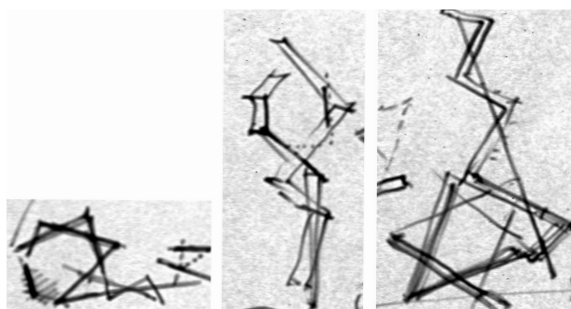
In a third group of drawings Libeskind sought to establish connections between people rather than places. In this series he plotted a partial star with the names of Mendelsohn, Celan and Hoffman [10]. Along the edges of the star he placed his own rendering of their signatures. In a letter to Kurt Forster written on 12 December 1989, Libeskind in fact requested the signatures of Heine, Celan, Varnhagen, Schleirmacher, with the intention of including ('by re-drawing') them in the drawings ('re-signed'). Again, a zigzag which stretches along one of the edges of the Star designates the footprint of the Jewish Museum building, and the word *signature* is written to one side. This suggests that Libeskind might have been thinking of his building as a signature/mark akin to those of Jewish Berliners.

Conceptual simulation: transforming the star diagram into the zigzag design

Thus far we have demonstrated that in the process of constructing and elaborating a meaningful conceptualisation of the design situation Libeskind focused on two major themes: the relationship between Jews and Germany in the history of Berlin and the invisibility of Jewish culture in present day Berlin. In this process he created a wealth of drawings to represent and combine conceptual issues. Often, the two history lines of Jews and Germans were represented as either intertwining or zigzagging lines, while the invisibility of Jewish culture was repeatedly represented in different contexts through variations of star diagrams. All the while, Libeskind was searching for a way to give meaning to the commitment of the design team to a zigzag spatial configuration. The path to resolution began when the two representations – star and zigzag – began to appear concurrently and at times converging towards a unified representation, thus enabling a coalescence of the two themes. The final series of star diagram manipulations led to the spatial breakthrough in the design of the building: the appearance of voids along a broken line passing through the zigzag configuration. We will now provide an interpretation of how those voided areas came about.



11 Libeskind's sketch of a Star unfolding into a zigzag (Box 31 Folder 2)



12 Libeskind's sketches showing Steps of the Star unfolding. Detail from Figure 11

In a group of drawings drawn not in a sketchbook but on a separate larger piece of sketch paper, Libeskind used the star specifically to establish a connection between the two components of his conceptualisation [11].³³ Here Libeskind drew several stars with different forms and nature. Few of these stars are complete. Most are either incomplete or distorted. What is most interesting about some of these incomplete or distorted stars is that Libeskind unfolded two lines of the original star, which has the effect of transforming it into a zigzag, as shown in the detail extracted from the set [12]. The two lines of the unfolded star open outwards as intertwined zigzagging lines, suggestive of the zigzag footprint of the museum building and also of the double-helix representation of the histories of Jews and Berlin noted earlier. In the drawings we highlight, one of the lines remains straight all the way through and the other makes zigzag turns, which corresponds to the overall spatial composition of Libeskind's competition entry.

We propose that Libeskind linked the two emerging themes in his design: the star, i.e., the conceptual theme of his design, and the zigzag, i.e., the generic spatial scheme of the building by means of this set of drawings. The zigzag and the distorted star are merged, as are the distorted, fragmented relations of the history of Germans and Jews. The voids comprise fragments of the exploded star. Deriving the spatial configuration from the star diagram imbues the building with the meanings established in Libeskind's conceptual elaborations.

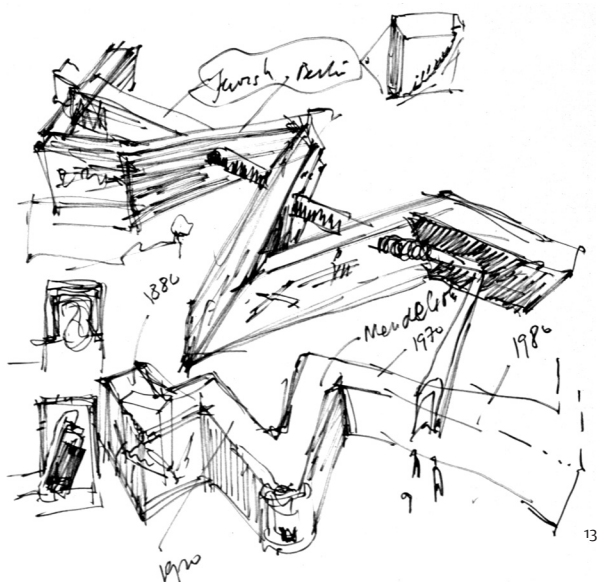
Significantly, once he had transformed two intertwining lines of the Star into a zigzag line and a straight line cutting through the zigzag, this change was propagated to the spatial configuration of the design. In subsequent drawings the geometrical form of the building became that of a zigzag and a line cutting through the zigzag; the line becoming visible only at times when it crosses the zigzag. At these crossings Libeskind placed voids, i.e., unoccupied spaces, which embodied the notion of the contemporary invisibility of the Jewish presence in Berlin.

