Chapter 5
Student Guide 3—How to Model Your Biophilic Design Thinking Process

Abstract Sustainable studios are pivotal courses in today's architecture education. Their unique characteristic is the use of a design framework to guide the design process, grounded in design thinking. This chapter discusses the fundamental ideas behind the design thinking process while elaborating five models used by students to integrate biophilic design frameworks into an environmentally sustainable design studio. These models are the (1) biophilic category model, (2) biophilic overlay model, (3) biophilic criteria model, (4) biophilic process model and (5) biophilic conceptual model. Further instructions are given for articulating and modelling the design thinking process.

5.1 Introduction

When you are enrolled in a design studio, you are asked to provide a design solution to a problem that varies depending on the specific brief. To do so, you usually follow a certain process. The terms 'design process' and 'design method' have been interchangeably used to identify this process, though in recent times the term 'design thinking' is more frequently used. They all refer to a systematic way of developing a design, with activities along different phases. Design thinking processes are usually depicted using diagrams.

Additionally, in ESD studios you are usually required to demonstrate that your project responds to specific criteria, benchmarked against a specific framework. So to say, now that you have developed your own BD framework, you should be able to integrate it into your design thinking process. The aim of this guide is to assist you in understanding how you can undertake this important step by illustrating five main models to use the 'success matrix' as an integrated part of your design thinking.

This guide includes a board discussion about design thinking models and their development in the context of sustainable design to facilitate your understanding on what is a design thinking model. You may recognize your own approach to design and realise that you may have used a similar process knowingly or unknowingly in your previous projects.

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This guide also includes instructions on how to record the design thinking process using a reflective diary, design sketches, models and critical reflections. We encourage you to consciously use a design thinking process and to record it properly, this will support you in controlling your design activities and return to an earlier step if you need to refine the design.

5.2 Design Thinking Process and Models

The term 'design thinking' was initially used in business studies to promote innovation and referring more generally to 'the cognitive activities that designers employ in operating the design process to generate ideas, solve problems, and make decisions' (Ghonim, 2016, p. 553). However, it quickly became popular in architecture. There are three main typologies that may be of interest for you: (1) design thinking models commonly used in design disciplines, (2) architectural design thinking process models and (3) sustainable design thinking models.

In the context of design thinking, you should note that there is a distinction between the process and the model. All the activities that take place during design is a process, and when you synthesise them into a replicable diagrammatic presentation, you will have a model. If you adopt a specific process, once you developed the related model you will be able to use this model again in the future.

5.2.1 Design Thinking Models

The notion of design thinking was introduced by Lawson (1980), with further developments by Cross (1982) and Schön (1983). However, with the wide popularity of design thinking across disciplines, numerous design thinking models have been later introduced.

A first approach was based on the fundamental idea of divergent and convergent thinking as an integrated part of the design thinking. Alexander (1964) and many other design researchers have emphasised this dual mode in the design process (Fig. 5.1).

As illustrated in Fig. 5.1, divergent thinking breaks the design problem into parts, usually denominated by the term 'analysis', while convergent thinking reassembles the parts into a new solution and is usually termed 'synthesis'. These two parts are employed to respond to the rational problem- and solution-finding exercise that characterize the design process.

This problem–solution pursuit can be presented as two relations: as a linear process (Brigs & Havlick, 1976; Pena & Parshall, 2012) or as an iterative process (Rittel & Webber, 1973; Schön, 1983). Figure 5.2 shows both processes.

Analysis–synthesis and problem–solution are the basis of all successive formulations of the design thinking process, with the further additions of communication (Archer, 1965; Cross, 2001; Thornley, 1963), evaluation (Koberg & Bagnall, 1972;

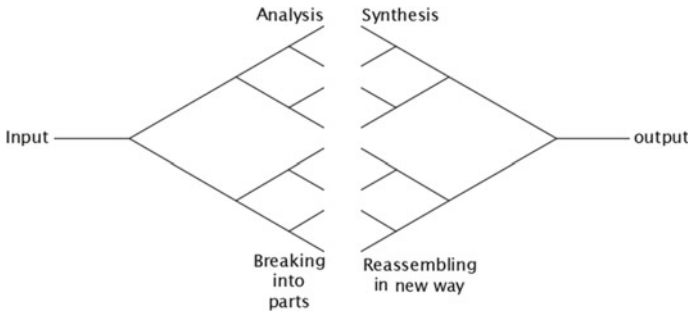

Fig. 5.1 Divergent/convergent model of design thinking based on Alexander (1964)

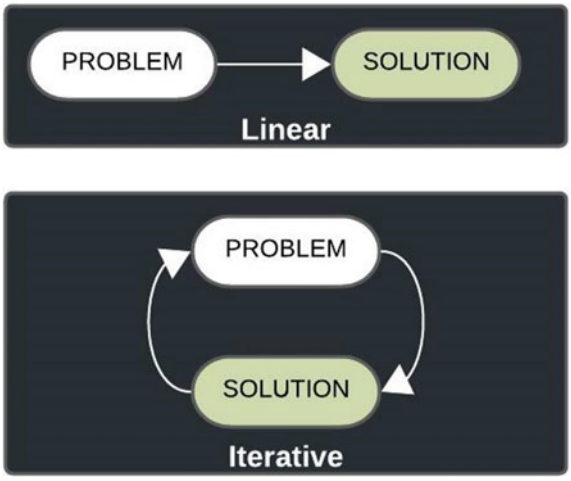

Fig. 5.2 Linear versus iterative problem–solution processes

Nigel Cross, 2000) and implementation (Koberg & Bagnall, 1972; IDEO, 2004), depending on the context of use.

The first-generation models considered the design process as a rational, linear process for optimising decisions (Plowright, 2014), which was then expanded from analysis to synthesis and into the seven-phase model by Koberg and Bagnall (1972), as shown in Fig. 5.3.

An extended version of the divergent–convergent approach was presented by Banathy (1996), as shown in Fig. 5.4.

