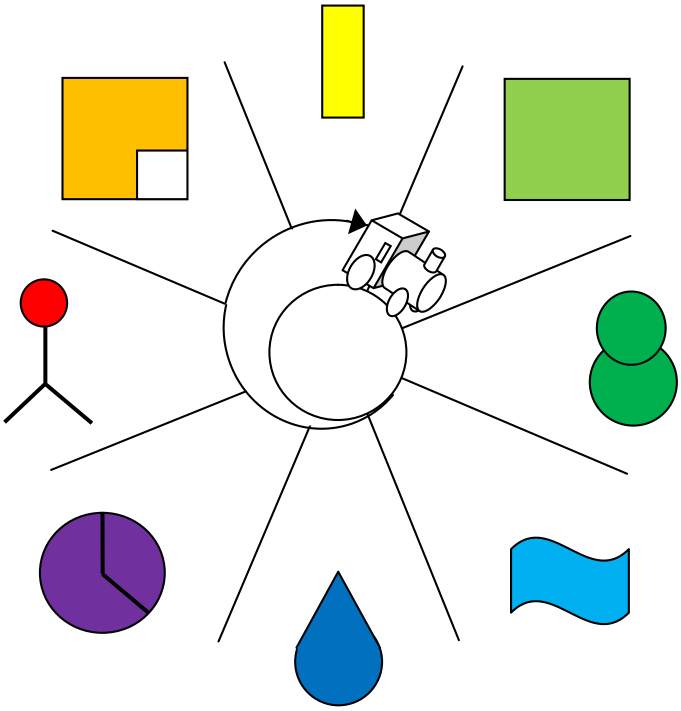
Detail Train



The train of thoughts when detailing architecture

by Thomas Rasche

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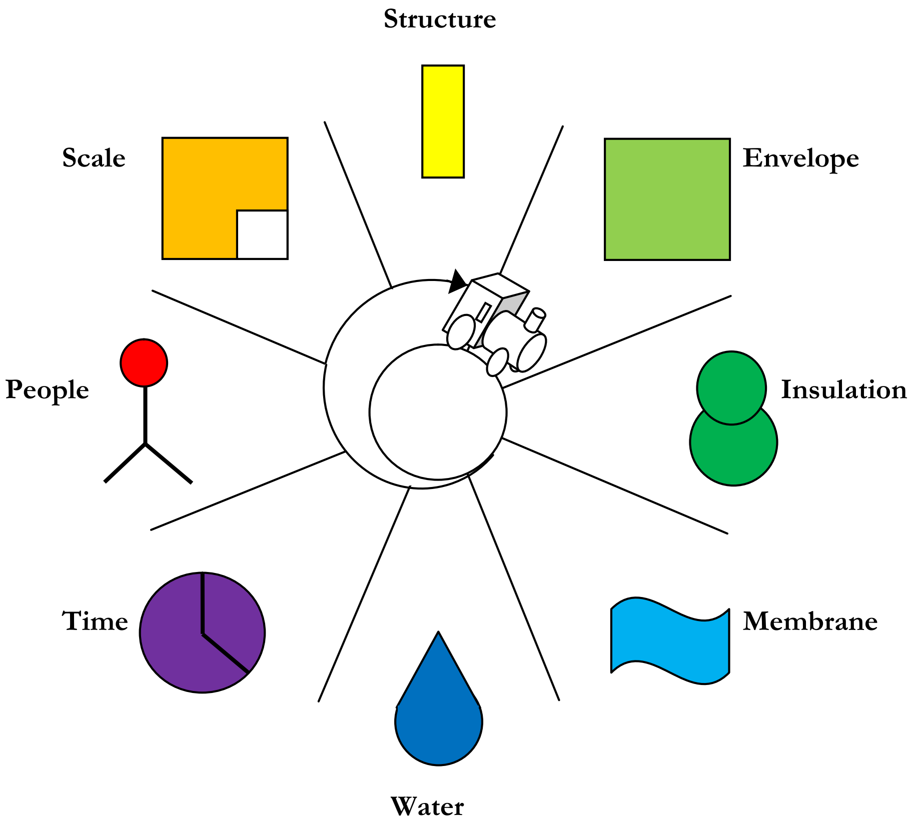
Structure
Scale
Envelope
People
Insulation
Time
Membrane
Water

About this book

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This book is a first draft version of the book:
'Detail Train – The train of thoughts when detailing Architecture'.
This book will be published, once the review and editing process is completed.

This pdf version is published on the web as a progress document, for feedback and reviews.

This is a draft document.

If you would like to review, comment or suggest changes and improvements for this book, you are invited to do so. Please email your comments to:

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Unfortunately, I cannot offer any assurance that comments will be included, acknowledged or mentioned in the final publication or at any location associated with this publication. All comments are understood to be offered freely, without any intellectual property claims, copyrights or similar.

Preface

Imagine sitting down with the intention of creating an architectural detail. It is clear that the detail must be a drawing that is clear and which explains the way the various parts of the building come together. However, to get a good result is not straight forward, as there are many issues to consider, all of which have an effect on each other. So what is the best way to do this? What is the best process to do this? This book is written to help you think about, develop and design your detail…

Why a Train of Thoughts?
When creating a detail, there are many thought processes and bits of information that float around in the designer's head. By describing these as a train of thoughts, it provides a framework with which to bring some order to what's going on. It is a way of representing a chaotic thought process into a sequential thought process. In particular, it is a sequence of considerations which act as a route map towards the goal of creating a useful and correct drawing.

Why the symbols?
The symbols are prompts to indicate a subject that needs to be considered: it represents a design decision(s) to tackle that subject. By working with the symbols of the diagram, important issues can be considered one after another, rather than all at once. The symbols are chosen to be simple shapes that relate to the subject that they refer to. The use of colour further distinguishes the shapes and makes them more memorable. Each set of considerations is grouped under a title, symbol and chapter in this book.

Why eight symbols?
When designing a detail, many factors are considered. It is from my experience as a designer of architectural details and of teaching that I have grouped the most important issues into the categories. To justify my choices for categories, I have chosen subjects areas that I find occur repeatedly during the design process, that have a more significant impact on the construction of the detail and apply to a wide range of details. Eight is an arbitrary number for symbols, but so that enough ground is covered without being too much. These categories are represented as titles, with associated symbols acting as a quick reference tool. This is not intended as a comprehensive set of issues when considering details.

Why a spiral form?
The symbols are arranged in a circular array, with a clockwise spiral Train of Thoughts going out from the centre. All the symbols are important, hence their equal distance from the centre. However, as each symbol is considered, new decisions build upon previous design decisions. Also, as the subjects are considered, they have an impact back on previous decisions and subjects. This is represented with the spiral, as it shows how previously considered symbols are revisited.

Is this the only way?
No. Every architect, technologist and designer has their own way of creating a successful detail. I offer this book as a helpful start or as an alternative way of thinking about the issues. As each designer develops their own methodology, so the Train of Thoughts becomes less important, irrelevant or is adapted into their own practice.

Each of the subject chapters in this book is divided into two headings: **Considerations** and **Revisit**. The Considerations cover the essential thoughts when considering this particular subject. The Revisit section covers the issues most likely to be reviewed, after the subject has been originally considered, with the considerations of the other subjects, and the subject is being revisited (as suggested by the spiral form of the Train of Thoughts).

The key words included in the Checklist are in **bold** within the body of the text for quick referral (if, like me, you read a book backwards, the summary before the text). The bold text is highlighted, because it is the sentence/paragraph where this is discussed most thoroughly. It is not the first, or only, occurrence of the key word.
Within this book, the words 'design' and 'detail' are used interchangeably, as a detail is a design; it is a design expressed in the form of a drawing.

Definitions:
Subject chapter: title, symbol and chapter text content of a group of considerations.
Subject: Partition window
Considerations: The Considerations cover the essential thoughts when considering this particular subject.
Revisit. The Revisit section covers the issues most likely to be reviewed, after the subject has been originally considered, with the considerations of the other subjects, and the subject is being revisited.
Train of Thoughts: The progression of thoughts when developing an architectural detail or design. Also the name of the Diagram containing the train on a spiral track, surrounded by eight symbols.
Action: a practical reminder of recommendations and summary of what needs to be considered.
Remember: a practical reminder of recommendations and summary of what needs to be considered.
Wild card: a practical reminder of recommendations and summary of what needs to be considered.
Checklist: a practical reminder of recommendations and summary of what needs to be considered.