There is additional evidence to support our claim that the two intertwining lines of the unfolded star were interpreted as the Jewish and German history lines by Libeskind. First, there are at least two drawings in which Libeskind labelled these lines *Jewish* and *German*.³⁴ In the first drawing Libeskind furthered the mediating role of the star between the Jewish and German lines of history. This time an incomplete star, labelled *Jewish*, first transforms and relabelled *Berlin*, and later becomes Libeskind's final scheme with the linear void cutting through the zigzag. Here, the star becomes the intertwined trajectory of Jews and Berliners, which eventually transforms into a zigzag. In the second drawing [13] the historical succession of events is plotted along a horizontal and a vertical axis, where the horizontal axis is linear and continuous and the vertical tends to zigzag around the linear horizontal axis. Historical events or dates are plotted along both axes. Libeskind labelled the straight line cutting through the building the *Jewish* history line and the zigzag block as the *Berlin* history line. We see for the first time an indication of a void as a rectangular prismatic configuration along the zigzag. The rhythm of the series and the idea of the voids conceptually merge both the missing Jewish artefacts and culture in Berlin and the wandering themes of Schoenberg's opera *Moses and Aaron* and Walter Benjamin's essay *One-Way Street*, which he had explored through another series of drawings focused on history that we cannot include here.³⁵

To underscore the meaning with which he had imbued the final architectural form, Libeskind changed the title of the competition and of the new building. The original title was *Extension of the Berlin Museum with the Jewish Museum*, but Libeskind now referred to the competition as *Between the Lines*, i.e., two lines of meaning that are intertwined throughout history. One line is straight yet broken while the other is continuous yet zigzagging. As Libeskind later expressed it, one represents organisation while the other represents relationship; they 'fall apart, disengage, and separate', exemplifying the history of Jews and Germans.³⁶

In addition to Libeskind's drawings, Bates' responses lend support to our interpretation that through this series of drawings Libeskind combined the two themes. In response to our query about this series, Bates confirmed the relationships:

The zigzag is the history of Berlin (by implication Germany). It is a continuous line, but one with abrupt



13 Libeskind's sketch of the Jewish and German history lines crisscrossing each other (Box 7 Sketchbook 2)

turns, contradictions, an often torturous continuity. The straight line of the 'voids' is exactly that – straight but not continuous. It is clipped, ruptured, segmented by the continuous zigzag line. This line of the 'voids' is the empty presence of Jewish influence and existences within the history of Berlin ... My opinion is that the zig-zag and the line of the voids is far more potent as an architectural device to tell this complex history. The distorted star [in this series] is to link the design back to history and the wider context, but it is the zig-zag and the voids that define in a way only achievable with architecture, this complex intertwining of the chosen and the 'Chosen'.

Discussion

Libeskind's star diagrams evoke different levels of meaning. At a semantic level it is a symbol of the Jewish belief system. At a conceptual level within the context of the Jewish Museum, it makes visible that which is invisible, i.e., integration of the Jews and non-Jews of Berlin. At the building level, this integration is symbolised by a pair of intertwining lines, one which represents Jewish history and the other the history of Berlin.

As an abstraction, the star diagram exemplifies Libeskind's fascination with 'radical elucidation of the original precomprehension of forms' which leads to 'true abstraction'.³⁷ The process of abstraction, according to Libeskind, does not invoke removal of meaning but isolates the structural essence. Through diagrammatic configurations Libeskind aimed at capturing the essentials of a design situation, which could be about its conceptual underpinnings, its formal configuration, or both.