However, these linear problem-solving models have a common weakness: their lack of consideration of users (Plowright, 2014). An alternative model, proposed by Schön (1983), focuses on the practice of design by the designer. This model is called reflection-in-action and it is based on iterative cycles (Fig. 5.5).

Based on the idea of iterative cycles, Archer (1965) introduced a model that is versatile enough to be applied within varied disciplines. This is the first model to include communication while reflecting iterative loops (Fig. 5.6).

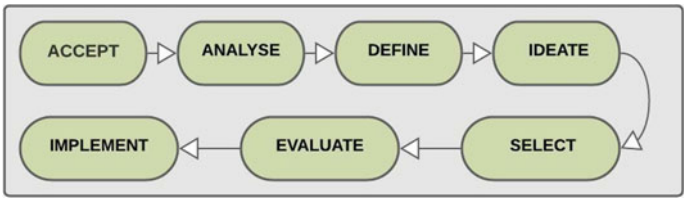

Fig. 5.3 Design thinking model by Koberg and Bagnall (1972)

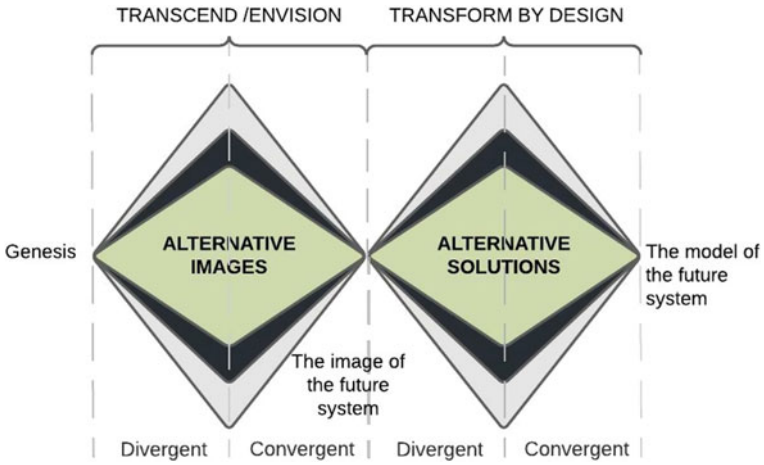

Fig. 5.4 Double diamond design thinking model by Banathy (1996)

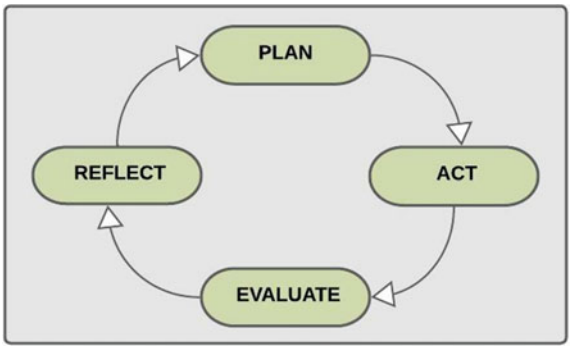

Fig. 5.5 Reflection-in-action design thinking model, based on Schön (1983)

5.2.2 Architectural Design Thinking Process Models

Architecture, and the architectural process, usually requires complex models that incorporate additional steps in an attempt to reflect the balance of rationality and creativity required for architectural solutions (Todoroff et al., 2021).

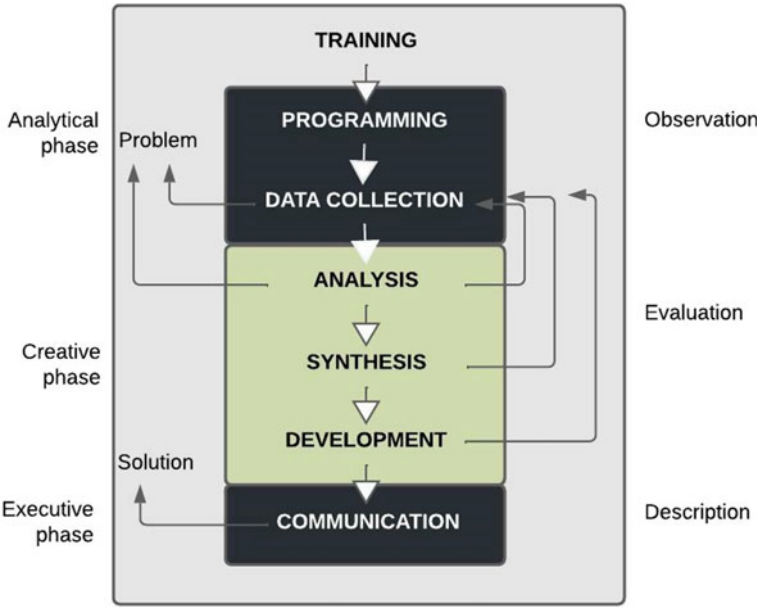

Fig. 5.6 Three-phased detailed design thinking model, by Archer (1965). *Source* Adapted from Dubberly (2004)

One of the earliest models for architectural design education, developed by Thornley (1963), and adopted by the Royal Institute of British Architects (Fig. 5.7), is the basis of the *RIBA Plan of Work*, which accounts for traditional steps and actions found in industry practice.

When we look specifically at a studio setting, the model described by Akpinar et al. (2015) demonstrates the complexity of activities taking place within the studio (Fig. 5.8), and it expands upon the previous iterative design thinking models while addressing the specificities of the architectural process.