Contents

Introduction

How to use this book
This book is intended to be like a journey timetable or itinerary. As a designer creates a detail, the procession of thoughts is represented here, including the priority issues and the re-visiting of these issues, as a detail is created. The book can be read and studied in detail, but once the principles are understood, it serves as a quick reference, with the checklists as an aide memoire. The Train of Thoughts graphic is a visual representation of the thought process that occurs in the designer's mind, during the creation of an architectural design. The subjects covered in the chapter are broken down into categories:

Consideration	The aspects within each topic that need consideration, together with explanations.
Revisit	The common issues for a topic as it is revisited during the design process, the Train of Thoughts.
Wild Card	Some unusual considerations that can easily be overlooked.
Checklist	A summary of the considerations, for quick reference.

Bold	Key words are in bold text. With the checklist, the topics are easily found in the body text.

Partitions of complexity
'There are many ways to skin a cat', so the saying goes. Equally, there are many ways to design a detail. The reason is partly due to the complex set of requirements within the brief. Also, the solution is a reflection of how the problem is interpreted by the designer. It is how they weigh the issues up against each other, and what they consider to be the priorities, that are reflected in the design.

A designer converts a complex need into a simple solution: a solution that is described in a drawing, which can be understood by all who need to use it. Furthermore, the character of a design is a reflection of the values that the designer has and how these are applied.

It is simple to make things complex, but complex to make things simple.

One useful method of dealing with a complex situation is to break it down into bits. If a situation is complex, such as when considering all the requirements of the brief, one of the easiest ways to deal with the complexity is to partition it. Partitioning is to divide up the whole into manageable sections. Then, once this is achieved, it gives us manageable tasks to deal with. It allows us to deal with one thing, or step, at a time. One thing at a time can also be described as iterations: where one partition is considered after another.

The symbols chosen in the Train of Thoughts represent partitions of the complexity when creating an architectural detail or design. They are the most useful sub divisions of the muddle, so that the issues can be seen separately, more clearly and then be worked with, one at a time. They can also be considered as windows, thinking hats, filters, frames or lenses, with which to view a problem. In this book, each partition will be referred to as a '**symbol**'.

In the digital age, where information is easily found, for example when using web search engines, it is important to realise that the skills that are needed now are the skills to think, in particular how to deal with the limitless information that is available. Information used to be available through universities, set up as centres of study. Now, their roles must change, with less emphasis on the access to information and more towards the application of knowledge. Indeed, this is particularly visible through the growth of university business incubators and their spin-off businesses, whose role is to apply the learning from the university. The windows discussed in this book are a method to apply thought to creating a detail design.

It is important to understand that the symbols used in this book as a Train of Thoughts are not comprehensive: there are many other possible partition windows that impact a design. For example, fire proofing and cost issues are not part of the symbols on the Train of Thought. However, the symbols that are chosen typically have the highest priority when creating a detail. They represent the decisions with more constructive impact first, thereby creating the context for the other issues.

It is also important to recognise that the iteration of partition windows, i.e. the process of dealing with one thing at a time, is sequential but not linear. This means that the partition windows are considered one after another. However, once they are considered, they will get revisited at a later stage. The spiral form of the Train of Thoughts illustrates this. For example, a designer might start with the decision for a type of structure, then consider and add the insulation, then the surfaces... Each of these issues is a subject that is considered, one after the other. Once a few subjects are considered, he will go back to the Structure subject: the structure of the insulation and surfaces now need to be considered, which will in turn change and develop the design. He has progressed his design by considering each partition window one after the other (in sequence), but goes from one, to another, and back again (a partition is used, and then again; jumping back and forth is not linear).

The design solution invariably reflects the character of the designer, whereby it reflects the values that are used to create it. The designer will always have a bias, either consciously or unconsciously, when considering a solution. This reflects which subject choices he uses, and what priority these receive. In all of architecture, this principle is visible, whereby an architectural language reflects the values and priorities that are in the mind of the designer.

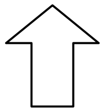
A design language is less visible in architecture than other design disciplines, such as engineering, because the subjects are often weighted with similar importance and influence. If, say, an aircraft engineer were to design a detail for an aeroplane, there is a very strong emphasis on one subject which is: the imperative to save weight. Therefore, when the design emerges, there is evidently a clear design language, which reflects the values of the designer: a solution that is, above all, lightweight. An architectural designer has less restriction or bias towards one subject. Instead, there is likely to be a tendency towards a combination of subjects. For example, the signature of one architect's designs might be the emphasis towards visible structure (such as hi-tech style) or the choice of a particular pallet of materials.

The design language is also more than just a representation of which partition windows are used, but more a reflection of the values of a designer. There is the subtle influence of art: a detail can be beautiful, or it can be a dog's dinner, even if both may work adequately. This becomes a reflection of the philosophy and approach to designing, rather than the method of doing it. This book, shows a way of thinking, represented as a Train of Thoughts. It cannot describe the art of designing, nor can it describe the brand that an architectural design has. This book and the Train of Thoughts is intended solely as a tool, to assist when reflecting and creating a construction design, helping to decide how to think, rather than how to do it.

Chapter 1

Plan your journey

What is it that you want to do, your purpose?



You find yourself sitting in front of a blank piece of paper, or an empty computer screen: the start of the work for the project. This is the most daunting part of all, with nothing laid before you except the problems. There is as yet no start, no idea and no sketch from which you can craft the detail that you want to draw. What do you do now?

It is at this point that you need to plan your journey: how to travel (by train?).

Considerations

Looking at what the overall task is, as well as what and for whom the detail is intended for, is an essential step. It gives context to the task ahead. Typically, this is in answer to question: what is the purpose of the exercise? With these clearly in mind, it can be decided that the best means of expressing and communicating an idea is (typically): as a computer aided design (CAD) detail drawing. Furthermore, with the purpose in mind, it is possible to review whether the Train of Thoughts is the best way of dealing with the task of thinking and developing a detail drawing.

This review of a project includes the review of the Train of Thoughts, and whether it is complete and correct for the task. This involves two aspects: prioritising the symbols and considering which other symbols are needed.

The prioritising of symbols focuses attention onto one of these more than another. As an example, a designer for a swimming pool will ascribe a high priority to the Water symbol. This means, when the Train of Thoughts sets off, one of the first things to think of will be the considerations associated with water.

The consideration of which symbols are needed is a review of completeness. When a detail is designed, there are many factors that are considered (many more than the eight that appear in the Train of Thought). These need therefore to be considered, so as not to be neglected. The symbols chosen to be in the Train of Thought are there partly because they have the highest priority, and also because they have most constructive impact, feeding back into the detail itself as it is drawn. They are the typical subjects when considering typical details in a building. As an example, a resistance to ultra-violet (UV) light is a consideration that impacts the design. However, as this is not a constructive problem (it can be resolved simply by changing the specification of a material, such as with a text label in the drawing) it does not need to be part of the symbols. Compare this to the Structure issues which are decided and revisited time and again, with many revisions in the detail.

Revisit

After you are clear about using the Train of Thoughts and its scope, it is time to review the external constraints, context and limitations imposed onto the detail.

The issues that need to be considered include the architectural and geometric constraints, as well as any other factors imposed onto the design. If a brief has already have been set out, then this is an advantage, as a lot will already have been addressed. The architectural and geometric constraints are the physical limits that the design needs to meet. These are particularly important when creating an architectural design, as the problems are mostly spatial in nature. For example, do you need to keep to finished levels, or height restrictions? These are like the lines of a football field, they are the outer limits, within which you create your design.

There are other factors which will be imposed onto the design which are not geometric. It is important to get information from the client or boss; after all, it is within their context that you are designing the detail. For example, is speed of construction a high priority? Or perhaps access to the site is difficult? Are there time constraints for noise? Are particular materials available or cheap? Is the drawing to form part of the documentation? All these influence and frame the design drawing.

As the detail develops, these thoughts can be revisited. By reconsidering the purpose of the detail and reviewing the constraints, it will enable the process of the design and the resulting drawings to remain on track. This is particularly the case if new information is used and incorporated into the project.

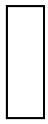
Checklist

Is a detail the best method of developing and communicating an idea?

Train of Thoughts: Is this useful as it is?
What are the priority symbols?
Are all the important subjects represented?
Is there a list of further issues (beyond the Train of Thoughts diagram)?

What are the external constraints, context and limitations imposed onto the detail?

Chapter 2
What are the structural issues?



Structure The vertical rectangle symbol represents structure. The shape is reminiscent of a column or post and represents the consideration of the structural aspects of the building.