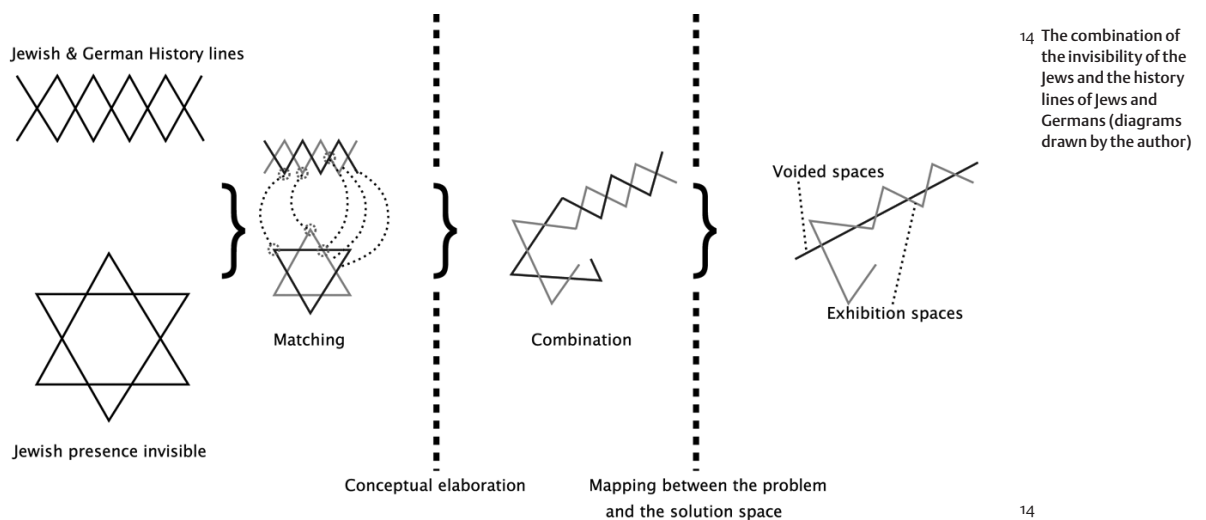
Libeskind's commitment to a zigzagging design scheme remained constant throughout the design process. The design process we have examined shows

him seeking a justification for and elaboration upon that scheme so as to imbue it with meaning. He established links between the history of German-Jewish relationships through to the present day by instantiations and manipulations of the star diagram. Through these processes, the conceptual basis of the design was elaborated by incorporating layers of meaning from different domains. Yet the core conceptualisation remained constant, i.e., the idea of establishing relationships through the mediation of Star of David to render the Jewish presence visible. The star diagram, therefore, becomes a running theme throughout the design process and establishes commonalities among different threads of thought and emotions to make a complex conceptual situation cognitively manageable. Cognitive research has established that diagrams can make complex conceptual relationships clearer and more easily grasped.³⁸ What is different in the case of the star diagram is that it fosters a creative process through which concepts are merged into new representations which enabled the designer to establish a common theme across the conceptual domain.

The star as it emerged in the beginning denoted a footprint of the building, but the imagery of the star was represented in many different contexts and forms. We provided evidence for the claim that the *fragmented star* emerged through an extended period of conceptual elaboration and a final coupling of manipulations of the conceptual diagram and Libeskind's mental models by means of which Libeskind merged seemingly disparate elements of his conceptualisations, rather than by means of a 'mental leap' triggered by the superimposition of the star over the Berlin wall and the Landwehrkanal. The archival materials of the design process strongly indicate that Libeskind was seeking a way to imbue the design and subsequent building with historical and cultural meaning, especially the visible and invisible presence of Jews in Berlin and Germany. He established links between the histories of Germans and Jews through to the present day by invoking the star diagram. In these processes the conceptual basis of the design was elaborated by incorporating layers of meaning coming from different domains including literature, music, theology, history and architecture.

Libeskind's design process for the Jewish Museum project is more extensive than we can discuss within the scope of this paper. Here, we limit our discussion to two main issues: 1) the nature of the design process with reference to characterisations of design, and 2) the cognitive role of conceptual diagrams in the design process.

With respect to the first issue, in contrast to most characterisations of design, the Jewish Museum case represents a process during which conceptual elaborations and spatial explorations often progressed in unrelated venues. This might appear to be a case of what some design researchers have called a *co-evolutionary* view of design, which argues that problem solution and problem structuring evolve simultaneously.³⁹ However, explorations in the



conceptualisation space and the solution space remained isolated and there was not much interaction between the two explorations until the final manipulation of the star diagram. In contrast, also, to *solution-oriented views of design*,⁴⁰ which argue that designers start with a solution in mind, we see an intense effort by Libeskind to further enrich the conceptual basis of the project from the outset of the design process. Finally, in contrast to *insight, or aha, views of design*,⁴¹ which argue that designs are created in sudden flashes of insight, the breakthrough emerged over the course of a rich, extended exploration process, as we have laid out.