This model reflects an iterative design process with numerous activities identified within a design studio. As you may already understand, a very important part in developing a design thinking approach is the activities and their relationships to each

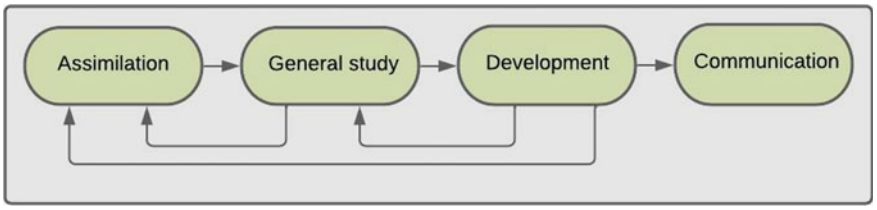

Fig. 5.7 Architectural design thinking processes. *Source* Adapted from Royal Institute of British Architects (1965)

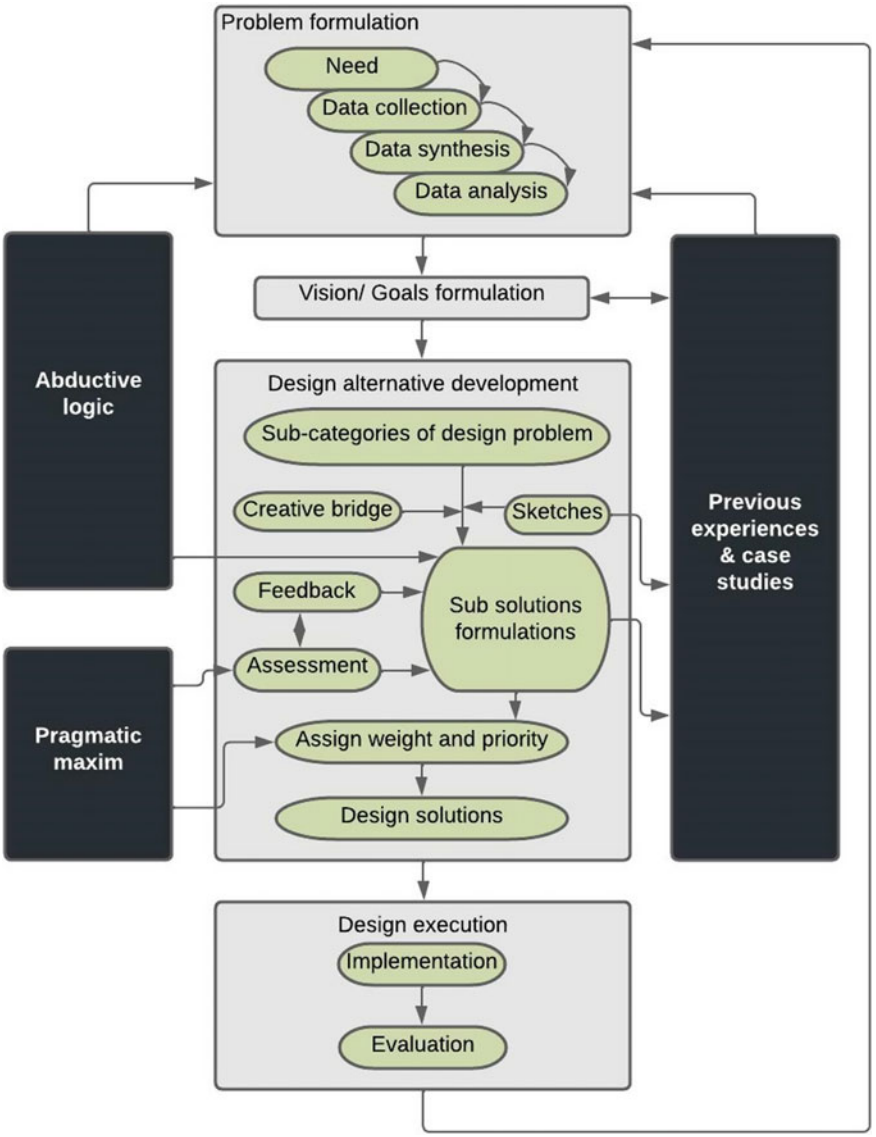

Fig. 5.8 Design thinking model for architectural design studio. *Source* Adapted from Akpinar et al. (2015)

other. Studies by Goldschmidt (1994) and Ahmed et al. (2003) provide a good set of activities you may come across in design studio. Main activities include:

- Studying the brief
- Planning the design process

- Collecting information
- Looking at examples
- Consulting with others
- Thinking solutions and sketching
- Analysing and comparing alternatives
- Evaluating interim and final proposals
- Preparing the final presentation

The list of activities in given above is not exhaustive, but it can guide your design thinking process.

5.2.3 Sustainable Design Thinking Models

Now, when looking at sustainable design processes, it is clear that something is missing from the picture in the above-mentioned models. Indeed, they all refer to the development of a product, which can be also an architectural object, overlooking the impact on sustainability during production and use of the product.

Hoolohan and Browne (2020) have proposed a design thinking model structured as a toolkit that can be used for intervention planning (Fig. 5.9).

You may notice that the steps in this model are quite different from those presented in the previous sections. Specifically, the step 'influence mapping' has been included

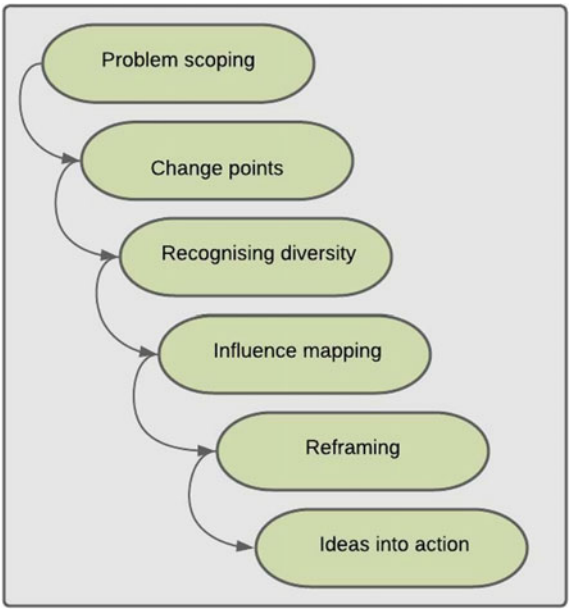

Fig. 5.9 Sustainable design thinking model for intervention planning. *Source* Adapted from Hoolohan and Browne (2020)