With the priorities, constraints and opportunities set out in the brief, it is now a matter of beginning the drawing. What are the first lines that are put down on paper (or on the computer)?

The first lines that are needed are the reference lines, the information for which can be taken from the brief, previous design decisions or other constraints. The first line is the, ±0.000 reference level. The floor levels are also usually decided very early on in the design process. Laterally, the building is set within limits that fit within the plot of land and existing structures.

Considerations
Once the first lines are put in place, it is then a matter of beginning the Train of Thoughts for the design. It is the first thought that can be applied to the design. An important consideration in a building is the structure: the building needs to stay up. Structure is so pivotal in the design of a building, that the essential decision for structure type is considered as part of the brief.

Structure is the functional requirement to hold the building, the people and objects in the building, so that they do not fall through the floors or get moved about. All the extra external loads also need to be resisted, such as gusts of wind lifting the building away or the loads applied by maintenance people and equipment.

There are two main families of structure to consider: live loads and dead loads. The dead loads are constantly there, like the weight of a roof. This opposite to the live loads, which are the variable loads as a result of people moving about, or the effect of wind on the building.

Dead loads
Let us consider dead loads first. These are the essential loads that need to be considered to have the building standing up in the first place. The dead loads are typically as a result of the force of gravity, so they will be in a vertical direction, acting downwards. A structural engineer therefore will consider loads by considering the weight of the roof first, and then adding all the weights as he goes down the building, to finally end up with the weights requiring support at the foundations. However, a detail designer is not a structural engineer, so the thought process is in a different order. It is important to have a sense where the forces are, whether they are vertical, or deflected with imposed loads into other directions or vectors.

Starting from the geometric requirements of a building detail, you need to make assumptions, or educated guesses, as to what the structure needs to be. Once that is done, it will be reviewed by the structural engineer who will provide an opinion on these assumptions, and his information should feed back into the detail drawing.

Live loads
Live loads are the variable loads in the building. These are typically the changing weights and loads applied by the users and the furniture of the building. However, these can also include environmental loads, such as wind loads. Some of these loads, such as wind loads are not like gravity; they can be in any direction. Therefore, these loads have to be considered in whichever way they occur, if they are down, up (e.g. wind lift), or sideways (e.g. wind loads or fall prevention such as with balustrades). Some changing loads cause vibrations, making them dynamic loads. Here, it is the effect of shaking and rattling that need to be structurally resisted.

A way of considering the structural aspects is to be cognisant that the object needs to hold itself up, and to a greater or lesser degree others up.

Revisit

The structure window is not only typically the first window with which to consider a detail, but as such is also the most likely to be revisited after the other windows are applied. For example, having applied insulation, the question arises: how is it to be held in place? Or, as another example, during the construction process, how is the building of the structure to proceed? In other words, are elements sufficiently held in place as the building is being constructed?

Creep is the effect of time on the structure. Will the structure sag in time? Creep occurs with the structural material changing shape, resigning itself to the imposed load on it. It is similar to settling, though settling is for looser material. If the building is subject to **dynamic loads** i.e. shaken, then settlement will occur for any loose material. With **movement**, a material can also work harden (such as metal becoming harder once it is worked) or work itself free. The movement can also be attributed to expansion and contraction, due to **temperature** or moisture. Particular attention is needed for relative movements between different types of materials. Some materials move considerably, such as timber expanding across the grain. The solution is to have a movement or expansion joint in the detail to **separate** the materials or building sections.

If a material has a high **pressure** imposed on it, above what the hardness of the material or surface can cope with, then it will result in **crushing**. For example, timber can crush across the grain, so a sufficient load bearing surface is required, say at the top of a supporting post.

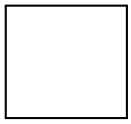
When considering how to hold a material or object in place, if it is not stable in itself, there are two methods to **fix** it. Either it is mechanically fixed, or it is chemically fixed (welded or glued). Mechanical fixing includes nails, screws, bolts, enclosing walls, supporting foundations etc. Note that mechanical fixing requires adjustment, so a nut is tightened onto a bolt, a nail is hammered and a brick is laid on a wall. Chemical fixing includes gluing, welding, bonding and sealing. Chemical fixing requires surfaces to overlap, so that there is sufficient gluing area. For chemical fixing, it is important to consider the surfaces are clean and flat

Wild card: If the concept design is already in place, the structural engineer may already have the set of drawings for the building. Using this information, almost no educated guesses are needed, with dimensions and fixings prescribed. The only new structural requirements are that the materials hold themselves up.

Checklist
Here is a checklist to help you, when using the structure window (note, this is not a comprehensive list, but a prompt only):

Live loads | **Dead loads** | **Creep** (effect of time) | **Crushing** | **Pressure** (surface indentation) | **Dynamic loads** (usage, knocks, shakes and rattles) | **Movement** (including settlement) | **Temperature** (and moisture effects) | **Fixing** (mechanical or chemical)

Chapter 3
What are the materials and finishes?



Envelope The square symbol represents the building envelope: it's materials and finishes. The lines of a square represent boundaries when enclosing a space. The line is continuous and divides the area of the piece of paper into the space within the lines and the space outside of the area.

Structure is all very well, but a structure is not yet a building. What is the next thing to consider next when considering a detail?

Considerations
A building is a shell, an enclosure of space. By creating enclosed volumes and extra floors, the building creates shelter and provides a controlled environment for the activity within it. To do this, the walls, windows and doors of the building act together as the shell, enclosing the different spaces. Another word for the shell of the building is it's envelope.

The characteristics of a building's envelope are its continuity. There is continuity even if there is a change of materials (e.g. from a wall to roof, a window or a door); the space within the building envelope is always enclosed. A detail should describe the envelope of a building, including the materials, finishes and also the transitions between these. A detail explains an envelope's continuity.

From the brief we know the extents of the envelope of the building. The envelope of the building is the whole, continuous construction, running between these limiting extents. The envelope window is a prompt to consider the continuous finishing surface at those limiting extents. In other words, it is the materials and finishes of the envelope that need to be considered. For the building's shell, there are two sides to consider: the face of the envelope towards the inner space and the face of the envelope towards the outer/external space.

When a building is perceived, it is the appearance of the innermost and outermost surfaces which present themselves to the eye (**external face** and **internal face**). This will always be a **material** of some sort, such as stone or timber. Furthermore, this material will be changed by the its finishing surface treatment. The **finish** may vary from a way to finish off the material (e.g. planed or rough cut timber), an invisible coating (e.g. transparent timber stain) or the finish will fully mask the underlying material (e.g. opaque paint or powder coated metal).

The materials and finishes are chosen for more than appearances, though this is very important. There are many other considerations, which are represented with other windows (for example the required structure or the environmental protection requirements). Ultimately, the materials and finishes are chosen for their specific location, required function and appearance.

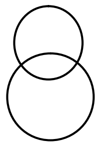
The envelope always has one feature: it is continuous. This means that the space is enclosed in a continuous way. However, that does not mean that the envelope will always have the same material throughout. The materials and finishes facing the inside of a building will differ from those on the outside, as well as changing depending on the part of the envelope one looks at.

Action: consider the various materials facing the inner space and the outer space. Do this for each part of the detail. The detail must demonstrate how the transition between these different materials and finishes are to be done.

Revisit

Checklist:
External face | Internal face | **Material** | **Surface finishes** (texture, patina colour and affect of light, surface spread of flame) | **Transition** (how does the envelope continue at the edges, as the materials and finishes change?)

Chapter 4
How is temperature controlled?



Insulation The two circle symbols represent insulation. These circles are reminiscent of a snow man (i.e. cold temperatures), as well as not being dissimilar to the curved hatching used in drawings to represent an insulating layer.

This window considers the functionality and requirements of the envelope. If there are adverse weather conditions outdoors, it is a requirement of the building to control and tame these conditions. The building needs to be warm, dry and comfortable. But how does a building achieve this?

In the Train of Thoughts, there are two windows which address the two most important methods of controlling the weather conditions. These are the Insulation window and the Water window. This chapter looks at the Insulation window. Insulation material takes up a lot of space, therefore it is important to consider early.

Considerations
The considerations when designing with insulation is what the intention of the insulation is? Is it to keep the cold (or heat) out (or in)? What is the temperature difference between the two sides of the insulation? Ultimately, insulation only serves to slow down the rate of heat energy transferring across it, from the warmer side to the colder side; it doesn't prevent heat transfer altogether. As the weather changes, the warm and cold sides could also reverse. It is therefore common to just use insulation to slow the rate of heat transfer through the building envelope, and then the essential consideration is the temperature of the internal space (air) of the rooms.