With regard to the second issue, from a cognitive perspective, we interpret the diagrammatic representations as affording a dynamical conceptual simulation from which the novel insight was derived.⁴² First, the final combination could have been triggered by the perceptual similarities between the two diagrammatic representations, the zigzag and the star, as we have rendered in Figure 14. The matching perceptual features are: crisscrossing lines, intersections and corners. Once the two diagrammatic representations were combined, Libeskind could superimpose the meanings attached to these perceptual features. In the final configuration, each element acquired a double meaning, at once representing the invisible nature of Jewish culture in contemporary Berlin and also the integrated history of Jews and Germans. Through unfolding the star into two crisscrossing lines, Libeskind at last managed to relate the two explorations, i.e., conceptual and spatial. In the final spatial configuration, Libeskind left a void where the lines crossed, symbolic of the invisibility of the Jewish presence in present-day Berlin.

Second, there is a large literature on mental modelling, mental simulation and diagrammatic reasoning in cognitive science that is pertinent to our interpretation, which we cannot examine here.⁴³ We conjecture that manipulating the physical representation – the conceptual diagram – evoked a corresponding simulation of the star unfolding into the zigzag and thus a change in the structure of Libeskind's mental model. This conceptual

simulation merged conceptual and spatial domains and created a meaningful design: the zigzag plus voids configuration. In general, the totality of the research on diagrams supports the contention that diagrams, as form of external representation, 'are not simply inputs or stimuli to the internal mind, rather they [as external representations] are so intrinsic to many cognitive tasks that they guide, constrain, and even determine cognitive behavior'.⁴⁴ As further argued by Nancy Nersessian,⁴⁵ active perception of diagrams while reasoning provides situational information to working memory that interacts with mental models. The diagrammatic representation and the mental model 'are best understood as "coupled," each providing their own constraints and affordances such that features of the external representations make direct contributions to transformations of mental models and vice versa.'⁴⁶ Libeskind's manipulation of the components of the two diagrammatic representations and their coalescence is an example of how changes in a physical representation can create corresponding changes in a conceptualisation. The change in the conceptualisation, in turn, triggered a change in the spatial configuration of the building. This superimposition of meanings was achieved through manipulating diagrammatic representations, and changes in the conceptualisation and in the spatial configuration were mediated by the structure of emergent diagrammatic representations. The emerging representation retained its structural correspondence to both of its corresponding conceptual domains and thus acquired double meaning.

Conclusion

Our study of the design process of Daniel Libeskind's Jewish Museum in Berlin shows how a generic representation of a design situation in the form of a diagram facilitated conceptual exploration, which resulted in an alignment of conceptual and spatial configurations. Libeskind used the star diagram in different contexts to draw together a wide range of ideas and to create a network of meaningful associations among otherwise unrelated ideas

pertaining to Jewish and German history. Each use of the diagram or parts of its perceptual features retained enough of its original formal configuration as well as semantic content to create a family of ideas, which, in turn, facilitated comparisons between explorations. We have argued that Libeskind's final manipulation, unfolding the star into a series of crisscrossing lines, led him to align his enriched conceptualisation of Jewish-German history with the zigzag spatial configuration of the building and to add the highly evocative voids.

This study shows that modifications and elaborations in design conceptualisations can be

fostered through the manipulation of components of conceptual diagrams, which are here considered physical representations that correspond to mental models. The study also shows that, regardless of whether design starts with a specific solution or with problem structuring, creativity in spatial design could be fostered through the construction of a meaningful and rich conceptual basis that consistently relates to a spatial configuration. The conceptual diagram mediates the relationship between design concepts and spatial configurations and thus enhances spatial creativity through conceptual associations.