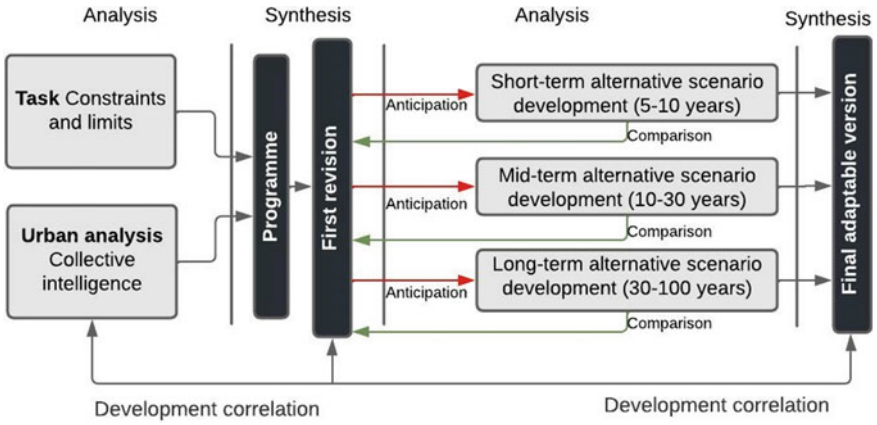

Fig. 5.10 Scenario-based feedback loop design thinking model, by Lüley (2020)

to reflect the planning activity for influencing user behaviour, that is important in the use of the product.

Lüley (2020) believes that we need to look at the architectural design process from a new perspective to integrate sustainability and has proposed a detailed model premised on scenario-based design loops, as shown in Fig. 5.10.

This model includes unique activities, but you can recognize a generic analysis–synthesis typology. The different scenarios for sustainable design are categorised into short-term, mid-term and long-term to anticipate future changes. This is unique step that will also account for user behaviour and building operation. However, this model includes activities in realistic design situation and long-term planning, limiting the use for studio settings pertaining to building design.

A design thinking framework developed by Berg et al. (2014) is better suited for studios. It provides the associations among design considerations (Fig. 5.11) used by students in developing a lamp using reused materials.

Figure 5.11 represents design thinking in a complex systems diagram. This use "systems thinking" a diagrammatic way to showcase show how different elements are connected to each other. The use of systems thinking has its merits for resolving sustainability issues, which have a complicated, multifaceted nature. This diagram is closer to a mind map that reflects the thinking behind design and could be used in modelling design thinking.

5.3 Types of Biophilic Design Thinking Models

The models presented in previous sections constitute a good starting point to understand design thinking, however, they need further modification to be adapted for specific ESD studio requirements. ESD studios demand additional activities such as

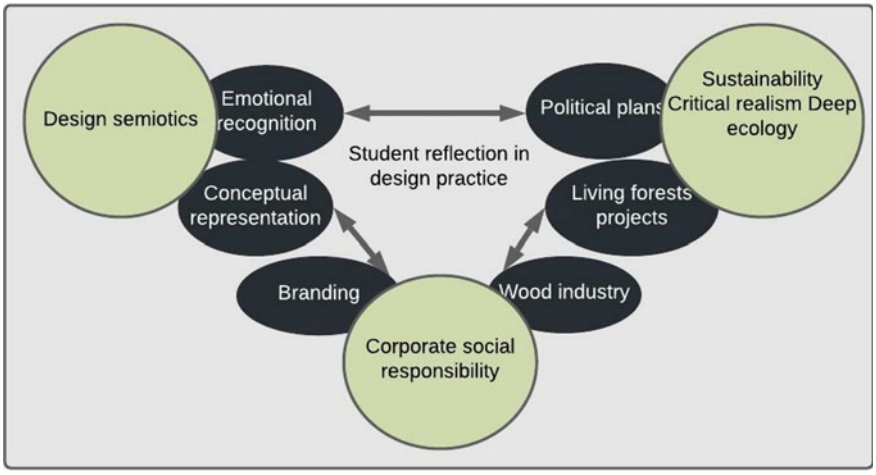

Fig. 5.11 Design thinking mind map for sustainable design. *Source* Adapted from Berg et al. (2014)

developing a sustainability manifesto, developing a design framework and providing evidence for sustainability achievement, to be undertaken by students.

Depending on how you integrated and synthetised the biophilic criteria within your success matrix, the design process and the design thinking process that you may undertook will vary. What we present in following sections are five design thinking models that differ by when the biophilic criteria is integrated into the design process. We developed these models using empirical data from students adapting BD within sustainable architecture design studio.

Table 5.1 shows the phases common to all models.

5.3.1 Biophilic Category Model

This design thinking model is more common where biophilic criteria are synthesised into a separate category. Across the design thinking process, the BD criteria and other ESD are designed separately. The BD response is initiated in early design stages (Fig. 5.12) and could be integrated well into the design.

The developed biophilic category within the success matrix can have criteria either to achieve building performance or to contribute to the sensory place-making of the design. Depending on the number of biophilic criteria used for building performance, compatibility with the ESD approach may differ. An important aspect in this model is that the evaluation is distinct for the BD response. The weighting assigned in the success matrix can influence the biophilic quality achieved in the overall design.