Heat, which is energy, can be transferred by conduction, convection and radiation. That means the heat energy can be conducted (passes through a material), convection (carried across) or radiated (similar to light waves). The heat energy is transferred until ultimately all the materials reach the same temperature. In the context of designing a detail, let us consider the three transfer methods:

The conducting of heat energy, through the materials of the building envelope, is the most likely way that heat is transferred out of the building. There are two ways to prevent this, either by using naturally insulating **materials** (such as wood), or creating a sandwich profile, so that the insulation in in-between and separates the warm from the cold side (insulation is not used on a surface because it's an ugly material). The latter is the most common way of achieving a high level of insulation in a building.

The convection of heat energy occurs with the movement of air. If the door is left open, the heat of the room escapes. In the context of convection through the envelope, it is air tightness which is the important factor to be considered. This is covered in the Membrane window.

The radiation of heat energy occurs in more extreme circumstances, and is an issue when an insulating material is bridged by the radiation. For example, solar heat gain is where the heat of the sun passes through an (insulating) window, or another example is if there is fire in a room, the heat can radiate through a window (even if the window is sealed).

We have seen that insulation can prevent the conducting of heat energy by being a separating layer. But, due to the features of insulation, it can also be used as a separating material (without regard for its temperature resisting properties). Insulation is a material that is soft and is available in sheets, designed to separate layers. This is useful if we need to separate layers for other reasons too, for example, insulation is ideal to use as a separating material to prevent sound transmission (it is also put under a floating floor primarily for this reason).

The thermal resistance of a set of materials can be measured, and this is expressed as a **U-value**. Set out in the brief (and therefore in the Purpose window) will be the U-values of the building. This takes into consideration all the components of the envelope, which includes the walls, windows and doors. The detail that is being designed needs to meet, or be better than, the U-value requirements set out in the brief.

The walls, roof, floor and openings, which make up the building envelope, enclose the internal space of the building. If the insulation of the envelope is to be useful, then there needs to be insulation in all these areas. In other words, if there is a gap, there is a cold bridge: a lack of insulation will enable to heat to escape, thus will be colder. This is important to prevent, so an important element to designing the insulation is its **continuity** through the envelope. If there is a section of the wall where the insulation is broken, this becomes a **cold bridge**: an area where there is relative high amount of heat escaping (conducting) out through the wall, making it feel cold. One side effect includes localised condensation, which is discussed in the Water window.

Related to the subject of insulation is specific heat capacity of a material. This means how much heat energy is required to heat the object up by one degree. We said that heat energy is transferred until ultimately all the materials reach the same temperature. Well, if one material has a high specific heat capacity, it will take a lot of energy to heat up to temperature (whereas a material with low specific heat capacity will change temperature quickly, with far less energy use). What implications does this have? It is particularly useful if the rate of temperature change is important, or if there is the need for a heat sink. A heat sink is the use of a material with a high specific heat capacity to provide temperature stability (it changes temperature reluctantly). A room's temperature can be kept stable and warm, even if the heating is switched off.

Revisit

Wild card

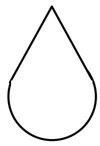
Insulation is a material that is hidden within the building envelope, as such, it is only required for its functionality. If it can provide multiple functions, then the construction is simpler (e.g. heat and sound?). Equally, could the facing materials have sufficient insulating properties, to reduce the amount of insulation within the envelope?

Checklist

Insulation (type, required **U-value**) | **Material** | **Continuity** of insulation throughout the envelope (no **cold bridges**) | With insulation: **more is better than less** | Other **functions**: (incl. fire or sound prevention and as a heat sink)

<u>**Chapter 5**</u>

How is water, in its various forms, controlled?



Water The teardrop shape represents water. The teardrop shape is the appearance of a drip of water as it falls to the ground.

When considering the functionality and requirements of a building's envelope, it is a requirement of the building to control and tame the adverse weather conditions. The building needs to be warm, dry and comfortable. Keeping the building warm, with the use of insulation, is discussed in the Insulation Window of the previous chapter. But what considerations are there if the building is to be kept dry?

This chapter looks at the Water window. Due to the many forms that water takes, it is also critically important to consider early.

Water has many different forms, all of which affect a building. The types affect the different parts of a building in different ways. So which types of water need to be considered when designing a detail?

Water has three basic forms: solid (ice), liquid (water) or gas (steam or vapour). Furthermore, water is a solvent (it can dissolve a solid, liquid or gaseous solute, resulting in a solution), it has a surface tension (enables capillary action) and is also an electric conductor (causing electrolytic corrosion). Water can also have physical energy: imposing pressure, causing buoyancy or with kinetic energy can act with force (the flow of water). It also has a high specific heat capacity, therefore it takes a lot of energy to heat up (inversely, it is a very effective coolant). There are many things to consider!

Considerations

For construction purposes, one of the main considerations when thinking about water is **rainfall**. This is from the sky downwards, although it is also deflected with wind driven rain (rain is carried with air, from an area of higher pressure to low pressure). To prevent the problems that rainfall causes, it is important to shelter the building, i.e. to build a roof. A roof covers the horizontal aspect of the building. The features of a roof include no gaps in the surface (otherwise it would rain into the building), and the water, once fallen, is guided away, towards a gutter, which is designed to direct the flow of water away, even in heavy rainfall. The edges of the roof overhang the edges of the building, so that there is protection from the vertical fall of rain.

Rainfall, when it hits a surface will **splash**. This sprays up the surrounding walls, up to a height of 150mm. This dimension is therefore a commonly marked dimension at the bottom of walls, indicating the limit of waterproof protection. After the splash, the water becomes water flow.

The second most likely place where the building will be affected by water is the ground. Eventually, the rain that falls will end up on, or in, the ground. If the water is on the ground, it is the **flow of water** that needs to be considered. The water will flow and pool towards the most direct lowest point. If the water is in the ground, then it moves with either capillary action, through fissures, or if it is lower down it is part of the **water table**. Therefore, to prevent the problems of ground water, a building will have protection throughout the floor against capillary action, with the sides high enough so as not to be affected by ground water flows or rain splashing. If needed, a building will need to resist the pressure of ground water (the building becomes waterproofed like a boat's hull).

Water runs downwards towards the nearest lowest point. All gutters and roofs therefore have a fall. A wall naturally causes the water to run down it because it is vertical. If the water cannot run, it will **pool**. This can be the case in a gutter (if it's blocked) or on the ground. If there is a nearly-flat surface in a drawing, the fall is marked into the detail. This provides instruction to the builder that a **fall** needs to be constructed.

Water **carries** stuff: It carries leaves and dirt, therefore drains need to have blockage protection. Water can also carry undesirables, such as waste water. This will make the water smelly, so an air trap (gulley trap) is required. If the water carries materials and then evaporates, it will deposit these materials where they were last carried to. If this waste collects, then there is likelihood of damning, so that pooling or blockage will occur.

Water vapour is a trickier subject to get to grips with, when designing with the Water Window. Terms like humidity, breathability, dew point and condensation all relate to vapour. Simply put, air carries water invisibly as vapour. The higher the air's temperature, the higher it's ability to carry water, and vice versa. Therefore, if hot air has 90% humidity, it is carrying a lot of water (not only because it is a high percentage, but also because the air is hot- it's able to carry a lot). Cold air cannot hold as much water vapour, so 90% humidity in cold air is much less water.

Water vapour is made up of very small particles, much smaller than water droplets. Water vapour can pass through materials much more easily than water. Water vapour moves from an area of high percentage humidity to a low percentage humidity. Therefore, water vapour will move from warm air 60% humidity to warm air of 40% humidity. Note: this is even the case if the air has different temperatures: water vapour will move from hot air 60% humidity to cold air 40% humidity. We can use another two generalisations: fresh air has relatively low humidity (because of wind) and indoor air has relatively high humidity (breathing, cooking, washing). This creates the common problem of water vapour passing through and out of the building. The term breathability refers to the movement of vapour through a material (or wall).

The problems with water vapour appear when the percentage becomes 100%. At this point, the vapour condenses to become droplets of water (this is what a cloud is). The 100% value is called the dew point. Once water droplets are formed, it is no longer as mobile as water vapour, so it settles where it is. This can cause water to get stuck in undesirable places, without means of escape and causing problems where it is. A good example of the problems is water forming within insulation, where it is soaked up and undermines the performance of the insulation (this is called **interstitial condensation**).