Notes

1. A. Huyssen, 'The Voids of Berlin', *Critical Inquiry*, 24 (1997), 57-81; E. Kligerman, 'Ghostly Demarcations: Translating Paul Celan's Poetics into Daniel Libeskind's Jewish Museum in Berlin', *The Germanic Review*, 80 (2005), 28-49; James E. Young, 'Daniel Libeskind's Jewish Museum in Berlin: The Uncanny Arts of Memorial Architecture', *Jewish Social Studies*, 6 (2000), 1-23.
2. Kurt W. Forster, 'Mildew Green Is the House of Forgetting', in *Daniel Libeskind, Radix-Matrix: Architecture and Writings*, ed. by Daniel Libeskind and Andrea P. A. Belloli (Munich/New York: Prestel, 1997), p. 7.
3. As Forster suggests, 'concepts of this kind are always borne by emotions. Instead of being a purely logical construct, the idea manifests itself in combination with an irreducible affect'. Forster, 'Mildew Green Is the House of Forgetting', p. 7. In tracing Libeskind's creative path we are not trying to reduce the whole process to a logical construction or to a reductionist rationalist explanation. On the contrary, we are trying to show the meaningful richness of Libeskind's explorations at multiple levels which we claim contributes immensely to the 'irreducible affect'. For an alternative view on studying the process in Libeskind's creative work see Stanley Allen, 'Libeskind's Practice of Laughter: An Intro by Stanley Allen', *Assemblage* (1990), 20-25.
4. See Nancy J. Nersessian, 'Opening the Black Box: Cognitive Science and History of Science', *Osiris*, 10 (1995), 194-211; and Fehmi Dogan and Nancy J. Nersessian, 'Generic Abstraction in Design Creativity: The Case of Staatsgalerie by James Stirling', *Design Studies*, 31 (2010), 207-36.
5. The cognitive-historical method assumes that cognitive science research in such areas as concept formation and categorisation and mental modelling provide working tools for historians, philosophers and psychologists to interpret archival records of creativity and discovery in a range of fields. Researchers using the cognitive-historical method have contributed, reciprocally, to the advancement of cognitive science in areas such as conceptual change, the use of imagistic reasoning and diagrammatic reasoning. See Nancy J. Nersessian, 'Faraday's Field Concept', in *Faraday Rediscovered: Essays on the Life and Work of Michael Faraday, 1791-1867*, ed. David Gooding and Frank A. J. L. James (New York, NY: Macmillan Press; Stockton Press, 1985), 433-462; Nancy J. Nersessian, *Creating Scientific Concepts* (Cambridge, MA: MIT Press, 2008); Ronald N. Giere, *Science without Laws* (Chicago: University of Chicago Press, 1999); Peter Cheng, 'Scientific Discovery with Law-Encoding Diagrams', *Creativity Research Journal* 9, nos. 2-3 (1996), 145-62.
6. Daniel Libeskind, 'Between the Lines (Architect's Competition Report)', in *Realisierungswettbewerb Erweiterung Berlin Museum Mit Abteilung Jüdisches Museum (Berlin Museum Documentation)*, ed. by Department of Cultural Affairs Research Library, The Getty Research Institute, Los Angeles (920061), 1990; 'The Jewish Extension to the German Museum in Berlin', *Architectural Design*, 60 (1990), 62-77; Daniel Libeskind, Berlin Museum Jüdische Abteilung, and Kristin Feireiss, *Erweiterung Des Berlin Museums Mit Abteilung Jüdisches Museum* (Berlin: Ernst & Sohn, 1992); Daniel Libeskind, and Hélène Binet, *Jewish Museum, Berlin* (Amsterdam: G + B Arts International, 1999).
7. Libeskind, Berlin Museum Jüdische Abteilung, and Feireiss, *Erweiterung Des Berlin Museums Mit Abteilung Jüdisches Museum*.
8. The reason why we are focusing mainly on the first and third is because these lines are more directly related to the content of the sketches. Here, we are not claiming to provide, neither attempting at, a complete explanation of Libeskind's creative process. Instead we are providing a partial exposition which can be enriched by further studies that will look into aspects that we had to omit in this paper.
9. Jeffrey Kipnis, 'Preface', in *Daniel Libeskind: The Space of Encounter*, ed. by Daniel Libeskind (New York: Universe: distributed to the U.S. trade by St. Martin's Press, 2000), pp. 10-13.
10. See Aaron Betsky, 'Can Daniel Libeskind's First Buildings Keep Pace with His Provocative Theories?', *Architecture*, 87 (1998), 101-07; Kurt W. Forster, 'Monstrum Mirabile et Audax' in *Erweiterung Des Berlin Museums Mit Abteilung Jüdisches Museum*, ed. by Daniel Libeskind, Berlin Museum, Jüdische Abteilung, and Kristin Feireiss (Berlin: Ernst & Sohn, 1992), pp. 17-23; James E. Young, 'Daniel Libeskind's Jewish Museum in Berlin: The Uncanny Arts of Memorial Architecture', *Jewish Social Studies*, 6 (2000), 1-23.
11. Personal correspondence with Donald Bates, 28 October 2003. All references to Bates will be to this correspondence unless otherwise noted.
12. Fehmi Dogan, 'The Role of Conceptual Diagrams in the Architectural Design Process: Case Studies of the First Unitarian Church by Louis Kahn, the Staatsgalerie by Stirling & Wilford Associates, and the Jewish Museum by Daniel Libeskind' (Unpublished Ph.D. Thesis, Georgia Institute of Technology, 2003).
13. Nersessian, 'Opening the Black Box: Cognitive Science and History of Science'; Nancy J. Nersessian, *Faraday to Einstein: Constructing Meaning in Scientific Theories, Science and Philosophy* (Dordrecht; Boston Hingham, MA: Kluwer Academic Publishers, 1984); Nersessian,