Table 5.1 Descriptions of phases in biophilic design thinking models

Phase	Description
Information gathering	Environmentally sustainable design would require a high volume of data, including a systematic search to find similar environmental solutions, sustainable materials, case studies, design guidelines and any other relevant information
Sustainability manifesto development	Developing a sustainability manifesto that communicates the sustainability perception adopted for the design
Success matrix development	Developing a success matrix that includes biophilic criteria
Evidence supplying	Use of simulation software or computations to demonstrate the achievement of sustainability criteria identified in the success matrix. This may also require research into environmental solutions, material properties and performance
Site and context analysis	Both site and context are analysed using climatic data, demographic data and other social and environmental aspects that can shape the building program
Conceptualisation	Building is conceptualised, representing both architectural and environment responses
Design strategies	Design strategies are developed to suit the criteria in the success matrix
Building components	Building components are designed to suit the design strategies
Design synthesis	Synthesising all relevant and customised design strategies along with building components into a design proposal
Evaluation	Evaluation of the design using the success matrix if developed as a self-assessment tool. In the absence of a self-assessment tool, the design is evaluated by justifying the design decisions and supplying evidence
Critical reflection	Critically reflecting on design process phases and returning if there is a need for amendments

5.3.2 Biophilic Overlay Model

In the biophilic layover model, a typical ESD design is completed and then an overlay of BD strategies is included to improve its biophilic response. The generated BD criteria are scattered across the success matrix or possibly not explicitly mentioned during every phase. The design thinking process only brings in concerns around enhancing biophilic quality in latter stages of the design (Fig. 5.13).

This design thinking model can be adapted even without generating biophilic criteria during success matrix development. Since this model contemplates the BD

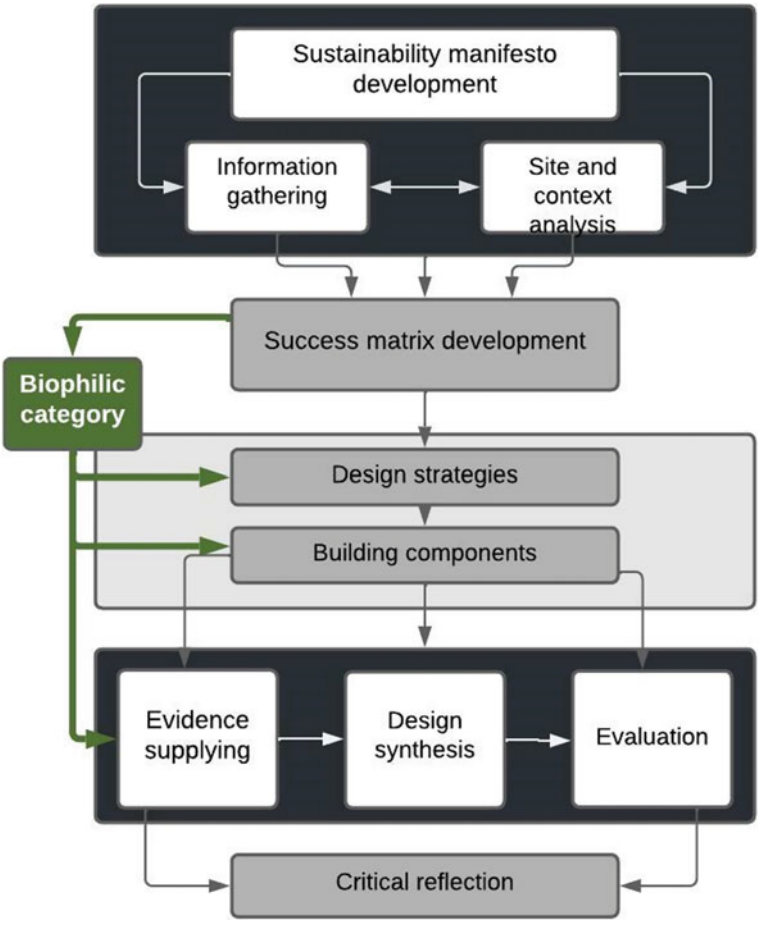

Fig. 5.12 Biophilic category design thinking model

response during the design strategy or building component phases, the potential to use natural biophilic elements for building performance is limited. Further, the use of BD strategies could conflict with the ESD approach, reducing compatibility. This can still potentially improve biophilic quality with a strong layover of BD responses. However, if the success matrix is developed as a self-assessment tool, this may not contain assessment criteria for BD, necessitating a specific justification for the BD strategies used in the design.

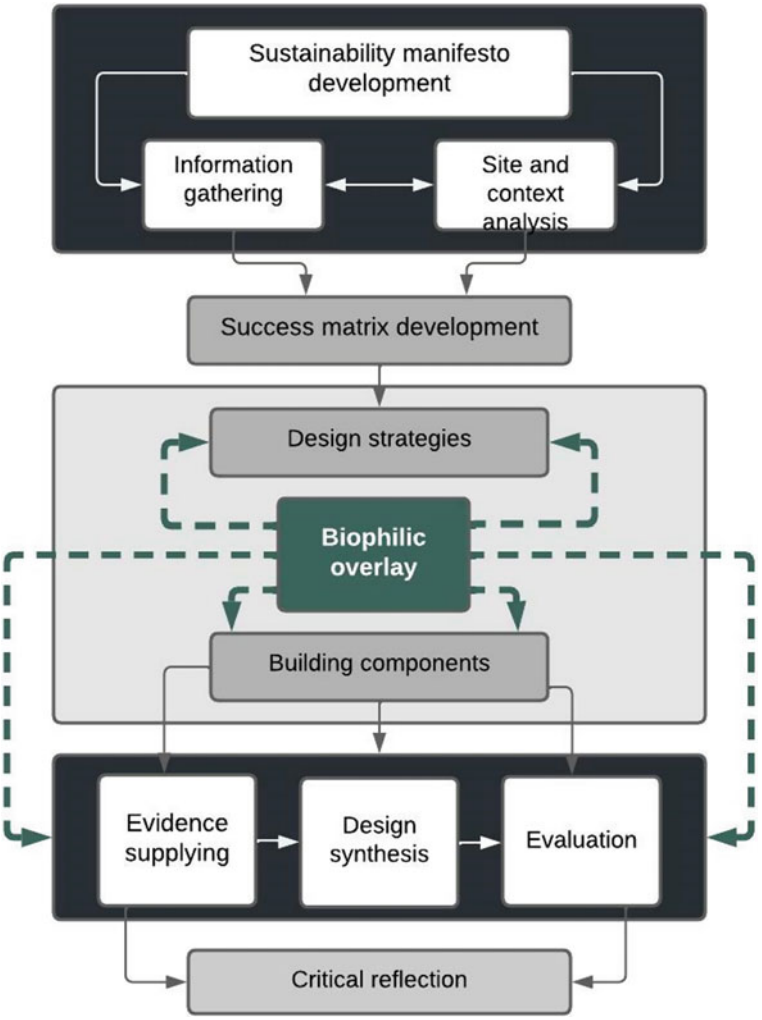

Fig. 5.13 Biophilic overlay design thinking model

5.3.3 Biophilic Criteria Model

This design thinking model has concise biophilic criteria highly compatible with the ESD approach. However, the placing of biophilic criteria is within a typical ESD-focused success matrix. Each category in the success matrix will include biophilic criteria that can be used to achieve building performance. The BD response is initiated at the early design stages and considered throughout the design thinking process (Fig. 5.14).