How does **condensation** occur? The most likely cause for condensation is a localised cold spot. This could be caused by a **cold bridge** or by air leakage or **air tightness** (see the Insulation Window and Membrane Window). A cold spot on the internal face of a wall will cause the air in that immediate area to cool down. However, the amount of water that air is carrying (as vapour) will still remain the same in absolute terms. As the air cools, it's ability to carry the water is undermined. With the air cooling, the humidity percentage will start to rise. Once the humidity percentage reaches the 100% dew point, then the water droplets will settle on the cold spot. As this is a wet spot, it is likely to become mouldy, or covered with mildew. Not nice.

How can a wall be designed to prevent condensation, either interstitial or on the surface? The first (and easiest) thing to do is to design a detail without a cold bridge. In other words, the insulation is continuous through the wall. This ensures the wall surface is continuously warm. Particularly vulnerable to cold bridges are jambs and soffits of openings. Another good thing to do is to ensure the building is air tight. If air leakage is prevented, then there is less localised cooling around the gaps, as cold air is not whistling through. Other preventions of surface condensation are to reduce the vapour in the rooms: create less vapour in the first place and to ventilate the rooms (in a controlled way). The design of the walls is also important, as this affects how water vapour behaves within them.

Water vapour passing through a wall can be controlled with the layers of materials in the wall. Again, the problems are caused by vapour passing from inside the building to outside. This is movement is happening because the humidity percentage inside is a relatively high compared to outside. The problem is compounded because the temperature also drops, so the water cannot be carried across as vapour: the carrying capacity of the air is impeded to such an extent that the dew point is reached. There are two solutions: stop the vapour passing through, or control the vapour passing through.

Water vapour can be stopped in a wall, if a (continuous) vapour barrier is put up. This prevents vapour passing through and condensing in the wall. But where is this vapour barrier to be located? It needs to be on the warm side of the insulation. If the vapour barrier is put on the outside of the wall, it is essentially in the cold zone. This will be too late: the vapour can pass all the way through the insulation until it reaches the vapour barrier, by which time the dew point will have been reached. The situation will become that of trapped condensed water behind the membrane, unable to escape. However, if the vapour barrier is put on the warm side of the insulation, the transition of vapour is prevented from reaching the cooler area. The air is still warm, and therefore it is above the dew point and there is no condensation. One down side is that there is no chance of vapour escaping out of the building unless there is ventilation, or a forced ventilation system.

Water vapour can also be controlled through a building envelope. What happens is that vapour can pass through without reaching the dew point. It can be considered as part of the way towards the vapour barrier as mentioned above. By slowing the passage of vapour, it has a chance to dissipate according to the rate at which it is cooling. As in the vapour barrier situation above, it is always the case that the vapour needs to be stopped or slowed to the warm side of the insulation. For this situation, a vapour check is used, it checks (i.e. controls) the passage of water vapour. Excellent design of vapour control would be to put a vapour check towards the inside surface, and the materials after the vapour check becoming gradually more open to water vapour towards the outside.

It has become common practice to put a breather membrane to the outside of the insulation, behind the external wall facing. A breather membrane means it is open to the passage of water vapour. It is therefore not used for water vapour design. However, it is a membrane that prevents water droplets passing through. So, should any external rain water (i.e. water droplets) manage to get through the external skin, it will be stopped with this layer. This has a particular advantage if the wall is constructed of materials vulnerable to water (such as soft wood fibres). This is likely to be the case, as the vulnerable materials are often also very open to water vapour, making them ideal to be part of a vapour controlling wall construction as described above.

A cautionary tale: putting new double glazed and sealed windows into old buildings may seem like a good idea: it will make the room warmer. This is true, however, the good seal around the windows means that there is less likely to be air leakage. Air leakage, could have been a good thing if it was the building's background ventilation, keeping the vapour levels in the rooms lower. Now, the warmer room contains static air, and because it is warmer can carry more water. It is still an old building, so insulation is likely to be poor, which in turn suggests a lot of cold bridges. The result? Lots of condensation on the walls and therefore lots of mildew. The building as a whole must be considered when designing for water vapour.

Wind driven rain is rain that is carried with the air as it moves from a high pressure area to a low pressure area. In some facade systems, if there is a problem of wind driven rain, it is possible to include a pressure trap: the wind can only blow in for a bit before the pressure is balanced. This is called a rain screen. It is a particularly effective way of designing in high-wind areas, such as tall buildings.

Capillary action is a result of surface water tension pulling the water through gaps and cracks. There are a few simple methods of preventing issues with this: a typical method to prevent capillary action is to block it altogether with a sheet of damp proof membrane (**dpm**). This is used for **ground water** rising up into the building, or a damp proof course (**dpc**) which is dimensioned to be as wide as a course of bricks. The **sealing of joints** (glued) is needed because otherwise the capillary action of the water will get through. Another simple solution is to widen the gap to be more than 5mm: the extent of surface tension. This is used on cappings and drips, whereby the capping and the protected surface are kept apart. There is also an unusual solution whereby the surface tension is broken down, with the same effect as detergent. This technique is used with some additives that are put into concrete systems for use below the ground water table, where a dpm is not used.

A water proof membrane such as a dpm or vapour check are thin sheets of plastic. However, even though they don't take up much space within the construction, they are difficult to include into a detail design. In part, this is because they need to be located in the correct place (e.g. warm side of the insulation). However, another aspect that is difficult is the fact that it is not good to fix through them unless you are sure of an adequate seal, and the membranes are not good if they are bent and folded around corners. In an ideal world, they are laid flat and held by gravity or glued. This however is difficult if the membrane is to be fixed into a wall.

Water encourages **corrosion**. It is often seen that iron rusts due to the effect of water. Electrolytic corrosion occurs when two different metals are in contact in the presence of and electrolyte. This forms a simple cell in which one of the materials is decomposed (the anode). The metals used in buildings (electro-chemical series in order of decreasing reactivity) are zinc, cadmium, iron, nickel, tin, lead, copper and aluminium. Also, water can carry salts (calcium chloride), which can corrode. The salts are dissolved in the water.

When surfaces are walked on, they will be affected if there is water, snow or ice on the surface. This will affect the grip on the surface, making is **slippery**. This is particularly important for wet areas such as bathrooms or external floor surfaces. To be more grippy, a surface needs to be rougher. An example where care is needed is a really smooth and hard surface such as polished stone. This may be wonderful to look at, but it is essential that it will always be dry under foot.

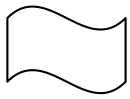
Revisit

Wild card

There is a rule of thumb for designing with water vapour: 'seal the inside of the wall more than the outside'. Why? Well, this is a useful way of thinking, whichever method vapour is dealt with. Firstly, we have seen that a vapour controlling layer (vapour barrier or vapour check) is best located to the warm side of the insulation. Secondly, this rule suggests that the building is sealed against air leakage, which is also a good thing. Thirdly, if there is any vapour within the walls, it will more likely find its way out through the easier (less sealed) route, i.e. to the outside.

Checklist
Rainfall (wind driven rain, splashing height) | **Flow of surface water** (including **fall** of the surface) | **Floor slippage** | **Pooling** |Objects **carried** by water | **Corrosion** and dissolving | **Capillary action** (<5mm) | **Ground water** (seasonal, flood plain) | **Ground water table** (therefore water pressure) | **Water vapour** (vapour barrier, vapour check and breather membrane) | **Cold bridges** and **suface condensation** | **interstitial condensation** | **air tightness** (with localised cooling and condensation) | Continuity of the water membranes (**dpm**, **dpc**, overlapped and **sealed joints**) | **Changes** due to extreme weather, season and climate | **Ice** (slush, snow, freeze-thaw and fog)

Chapter 6
Are the membranes continuous (how are they edged?), and are they permeable?



Membrane The wavy symbol represents the membranes. The wavy shape is reminiscent of a sheet, and represents the thinking applied to the membranes, in other words the enclosing materials of the building. In particular, the continuity of the materials (and hence edges) and their permeability.

The envelope of the building wraps around the building, including the walls, roof and floor. It needs to be able to meet its requirements in all these areas. It needs to maintain the purpose when there are changes in the envelope location (a wall becomes a roof or floor), or changes in its character (a wall becomes an opening, such as a window) or in its circumstance (in the floor it is affected by ground water and radon, which is not the case for walls). To cope with these, the enclosing materials are to be treated and considered with various criteria, based on these circumstances, but what are these?