- Creating Scientific Concepts (Cambridge, MA: MIT Press, 2008).
14. Fehmi Dogan, 'The Role of Conceptual Diagrams in the Architectural Design Process'; Fehmi Dogan and Nancy J. Nersessian, 'Generic Abstraction in Design Creativity: The Case of the Staatsgalerie by James Stirling', *Design Studies*, 31 (2010), 207–36; Fehmi Dogan and Craig M. Zimring, 'Interaction of Programming and Design: The First Unitarian Congregation of Rochester and Louis I. Kahn', *Journal of Architectural Education*, 56 (2002), 47–56. In the Kahn study, we discussed how an initial concept in the form of conceptual diagram brought together abstract and spatial issues. In the Stirling study, we illustrated how abstraction through diagramming helped the designer to highlight the main features of a design idea.
 15. A. Huyssen, 'The Voids of Berlin', 57–81.
 16. *Ibid.*, 79. For the meaning of voids in the Jewish Museum see also J. Derrida, 'Response to Daniel Libeskind', *Research in Phenomenology*, 22 (1992), 88–94; Anthony Vidler, *Warped Space: Art, Architecture, and Anxiety in Modern Culture* (Cambridge, MA: MIT Press, 2000); E. Kligerman, 'Ghostly Demarcations: Translating Paul Celan's Poetics into Daniel Libeskind's Jewish Museum in Berlin', *The Germanic Review*, 80 (2005), 28–49; Alois Martin Müller, 'Daniel Libeskind's Muses', in *Daniel Libeskind, Radix-Matrix: Architecture and Writings*, ed. by Daniel Libeskind and Andrea P. A. Belloli (Munich; New York: Prestel, 1997), pp. 116–19; Michael Spens, 'Berlin Phoenix: Jewish Museum, Berlin, Germany', *Architectural Review*, 205 (1999), 40–47; Young, 'Daniel Libeskind's Jewish Museum in Berlin: The Uncanny Arts of Memorial Architecture'.
 17. Daniel Libeskind, *Daniel Libeskind: The Space of Encounter* (New York: Universe, 2000), p. 224.
 18. D. Libeskind, D. F. Krell, and S. Allen, 'Between the Lines: Extension to the Berlin Museum, with the Jewish Museum', *Assemblage* (1990), 19–57.
 19. Aaron Betsky, 'Can Daniel Libeskind's First Buildings Keep Pace with His Provocative Theories?', *Architecture*, 87 (1998), 101–07; Bernhard Schneider, and Daniel Libeskind, *Daniel Libeskind Jewish Museum Berlin: Between the Lines* (Munich; New York: Prestel, 1999); Michael Spens, 'Berlin Phoenix: Jewish Museum, Berlin, Germany', *Architectural Review*, 205 (1999), 40–47; James E. Young, 'Daniel Libeskind's Jewish Museum in Berlin: The Uncanny Arts of Memorial Architecture', 1–23.
 20. Michael Brawne, *Architectural Thought: The Design Process and the Expectant Eye* (Amsterdam/London: Elsevier, 2003); Hilde Heynen, *Architecture and Modernity: A Critique* (Cambridge, MA: MIT Press, 1999); K. M. Zarzar, 'The Use of Architectural Precedents in Creative Design', in *Understanding Meaningful Environments: Architectural Precedents and the Question of Identity in Creative Design*, ed. by K. M. Zarzar and Ali Guney (Amsterdam: Delft University Press, 2008), pp. 7–22.
 21. Zarzar, 'The Use of Architectural Precedents in Creative Design'.
 22. Heynen, *Architecture and Modernity: A Critique*.
 23. All documents in the Archives, textual as well as visual, were organised and numbered, including their dates when available, by the Archives' researchers. The documents were acquired from Libeskind in 1992 and were kept in their original organisation to the extent possible. The documents are ordered according to phases in the design process and most documents studied for our research come from the competition phase, which includes several sketchbooks and drawings on different media. The sketchbooks are numbered and stored in five boxes, but since they are undated it is not possible to establish an exact chronology for the sketchbooks. They cover a period of five months. The natural sequence of the pages within a sketchbook establishes a chronology within each. We determined the chronology of the boxes primarily by sequencing the themes and design elements present in them. The archival materials include three additional documents that were crucial for identifying the requirements of the client, the history of the competition and the design, and the major themes of the architect. The original competition brief that was provided to Libeskind describes the objective of the competition, the design task and other requirements, and includes additional information of the design situation. Libeskind's original copy has marks and annotations along the text. The second document, Libeskind's architectural report which was submitted with the competition package for 28 April 1989 deadline, summarises the main conceptual issues addressed in his scheme and the major features of his design (see Libeskind, 'Between the Lines (Architect's Competition Report)'). Finally, the book published in commemoration of the competition includes parts of the brief, the architect's report, as well as other writings detailing important developments leading to the competition and after the competition (see Department of Cultural Affairs, *Realisierungswettbewerb Erweiterung Berlin Museum Mit Abteilung Jüdisches Museum (Berlin Museum Documentation)*). Research Library, The Getty Research Institute, Los Angeles (920061), 1990).
 24. We initially contacted Daniel Libeskind's office and corresponded with Nina Libeskind about a possible visit to their office while it was still located in Berlin. We were unfortunate not to have the possibility to visit their office at the time even though we had a kind invitation from Nina Libeskind. After, we were told that all the documents from the Jewish Museum project were housed at the Getty Research Institute and per N. Libeskind's suggestion, we decided to focus on the archival investigation. Subsequent contacts with Daniel Libeskind's office for a possible visit did not yield any results because at the time they were very busy with the Ground Zero Project in New York and they had decided to move the office to New York. The same questionnaire which was sent to Bates was sent to Libeskind's office also, however, we did not receive responses to the questions.
 25. We of course are aware of the treacheries of post-hoc remembrances, such as those provided by Bates, and that they need to be corroborated with independent sources of evidence to the extent possible. Bates' recollections do not figure into our specific interpretation of how Libeskind derived the voids.
 26. *Competition for an Extension to the Berlin Museum to Include the Jewish Museum*.
 27. Rolf Bothe, 'Das Berlin Museum und Sein Erweiterungsbau' (the Berlin Museum and Its Extension), in *Erweiterung Des Berlin Museums Mit Abteilung Jüdisches Museum*, ed. by Daniel Libeskind, Berlin Museum, Jüdische Abteilung, and Kristin Feireiss (Berlin: Ernst & Sohn, 1992), pp. 32–52.
 28. All drawings are from the Daniel Libeskind papers (© Research Library, The Getty Research Institute, Los Angeles, 920061) collection, unless otherwise noted.