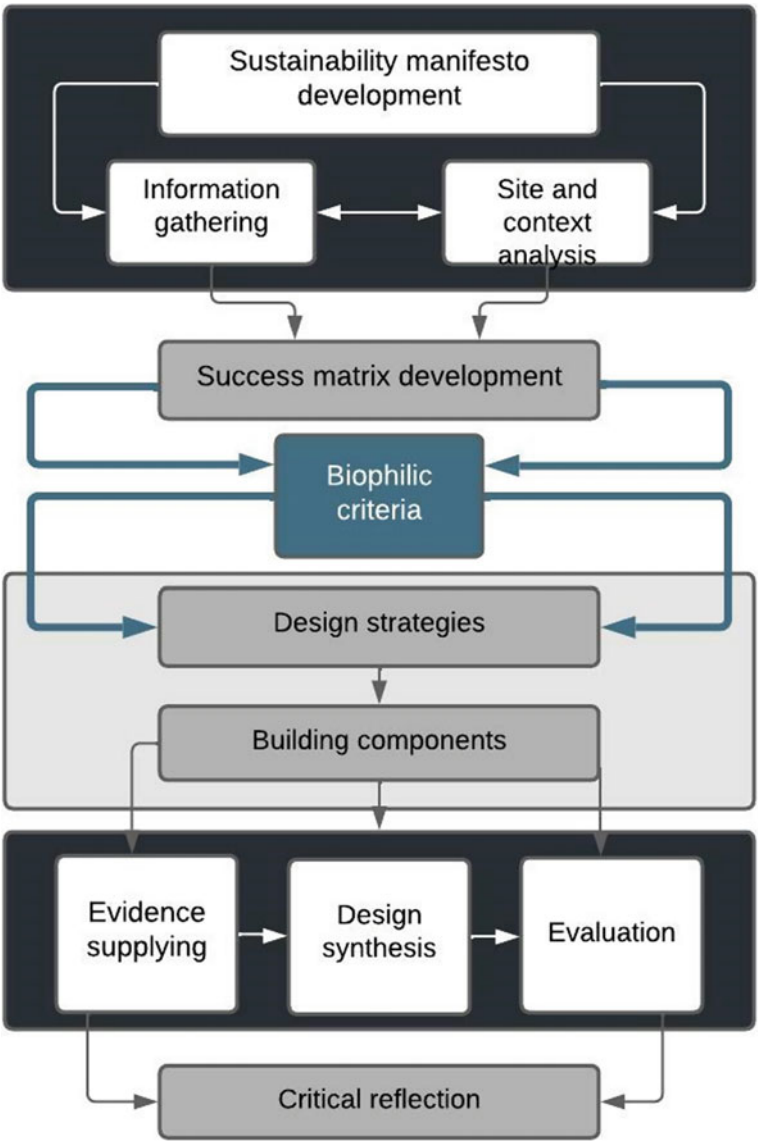

Fig. 5.14 Biophilic criteria design thinking model

If you synthesised your biophilic criteria into a BD framework and use it as the success matrix, this design thinking model is the most appropriate to be used. If the biophilic criteria is being explicitly generated to achieve building performance, using the process-bridging technique, BD response will have high compatibility with the ESD approach. The assessment of the BD response is not distinct, since the criteria

are within ESD categories, yet design strategies will be supported with solid evidence. Overall, the design can achieve a high BD quality with BD design considerations brought in at early design stages.

5.3.4 Biophilic Process Model

This is an interesting design thinking model, wherein BD responses are brought into the design to achieve building performance through natural processes. Biophilic criteria are not explicitly observed in the success matrix, similarly to a typical ESD framework. However, when identifying design strategies for sustainability criteria, natural processes are given priority, thus enhancing the BD response. Adoption of BD is found only during the design strategy phase (Fig. 5.15).

This model requires extensive research on how natural processes are used for building performance, rather than a specific set of biophilic criteria. Using this model, you can achieve high BD compatibility with the ESD approach. However, you will not have a distinct assessment of biophilic quality through your success matrix. Indeed, this design thinking model does not highlight the sensory place-making response by using visible elements. Therefore, even if you used natural processes, your biophilic quality may not be high.

5.3.5 Biophilic Conceptual Model

This design thinking model presents a process that adopts a biophilic concept for the overall design. This model is based on a BD framework that is used as the success matrix. This concept is more of a metaphorical representation of the building that connects all the ideas and decisions. Plowright's (2014) concept-based architecture is the most dominant way to generate architecture. The concept may be present in abstraction from the inception of the design, which will also guide success matrix development. The influence of the overarching concept is visible across the process (Fig. 5.16).

In most instances, for biophilic conceptual model, you would generate biophilic criteria, synthesised into a BD framework, and use the framework as your success matrix. If you generate biophilic criteria using the PBT we introduced in the previous guide, you can achieve high compatibility with the ESD approach. However, with a biophilic concept, you can also have a BD response with high BD quality focused on sensory place-making aspects of the design. Evaluation is highly focused on biophilic quality, and you may have to make extra effort to supply evidence for building performance achievement.