The enclosing materials, including insulation, finishing materials and waterproofing always go completely around the envelope. Only their characteristics are adapted to the circumstances. To consider this, we use the Membrane Window.

What can **pass** through materials? There are many things, including water, water vapour, vibrations, movement, air, gasses (radon), heat (fire), cold, vermin, germs, small particles, noise, radiation and light can all pass through materials.

Considerations
To consider the **continuity** of the membranes, it is required to consider their **edges**. Each material has an edge: where it comes to an end. In rectilinear buildings, materials will have four edges: top, bottom and two sides (note that the two faces of the material are considered with the Envelope Window). To consider are the two types of edges: either the joints connect to similar sheets creating one large surface (for example the material overlaps), or the edge of the material as a whole is to be considered, where it ends, changes or is connected to a different material. If the material is weak, it will need to be fixed.

The **permeability** of a membrane is to consider the passage through the material. For example, water vapour passes through a breather membrane, or light passes through glass. The passage through a membrane can be easy, difficult or none. For example, in the Water Window, there were three types of membranes for water vapour: vapour barrier (vapour has no passage), vapour check (vapour passage is controlled or reduced) and breather membranes (vapour has easy passage).

The moisture membranes require particular consideration, when thinking with the Membrane Window. The issues of moisture membranes, whether they are to prevent the passage of water, vapour or water pressure, are also discussed in the Water Window chapter. When all these aspects applicable to moisture are considered, the chances are that the vulnerability of the material is in the edges, and hence the requirement to consider them in the Membrane Window. When a detail is drawn, and labelled, it must describe how the edges of the membranes are treated. Also, together with the Purpose Window, it is important to be aware of which problems are being faced.

The edges of a material are to be considered in three dimensions. Each material has a thickness, as well as an edge. Therefore, when considering how a wide material fixes to a narrow material, only one surface can be aligned. Since a drawing expresses a detail in two dimensions, it does not show this information. A note (about levels or finished flush), or a section detail are therefore required.

Fixing materials can cause problems for the continuity or permeability of a material. For example, a water membrane with a nail through it will leak water (in which case gluing is better), or fixing sound insulating plasterboard with a nail causes the nail to act as a sound-post (address this problem with a separating plug/cap or avoid by using offset studs to fix). When fixing sockets and switches, these are objects that require a deep cut into a wall to be housed. This can cut through many layers, and unless made good, they are likely to cause gaps, with resulting air leakage and cold bridges.

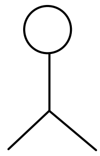
When designing for fire protection, a technique to control the fire sufficiently for the occupiers to be safe, is to **compartmentalise** the building. This means that various walls and floors are considered the envelope, with acts as a sufficiently fire rated membrane.

Revisit

Wild Card

Checklist
Continuity | **Permeability** | **Edges** (these also in 3-dimensions), junctions and connections | **Fixings** | **Compartmentalisation** | What **passes** through the material? (water/water vapour, vibrations/sound, movement, air (air tightness), gas/radon, heat (fire)/loss of heat (cold bridge), vermin/germs, small particles, light.

Chapter 7
Who's in the building?



People The stick figure symbol represents people. The stick figure is reminiscent of a person, but it actually refers to all the many users and people involved in the building. In short, it is the consideration of the stakeholders in the building.

With the technical functions of the building considered, it now requires the consideration of other functionary aspects. The people using it don't consider the technical issues within the building, they just want to use it. To use a building, to use it well and to appreciate it, also reflects the function of the building. These are the social and artistic functions.

Buildings are built by people, for people. People are involved with every stage of a building, from its inception, construction, use, maintenance until it is finally demolished. A building therefore needs to have all these people considered, and designing a detail is no different. In fact it is participatory: the person creating the detail is also part of the network of people involved with a building. With so many people to consider, which are particularly important for the designer of a detail? To consider this, we use the People Window.

Considerations
There are two sets of people associated with a building, for the purposes of creating a detail design drawing. These are the people involved in the building itself, and also the people who will be using the building but are doing other tasks.

The people involved with the building itself include the client, designers, manufacturers, suppliers, builders, installers, cleaners, maintenance staff and demolishers.

When creating a detail design, it is important to recognise the purpose of the drawing (Purpose window). The drawing is there as an instruction, as a **communication** document, and it informs the reader of what is to be built and how. Therefore, the drawing must be clear, legible and tailored to the person who ultimately will be using or reading it. The information in it should be sufficiently clear to allow them to create the building or object, with sufficient knowledge imparted to them that the end result meets the original intensions of the client, and functions as decided by the designer. The drawing has authority, if it is issued by the designer's office, as well as it being signed off by the client.

Various people design drawings in parallel to the design detail. These include associated engineer's (structural) drawings, shop drawings (by the builder) and other manufacturer's drawings (components). The central communication document is the detail design, as everyone works from that. As the other drawings are created, there has to be feedback, so the detail design is corrected and updated with the extra information. The updated drawings then need to be redistributed as an update to all concerned. Due to it being a central document, it is beneficial if the detail design contains much information. This is particularly the case for 1:50 drawings, which are the general arrangement drawings, and hence the central documents. They are created early enough in the design process to be a key document throughout the building process.

When a building is created, it is the builder who creates it. It is their job to read and convert the drawing into real life. How they go about this is important. There will be a requirement to bring materials to site, store them, sort them, lift them to the correct position, fix them and adjust them. All of these require space. A detail designer therefore must consider the accessibility of every part of the construction.

The designer is required to provide the solution for the **builder**, which is the detail drawing. If there is only one builder, it is clear that they will be doing all the work. However, it can be the case that there are different builders involved in the project. The detail design drawing must clearly express which works are done by which builders. Some though, may be obvious, that for example the electrician does the wiring. If it is unclear which builder does what, then it needs to be spelled out. A good example of this is if off-site components are **manufactured** by others and then fixed on site.

Not all materials for a building site arrive as raw materials. Especially with modern constructions, there is a large element of pre-manufacture which takes place off site. If these components are manufactured by specialists, then they will have better knowledge of that product than the building designer. The detail being designed therefore needs to include these objects with enough information so that they can be installed correctly. It is a matter of judgement how much detail which belongs to the component needs to go in the detail drawing. If the geometries, aspects that interest the builder are included, then that is usually sufficient, together with any other applicable criteria for when it is ordered. To consider is if the component is ordered by the designer or the builder. In the drawing, the labels that interest the builder for the construction are: what it is, how it's finished and how it's fixed. Added to this is then the ordering information: manufacturer, contacts and reference number/name.

For a part or component to be delivered, there are two parts:
Supply: order, manufacture, deliver to site and off-load.
Fix: fix in place, make it functional and make good the area affected by this.
The transitions are often the difficult bit. This includes between the supply and fix is the storage and sorting of the objects or materials. Also, there needs to be access for a builder to his work area, with obstacles moved out of the way. To decide is who supplies and who fixes each component in the drawing.

Health and safety has become a key issue in the building industry. The designer needs to create a drawing, together with health and safety policy/statement, that ensures that the building can be built without risk to anyone. In the whole process of construction, it is up to each person involved to be aware and contributing their part to the overall safety systems and planning.

During the lifetime of a building, it needs to be **maintained**. This includes the minor maintenance work such as window cleaning and servicing, to the more involved aspects of component replacement or renewals. The drawings must consider these aspects, and provide solutions to these requirements. Note that renovations and demolitions are usually re-assessed for access, safety and all other aspects, including newly created detail drawings, so they are less necessary in the original design drawings.

When considering people involved in the building, during the process of building and maintenance, it is typical to consider the following: where they are walking and stepping, what their reach is and what are they are looking at. It is common to consider **eye level** and access/protection through glazing bars in windows, including how they interrupt view lines when standing or sitting. If there are hazardous circumstances (trip, fall, chemical, noise, mechanical movement etc) then these are also considered, depending on the location and circumstances of the work.

Revisit

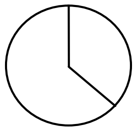
Wild Card
Eg draw dimensions relative to the walls and floors that will be in place when the person on site does the measuring. If it is a designer who reads the drawing, they need to see finished dimensions. If it is a contractor, they need dimensions relative to what they see (structural walls are in place, but no finished surfaces are yet in place).

Checklist
Who are you **communicating** with? | Who is the **builder**? | Who will **manufacture**? | Who will **supply** (and deliver)? | Who will **fix**? | Who will **maintain** and service? | Who are the building users and what do they require? | Health and Safety | **Eye level**, reach and walk surface (ergonomics)

<u>Chapter 8</u>

What is the effect of time (and sequencing)?