29. Libeskind, Berlin Museum Jüdische Abteilung, and Feireiss, *Erweiterung Des Berlin Museums Mit Abteilung Jüdisches Museum*, p. 63.
30. Daniel Libeskind, 'The Never-Ending Story: A New Jewish Museum Bridges the Abyss of the Holocaust', *Newsweek (Atlantic Edition)*, 138 (2001), 27.
31. Libeskind, 'Between the Lines (Architect's Competition Report)'.
32. Libeskind, and Binet, *Jewish Museum, Berlin*.
33. This particular drawing appears in an archive box with a number higher than the sketchbooks' boxes. This, however, does not necessarily indicate a chronological order. This drawing is in a separate box because it is on a larger and separate piece of paper. Donald Bates reported to us that the design team did not work on voids until late in the design process, which suggests that the indications of voids and the void line cutting through the zigzag must have emerged much later, after Libeskind's intense conceptual elaborations.
34. We suggest that these drawings came after the merging of the zigzag and the star because they are the first and only instances of voids in all of Libeskind's sketches for the Jewish Museum project. We know that the design element of the line and zigzag only arose in that context – confirmed by the evidence of the drawings, Bates' personal account, and Libeskind's own reflections.
35. In the sketchbooks, there are several facade drawings with trajectory lines alluding to two journeys which were crucial in Libeskind's conception. The first is Moses and Aaron's journey from Egypt back to Israel, without a definite end, which Libeskind reads from Schoenberg's opera. The second is Walter Benjamin's journey in Berlin in his essay 'One-Way Street', which wanders in the city without a definite target. In his facade drawings, Libeskind transcribes this on the exterior of his building making the elevations highly symbolic that could be read as pages of a book. Here, the building becomes a metaphorical book on the history of Jews and their relationship with the Germans.
- Several of Libeskind's drawings illustrate his conception of folded and inclined walls of the museum as half open pages of a book or as an unfolding scroll of Torah.
36. Libeskind, Berlin Museum Jüdische Abteilung, and Feireiss, *Erweiterung Des Berlin Museums Mit Abteilung Jüdisches Museum*.
37. Libeskind, *Between Zero and Infinity: Selected Projects in Architecture* (New York: Rizzoli, 1981).
38. See Malcolm I. Bauer and P. N. Johnson-Laird, 'How Diagrams Can Improve Reasoning', *Psychological Science* 4, vol. 4, no. 6 (1993), 372–78; Merideth Gattis and Keith J. Holyoak, 'Mapping Conceptual to Spatial Relations in Visual Reasoning', *Journal of Experimental Psychology: Learning, Memory & Cognition* 22, no. 1 (1996), 231–40; Janice D. Gobert and John J. Clement, 'Effects of Student-Generated Diagrams Versus Student-Generated Summaries on Conceptual Understanding of Causal and Dynamic Knowledge in Plate Tectonics', *Journal of Research in Science Teaching* 36, no. 1 (1999), 39–53.
39. See Kees Dorst, and Nigel Cross, 'Creativity in the Design Process: Co-Evolution of Problem-Solution', *Design Studies*, 22 (2001), 425–37; Mark D. Gross, S. M. Ervin, James Anderson and Aaron Fleisher, 'Designing with Constraints', in *Computability of Design*, ed. by Yehuda E. Kalay (New York: Wiley, 1987), pp. 53–83; Mary Lou Maher, and Hsien-Hui Tang, 'Co-Evolution as a Computational and Cognitive Model of Design', *Research in Engineering Design*, 14 (2003), 47–64; Masaki Suwa, John Gero and Terry Purcell, 'Unexpected Discoveries and S-Invention of Design Requirements: Important Vehicles for a Design Process', *Design Studies*, 21 (2000), 539–67.
40. See B. Lawson, 'Cognitive Strategies in Architectural Design', *Ergonomics*, 22 (1979), 59–68; Peter Lloyd, and Peter Scott, 'Discovering the Design Problem', *Design Studies*, 15 (1994), 125–40.
41. See Ömer Akin, and Cem Akin, 'Frames of Reference in Architectural Design: Analysing the Hyperacclamation (a-H-a-l)', *Design Studies*, 17 (1996), 34–61.
42. See Nancy J. Nersessian, *Creating Scientific Concepts* (Cambridge, MA: MIT Press, 2008).
43. See Nersessian, *Creating Scientific Concepts*, especially Chapters 4 and 5, for a critical analysis of this literature.
44. Jiajie Zhang, 'The Nature of External Representations in Problem Solving', *Cognitive Science Journal* 21, no. 2 (1997), 180.
45. See Nersessian, *Creating Scientific Concepts*.
46. *Ibid.*, 166. See also J. G. Greeno, 'Situations, Mental Models, and Generative Knowledge', in *Complex Information Processing: The Impact of Herbert A. Simon*, ed. D. Klahr and K. Kotovsky (Hillsdale, NJ: Erlbaum, 1989), 285–318.