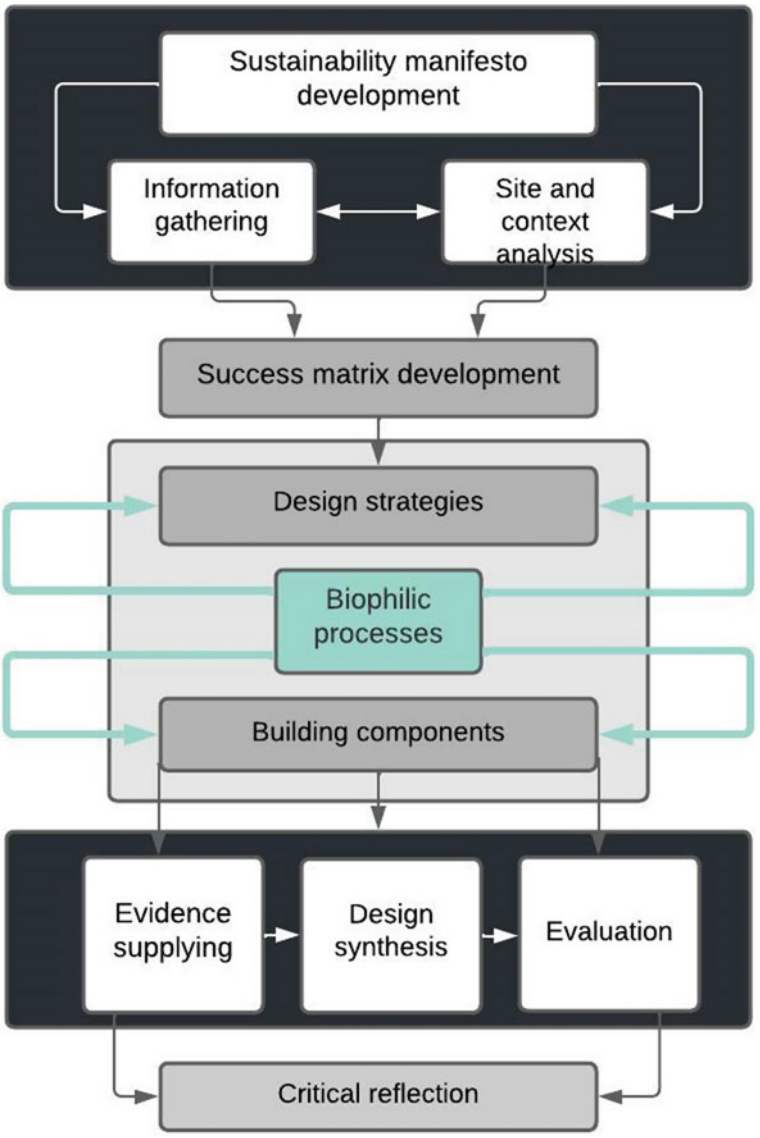

Fig. 5.15 Biophilic process design thinking model

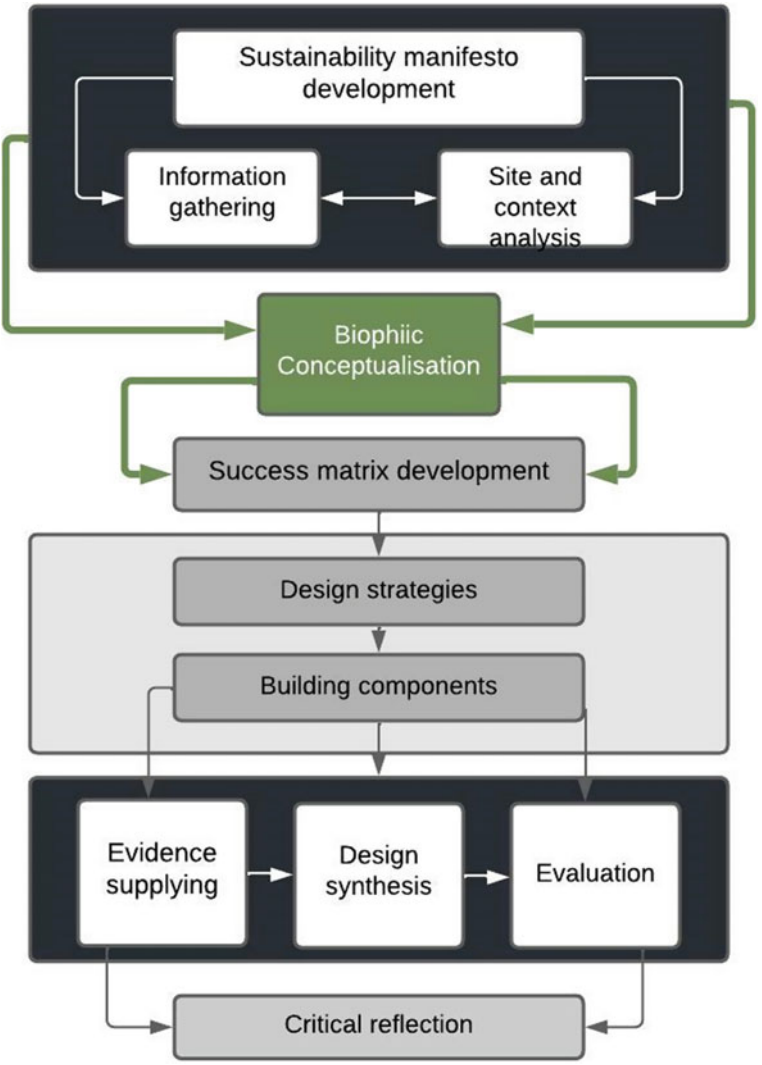

Fig. 5.16 Biophilic conceptual design thinking model

5.4 Recording and Modelling Your Design Thinking Process

To create your own personalized and tailored design thinking process, you need to report the design activities undertaken. Recording your design thinking as you move across different phases, detailing the sequence of activities and rationale for decisions, is crucial for you to analyse, implement, and reproduce your design thinking process.