Time and sequence



Time The circle with two lines represents time and sequence of construction. The circle with the two lines is reminiscent of a clock face, which is how time is measured (at least within a day). The line, which slopes to the bottom right, is reminiscent of the line when a capital 'Q' is written. This 'Q' reminds us of the se***q***uence of construction.

Rome wasn't built in a day. In fact, even an individual building will have taken more than a day. The whole process, from first thoughts to end result is ages, it is more like years. Within the whole process, each individual element also takes time to achieve. But what time aspects are there to consider when designing a detail?

Considerations
Time is an important consideration, as it has an effect on the construction. A building is built to last, so there should be adequate planning for this, with maintenance and servicing of the building also considered. Furthermore, as the building is constructed, the sequence of construction is important. One trade follows another, and if this happens in the wrong order, they are can be in each other's way, or worse, there will be nothing for the trade to work on as the previous trade has not done its job. To consider this, we use the Time Window.

There are the two aspects to this: the time and the sequence. The time a building, material or construction lasts, can be estimated and allowed for accordingly. The sequence of construction however, is an order. One trade follows another. Preparatory and foundation work is done before the work itself, and safety systems, such as scaffolding, have to be in place before access is possible to high areas.

The effect of **time** on a building are to wear out and degrade materials. For example, superficial surfaces get affected by footfall wearing the floor surfaces down. All the surfaces get dirty and need to be cleaned (maintenance) or renewed. Within the building envelope, materials can degrade, so wires will need to be replaced and pipes unblocked and renewed. It is important for the detail designer to allow for **access**, for not only inspection, but also to mend or replace a broken part in the building. Ultimately, time will make a building useless, requiring its demolition. An example where the knowledge by the designer affected demolition is with asbestos insulation. Asbestos is extremely hazardous to health to remove (but was used because it is a good insulator).

Over time, and buildings last a long time, the small everyday effects become important, as they are multiplied. All effects of time are not necessarily bad. Some negative impacting effects can be designed with in a positive way. For example, ultraviolet light (UV) from the sun usually causes materials, especially plastics, to degrade (they become brittle and break). However, if one is aware of the effect UV has, then one can design with it, such as in the case where wood discolours as a result of UV. Another change due to the affect of time is oxidisation. An example is copper, which changes from its metallic orange colour to a lime green colour after a while, as a result of oxidisation. The effect can be over a whole surface, or it can be dappled, particularly in a case where natural facing materials are used. This change over time is called the **patina**. Patina can be a desirable aspect of a material's life, and can be considered when facing materials are chosen.

With time, the other Windows are also affected. For example, the Structure Window is affected, because materials will sag, creep or degrade over time. The People Window is affected, because different people and users will be in the building, with their different needs (and technologies). The Purpose Window is affected, because the use of a building changes with time, with greater insulation needs (Insulation Window) or rising ground water levels (Water Window).

The **sequence** of construction is very important for a project manager, who schedules builders and trades on a site during the construction phase. What importance does this have for the detail designer? It is the detail designer, who establishes the geometries of the building. Therefore, any material or object is fixed in place at a certain stage, once the underlying work is done; but before the overlying work. Sometimes, parts of a building are not built layer upon layer. A builder, when looking at a detail drawing, will notice if something is not buildable due to the sequence of construction. In this case, the detail will need to be redrawn, at best changed, or at worst the builder will do his own thing (which may end up nothing like the originally intention).

An important skill for the detail designer to learn, is to be able to draw the detail in the sequence that it will be built. To draw the detail as if it is being built on the page (or screen). This may sounds simple, but this needs to be done at the same time as considering all the Windows in this book! By recognising the way that parts are actually built, sufficient space and appropriate geometries can be considered. This reflects the understanding of practicalities that the trades face.

However, the construction sequence is not explicitly expressed in a drawing. It is clear in which order the building is to be built, with the various layers of materials shown in the drawing. This is the advantage of using a drawing as a means of expression; the sequence of construction can be read from it. Seldom is there a need for a label to instruct one part to be done before another.

One clear example, where the sequence is apparent, is if there is some **off-site** work (such as a factory produced component) to be done. This component will have to be manufactured first, then shipped to the site, before it is fixed into place.

A modern method of construction is to build as much off-site as possible. This has significant impact on both the timing of a site and the sequence of construction. It is advantageous, because the time it takes to build a building is reduced (at least on site). The building becomes essentially a kit of parts. As these advantages are explored, sequencing, and the timing of deliveries, becomes a **logistics** problem. Therefore, in this circumstance, logistics can also be considered in the Time Window, closely with the Person Window.

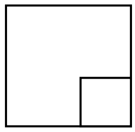
Revisit

Wild Card
It is a useful technique to create the drawing in the same order that it would be constructed on site.

Checklist
Time (short and long term time effects) | **Access**, service and maintenance |**Patina** |**Sequence** of construction |**Off-site** construction |**Logistics** |

<u>Chapter 9</u>

What affect are various scales?



Scale The square within a square symbol represents scale. The smaller scale within the larger square is the same shape, just drawn at a different scale. The image is also reminiscent of a detail design, which has a title section in the bottom right hand corner. This title section is the reference for the drawing and gives it context, with a location sketch, contact details and drawing reference numbers. In effect, a drawing title is information from a higher scale: that of the project as a whole. This symbol is easy to remember, as it is located in the bottom right of the matrix, which reflects its appearance.

Scale is the effect of different orders of magnitude. At each level of scale, new rules apply, as there is a different circumstance of that context. For example, at the human scale, we can physically relate to things: our eye level is the comfortable level to look around us and objects and surfaces are at a comfortable reach size or height. In a primary school, the smaller desks and chairs demonstrate the smaller scale of the children. We understand the scale of a building by relating to a part of it, such as a brick in the facade, and then recognising how that repeats over the whole building. So how does the effect of scale impact the design of a detail?

Considerations

The scale within which a detail is situated is impacted by the larger scale(s) above it, and it in turn impacts the smaller scale within it. Most common considerations when designing a detail is the decision to which scale the drawing should be. The general arrangement drawings include 1:50 and 1:100, but can be even more. The details and sections reduce to include 1:20, 1:10, 1:5 and 1:1. These are the most common scales used in architecture, though imperial and engineering scales provides a huge amount of choice of drawing scale. To consider not only which scale a drawing should be drawn in, but also the impact of smaller and larger scales, we use the Scale Window.

Let us consider scale from three perspectives: the scale at which one is working, the scale above and the scale below. This then provides the opportunity to recognise the impact of scale in three ways: the scale above and its impact on the drawing, the current scale and the issues there, and the impact the drawing has on the smaller scale below.

When first setting out a drawing, a scale is decided upon. When drawings were done on paper, this implied certain information can be represented, but other information was too small to physically draw on the page. Working on a computer, one can zoom in and out of the drawing, constantly changing the scale of the image. The result of this computer working method is to be distracted from the relevance of scale. By considering scale consciously, using the Scale Window, we can counteract this distraction.

The feature of a particular scale is that it represents information to a certain level of detail. Some information, belonging to the higher scale, cannot be shown, as it is too big. This then needs to be referred to, in particular it is a reference to a larger scale drawing. Also, too much detail is to be avoided, and left for a smaller detail drawing. A simple rule is to recognise the information that you need to express, together with the print-out scale. If the elements are not visible or illegible, then they can be omitted.

The larger scale impacts the current drawing. In the correct procedure of creating building documents, the larger scale aspects are considered first. Therefore, the larger scale aspects should be decided and visible in another drawing. These need to be taken into consideration in the current scale. A classic example of this impact is if the fall in a surface (such as a roof) is described in a 1:50 drawing. This information affects a detail at 1:20, because the height of the roof will be different, depending on where it considers the height of the surface (roof). The 1:20 detail should be drawn to accommodate all the relevant circumstances that arise from the larger scale. There is some information that flows the other way too though, whereby the smaller scale affects the larger scale. The layers and details of the current scale can inform the geometries and situations that are in the scale above. If this is the case, it is likely that the drawings of the above scale need to be revisited.

The current scale should be such that the information according to the scale can be expressed. The information is a drawing needs to be coherent. This is normally so, but in some cases, visual adjustments have to be made. For example, moisture membranes are drawn with an exaggerated thickness. If a membrane were to be drawn to a true thickness, it would only be a line across the page. Therefore, due to the importance of the membrane, it is over dimensioned to become more visible: it is drawn substantially, it has two lines that are filled with an alternating black/white hatching.