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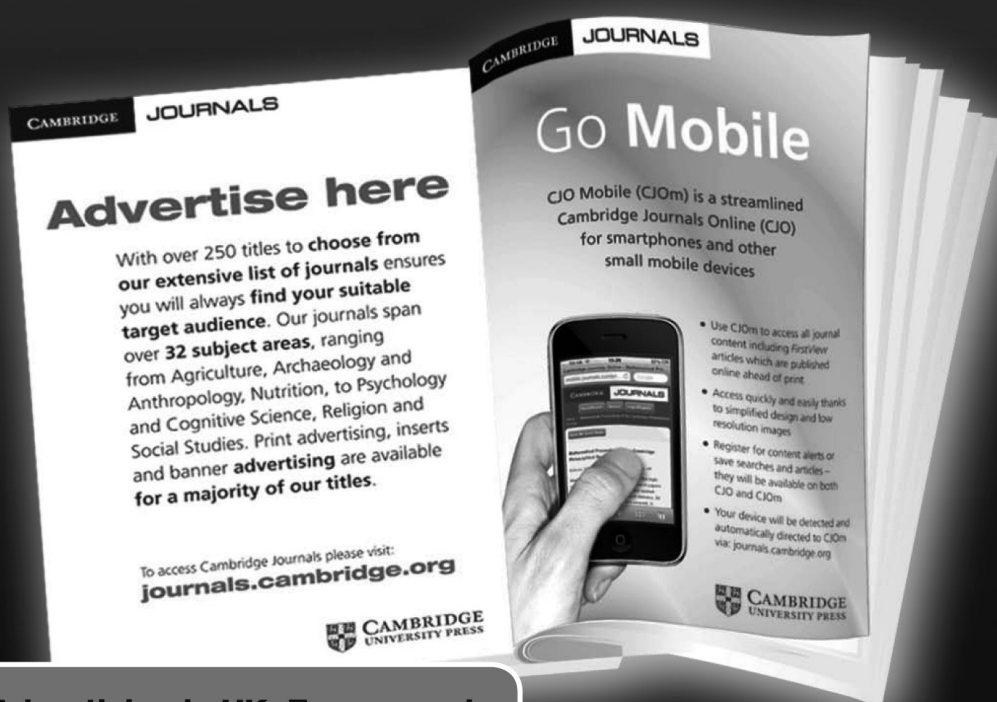
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