You would be familiar with final design presentation or development portfolio, where you are usually asked to report your design development. However, this document often represents one specific design solution and not always systematically connect one studio to another. Therefore, they may not suffice to comprehensively record the process of design thinking.

There are reporting methods that help designers successfully detect, document and reflect upon their design thinking process. These methods are:

– Reflective design diary
– Design development sketches and working models
– Critical reflections

You can use one of these techniques or a combination of the three, depending on what suits better your own learning journey.

5.4.1 Reflective Design Diary

The use of design journals and diaries is quite common in design education. They can be used to record your daily design activities, either as written notes or as sketches. The diary should not just report the development of your design, but also your own reflections upon the process: e.g. Why did you take a specific decision? What are the drivers, barriers, enablers and their impact on the design? This will assist you in two ways. First, you revisit your earlier design decisions when you make a new entry, allowing you to improve your design process by reflecting on the rationale and the impact of the decision. Second, your reflections will assist you in identifying where you are in regard to the design process, which, ultimately, will allow you to iterate in between phases more efficiently.

Traditionally, designers have been using physical notebooks and sketchpads as diaries, but now digital media also becomes commonly used for diaries and record keeping. You may create your own way of doing this, or use digital portfolio or diary in your learning management system, if it has such record keeping functions.

Some tips to remember in making entries:

- Always date your entry
- This is like individual brainstorming—just record your thoughts; this is not about correct or wrong thinking
- Use diagrams—they help you to organise your thoughts—then reflect
- You can record insights you gain from research
- You can use mind-mapping and concept maps to organise information from research
- Use the diary to also record feedback you get from your tutors, and include your reflections.

5.4.2 Design Development Sketches and Working Models

This is the conventional practice in the design studio, whereby you construct artefacts in the learning process. We use sketches and working models to show design development. In an ESD studio, you may find yourself exploring a high number of design options and development processes as response to specific environmental needs and impacts mitigation. If you use simulation modelling, the various iterations will also be part of your design development.

This technique requires, however, further elaboration to define the design thinking model. Starting from your sketches and models you will need to analyse and synthetise them at a later stage.

Some tips to remember in recording with sketches and models:

- Dating your models makes it easier to sequence the design development
- After going through the design development phase, you may have to analyse the process and sketch the development process
- You can have a separate development process for simulation models
- Try to use same scale for all the models
- If models are in different scales, use photographs.

5.4.3 Critical Reflections

The ability to critically reflect on the design process is an essential skill for a design student. This differs from the reflective diary in that it means systematically reflecting on important aspects rather than upon your routine design activities. In a sense, this technique uses a complementary approach to the reflective diary: if we use the reflective method describe by Bain et al. (1999), there are four main steps, that are reporting, relating, reasoning and reconstructing. 'Reporting' means describing the activity that you intend to reflect upon. In 'relating', you connect the activity to your design process phase. In 'reasoning', you will think through why you conducted an activity a particular way. Finally, in 'reconstructing', you consider the future use of the activity and whether and how you will repeat it. It is easier to reflect by using guiding questions to prompt your thinking and write the reflection by answering those questions.

The following example gives you some guiding questions that you can use to reflect on the BD in your design thinking process.

Main question: Where do I fit BD into my design thinking process?

- **Reporting:** At what point did I use BD principles in my design thinking process? Was it during conceptualisation? Or did I bring them in during design development? Or did I just add them in my model to make things better? Is my whole design generated around human–nature connectedness and the use of BD principles?

- **Relating:** Did I use a design thinking process at all? Was BD part of my whole design thinking process? Did I consciously use it? Did I think about the implications of BD and incorporate it as an integral component into my design thinking process?
- **Reasoning:** Did I have enough information on BD to include it in my design thinking process? Did I think it had a value? Was it in my philosophy to have a design thinking process focused on nature? Did I have the skills or tools to incorporate BD into my thinking process? What was difficult in adopting BD within my design thinking process?
- **Reconstructing:** Will I be consistently using BD in my design thinking process? How can I overcome the difficulties in adopting BD for my design thinking process? What learning support I need to understand the implications of BD within the design thinking process?

While using this method, you may not have to answer all the questions as part of one reflection, but they can give you options to suit your line of thinking. Critical reflections are generally presented in written form.

5.4.4 Modelling the Process

Once that you recorded and reflected on your design thinking process used, you can derive your design thinking model. For the analysis of your recorded data, you can use mind maps, systems diagrams or concept maps to organise design activities and design thinking. Starting from scratch and developing a design thinking model is a time-consuming task, and we recommend you select an existing design thinking model and map your activities onto it. In Sect. 5.2, we provided design thinking models that are either used across design disciplines, or specifically developed for architectural design or found in sustainable design. The BD thinking models discussed in Sect. 5.3 are tailored for ESD studios, and you can directly adapt them.

You can use the following steps to model your design thinking, assuming that you have selected an applicable model from the five given models.

- Step 1: Select an appropriate design thinking model
- Step 2: Define each phase and activity with your understanding
- Step 3: Identify activities and thinking, using your recorded data for each phase
- Step 4: If there are activities that do not fall within any phase, map them onto the design thinking model as new phases or activities
- Step 5: Check whether links to each phase and iterative activities are correctly recorded
- Step 6: Include additional links and feedback loops that you used
- Step 7: Revisit your critical reflections and check whether phases, activities, links and iterative loops are all presented in the model
- Step 8: Redraw the design thinking model while optimising diagrammatic presentation for visual clarity and simplicity.

5.5 Concluding Remarks

This chapter provided guidance on how to engage in the design thinking process in your sustainable design when a BD framework is used. We outlined five models: sometimes, you may have a unique process and model, other times it will be a combination of more. Examining the functioning of the five BD thinking models provides a framework for understanding the design process within an ESD studio, the key activities and when they take place. We also found that use of the biophilic conceptual design thinking model will result in designs with high biophilic quality; the exemplar shown in the next chapter uses this biophilic concept model. We also provided instructions for recording and modelling your design thinking.

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