The smaller scale is important to consider, as it is directly affected by what is being decided and drawn. If a roof is designed with a specific fall, or dimensions are provided for a detail, then these become the constraints of the smaller scale. It is sometimes the case that a critical part of the smaller scale is considered way before the rest of the information at that scale, due to it's importance at a higher scale. For example, an early decision of the build up of a floor (small scale) informs the geometries of the building (large scale), such as the relationship between the finished floor level and structural floor level.

Revisit
The whole of the Train of Thoughts can be applied to the various scales, when considering the current scale, the scale above or below.

Checklist
What **scale** is the current drawing? | What is the **information** associated with this scale? | **Higher and lower scales** (what impact do other (especially higher) scales have here and what decisions here affect the (especially lower) scales)?

Chapter 10
Review

Considerations
Have all issues been considered?
Here are some further issues that need to be considered with a design. Note that these usually do not have a major constructive impact, but rather influence the grading or finishing specification of a material or product:

Other climates
If the building is designed for other climatic or microclimatic regions, then the priority of the windows will need to be adjusted accordingly. For example, the building may face extreme climatic or environmental situations such as temperature (desert or polar), forces (wind, tides), corrosion (salt) and more.
Other functions
If the building is designed with functions other than housing people.
H&S, including COSHH
Why not on the list: Less constructive impact (i.e. the shape of a design is less affected by this). A note or similar in the drawing or specification accompanying the drawing may be sufficient.
Ecological principles, sustainability and the environment
Why not on the list: Less constructive impact (i.e. the shape of a design is less affected by this). A note or similar in the drawing or specification accompanying the drawing may be sufficient. Climate change, fossil fuel depletion, ozone depletion, freight transport, human toxicity, waste disposal, water extraction, acid deposition, ecotoxicity, eutrophication, summer smog, mineral extraction, replacement intervals, recycled input, recyclability, energy saved by recycling. 1) energy cost: embodied energy and usage energy 2) toxins.
UV
Why not on the list: Less constructive impact (i.e. the shape of a design is less affected by this). A note or similar in the drawing or specification accompanying the drawing may be sufficient.
Corrosion (electrolytic, dissolve, salt)
Why not on the list: Unusual consideration. Can be dealt with after main design of components.
Building Regulations
This is a major influence on the design of a detail, where non-conforming details are illegal. this is a key aspect that does require consideration, which is at the review stage of a detail.
Sound (noise, wind, etc)
Structural, Air-borne, weakest link, frequency.
Fire
Temperature resistant, Combustion resistant, Radiating heat, Conducting heat. This is not one of the main windows in the Train of Thoughts because it has less constructive impact. In other words, when considering fire requirements, the design is not significantly altered: it is only adjusted (e.g. with a specification value or the adding of a cavity closer). Of course, if it is a key aspect that does require consideration, then this is recognised in the purpose.
Window clean
Security
Why not on the list: Less constructive impact (i.e. the shape of a design is less affected by this). A note or similar in the drawing or specification accompanying the drawing may be sufficient. Or else, if has a constructive impact, will be an unusual consideration.
Cost and Value
A design first needs to function. A quote and cheaper alternatives are then later developments. Unless prioritised first of all. Cost is the amount of money spent. Value is the relationship between cost and benefit.
Quality
Services: integration of heating, ventilation etc into a detail. A matter of scale
Written information. Some written information is required in a drawing. This includes labels, dimensions and specifications. The drawing should always be labelled and named. It should also be easy to understand its place, as well as to cross reference it with other documents for the project.
Labels. The text that labels a drawing adds information. It, together with a specification, sets down specific details for should include the following:

> **What the product <u>is</u>.** The name of the product with its product name, grading or finishing standard. This describes what is ordered from the manufacturer/supplier.
> **How the product is <u>fixed</u>.** This includes whether the object is fixed mechanically (nails, bolts, screws, folding welts etc.), or with an adhesive (chemical or glue). If the product is only held by gravity, then the word '...on' between layers is useful. If the fixing requires a process (such as compacting of soil, or finishing to a BS standard), this is also included.

How the product is <u>finished</u>. This includes the type of paint, colour, treatment etc. This is the work the contractor does on site to the product once delivered and fixed into place.
Name and contact details of the manufacturer and/or supplier. Including this enables a contractor to quickly find out more about a product. Adding the words '...or similar' to a product description enables a contractor to quote with a different product that meets the same criteria, but may be cheaper or better in some way. This is common for specifications of public buildings, to avoid product favouritism.
Other information. This includes relevant building regulations that apply, project specific requirements, references to further information (e.g. to a paragraph in the specification), other detail drawings etc. The word 'as' is useful if the purpose (and function) of a material is particular or unusual. For example: 'particle board as vapour check', (this enables better understanding of the purpose and therefore better assessment of alternatives).

Chapter 11

End destination: is the design finished and suitable?

Considerations

The design has to be fit for purpose, but what does this mean?

Firstly, let us consider the drawing itself: it is a communication document. If it communicates thoughts, decisions and information in a manner sufficient for the recipient to use, then it meets this requirement. Often, a drawing is used by many people, as it is a document that pulls subjects together. A drawing therefore needs to be used and edited by the designer. It needs to be the basis for further design decisions (for example by an engineer), as well as ultimately being the instruction document for the contractor on site.

Secondly, the consideration is whether the document is fit for purpose regarding its content. Essentially, if all the subjects considered in the Train of Thoughts, as well as all influencing factors are absorbed into the design, then it should be fine.

A legislative role: The design has to conform with the law. This means it has to meet the building laws, including the granting of planning permission and meeting the building regulation requirements.

An administrative role: The design has to pass the legal milestones. These are administered by the official bodies in the building process, including Planning permission and Building Control.

Financial role: Will the insurance provide a warranty for the work.

Aesthetic and functional role: is the builder happy, is the client happy?

Two paths for a designer creating a design: 1) go down a conventional route, thereby standards, details etc. are familiar. Or, 2) go an unusual route, whereby decisions need to be proven to work (i.e. to conform to the law). The distinction between these is found in where the burden of proof for suitability lies. Buildings fall somewhere between the two.

An example is that a building is (almost) always a one-off, as its site and structure is unique. Therefore, a structural engineer is required to ensure the one-off structural designs meet the required standards. However, the use of some products within the building are familiar (e.g. plaster board), so these do not require proof of suitability. All that is required is that the materials are used in accordance with the manufacturer's instructions. In this case, the burden of proof (for the plasterboard) lies with the manufacturer, as they are the ones who have created and brought the product to market. For example, they would have an Agrement certificate and associated liability insurance for a product.

With experience, a designer can create a design that has a combination of the one-off and standard solutions. It is the one-off elements (such as structure) that can be proven, by an engineer with calculations. Other products are used in their normal capacity. Some areas fall in between the two: part unique, part conventional (such as an oversized window arrangement). In this case, a specialist subcontractor can combine the product with the proof (certifications) required.

Further reading

##
Six Frames: For Thinking About Information (Paperback)
by Edward De Bono (Author)
Publisher: Vermilion (August 7, 2008)
ISBN-10: 0091924197
ISBN-13: 978-0091924195

##
This is a business book. It looks at how ideas are expressed, with a hierarchy of thought and presentation. This includes:
-Horizontal divisions by deductive or inductive thinking, which refers to the row above.
-Vertical divisions by questions and answers.
-Presentation by: context (story), situation (problem), question, answer (Q&A itemised).
The Pyramid Principle: Logic in Writing and Thinking (Paperback)
by Barbara Minto (Author)
Publisher: Financial Times/ Prentice Hall; 3 edition (18 Nov 2008)
ISBN-10: 0273710516
ISBN-13: 978-0273710516

##
This book is from the subject of IT, not architecture or buildings:
Simple Architectures for Complex Enterprises
(PRO-best Practices) (Best Practices (Microsoft))
(Paperback)
by Roger Sessions (Author)
Publisher: Microsoft Press (May 19, 2008)
Language: English
ISBN-10: 0735625786
ISBN-13: 978-0735625785

##
A readable, technical guide to environmental science. Useful for understanding U-values, specific heat capacity and more.
Environmental Science: T.E.C.Level 4
(Longman Technician Series)
by B.J. Smith (Author), G.M. Phillips (Author), M. Sweeney (Author)
Publisher: Longman (16 May 1983)
Language English
ISBN-10: 0582416205
ISBN-13: 978-0582416208