Materiality refers to the perception of the quality and state of each material applied to components of a space or a product. **Perception of a material** is a complex cognitive process, involving the engagement of multiple senses as well as the mind. It simultaneously stimulates visual, tactile, auditory, and olfactory senses; colors and texture, being shiny or matte, feeling of cold or warmth, being taut or loose, etc. Furthermore, it also incorporates the end-user’s experiences, expectations, preconceptions, upbringing, and culture; it can be highly subjective. For instance, the amount paid for a product affects its self-constructed value, it influences how the quality and refinement of the finish is perceived. A similar bright colored and reflective vinyl finish might be perceived as plasticky on a $15 skirt, or tasteful and refined on a $500 one. The success of the end product in terms of material selection depends not simply on finding the material that fits the budget and performance criteria well and has the most aesthetic appeal, the designer has
to anticipate how the material will be perceived by the intended end-user as well.

Individuals develop an understanding of the materials that constitute their environment through visual, tactile, auditory, and olfactory senses. Each sensation shapes their expectations and affects the overall experience of a space, component, or product. For instance, perceiving an oversized puffy pillow will create an expectation of comfort or the view of a brick fireplace will create a sense of hominess, coziness, safety, and relaxation. On the other hand, transparency may create a sense of invasion of privacy, or the reflections suggesting wetness might create discomfort due to an impending accident, or glare from intense reflections will create a more direct and discernible source of disturbance. One would know that velvet will be pleasurable to touch or intuitively understand that the smooth surface of the handrail will be safe to hold on to. Bits sticking out a surface will contribute to the perception of discomfort, or stickiness might evoke a sense of disgust. Wooliness will support a sense of warmth, or steel will feel cold as it quickly drains the heat away from the body. Hearing a lot of reverberation in a space will suggest openness and eeriness, whereas hearing no reverberation will suggest restriction and confinement. A sense of achievement can be instilled with the “new car smell” or the smell of mold & mildew can urge the user to run away.

Understanding how users perceive materiality with distinct senses bears substantial importance for the designer, so that the designer can effectively manipulate how the end-user will experience the design product.

Exactly where and in what way a material is utilized plays a significant role in how it will be perceived. User expectations and preconceptions play an important role in the perception of materiality, shaping the situation into a positive, negative, novel, or bland experience. The reaction of the end-user to a glass floor will be much different than to a glass wall. The same goes for using polished aluminum for a shoe, where a softer material is expected instead of a rigid metal. The designer needs to remember that, for a space that is visited once every while, such as an expensive restaurant or a retail store, a novel experience will stay to be novel; and the downsides can be tolerable. But using this novel material in a residential setting might lose its novelty over time, as it will be experienced on a daily basis; the sense of novelty might quickly transform into annoyance.

Fig.02/01 Wool creates an expectation of warmth and in some cases itchiness.

Fig.02/02 The glass facades of Farnsworth House have been a major source of privacy related controversy.
Reflecting upon the history of materials can inspire innovative uses and combinations. The designer can foster connections among materials, fabrication, users, and place. For instance, once very demanding wood inlays can be fabricated by precise laser cutting and CNC milling today for a fraction of the cost. Though, the perception of delicacy and lavishness can still be present. Another example can be “béton brut” or raw concrete’s association with the Brutalist movement mindset. Breaking free of any such associations requires innovative thinking. Social and cultural norms are another important component of the overall design context. Different social groups with different cultural idiosyncrasies will perceive materials differently. For instance, Bamboo is a material that has many cultural associations reflecting traditional Chinese values, or a Muslim individual might avoid wearing pigskin leather for religious reasons.

Context is the physical, socio-cultural, or financial conditions and constructs that surround a design problem, affecting how it is perceived and approached. Historical context, cultural context, and environmental context affect how materiality is perceived. Context also includes the clients’ or prospective users’ needs and requirements, building program, ongoing trends and preferences, human factors, sustainable thinking, etc. Furthermore, perception of materials doesn’t occur in isolation, per surface or object. Each material within a space affects the overall context. When specifying materials, the possible synergy and the overall combined effect should be carefully considered. Imagine a large wooden conference table in an otherwise minimalistic and sterile conference room. It should bring a sense of warmth and a connection to nature to the environment, via an easily perceivable contrast. On the other hand, the same conference table might not work as well in a room with elaborate wooden paneling, even though it has the exact same physical properties. The perception also involves paying attention to not only surface quality but also color scheme and the lighting conditions of the environment. A chrome-plated metal border on a polished granite wall may not create the same impact compared to when it is combined with a vein cut travertine cladding, as the contrast in texture and sheen will help it stand out. It is the overall effect that counts and it requires careful thinking.

The designer should always ask, “how will this material be perceived within this context and what kind of synergy it will create with its adjacent surfaces?”
Trends are another important notion that influences end-user’s perception. In the context of spatial design, trends can be defined as a specific color, material, or finish inspiring collective attention and desirability for a period, owing to exposure, popularity, or association. Trends can be relevant for some contexts, such as a trade expo stand or a retail space, whereas in others not so much, such as a government office or a history museum. For some types of materials, such as fabrics and wallcoverings, trends are highly relevant. Oftentimes products that were released around the same season seem to resemble each other and companies invest large amounts of money to track and set trends. The designer needs to know about existing trends and forecasts but also needs the skill to manipulate user perception and generate interest. For example, subway tiles are deemed as classic and timeless by some but in a modern interior, they can easily look dated. However, a contemporary re-imagining of a subway tile with an elegant finish might be a good nostalgic touch or a clever throwback/reference.

A recently trendy material, color, and texture can look distinctly dated when it goes out of vogue.

A design concept is an abstract framework for design development, a tool for outlining design intent, distinguishing a design product from a mere object of function or decoration. A conscious and methodical approach to the material scheme is key for meaningful and impactful design; one area where the design concept will manifest itself. In his 7132 Thermal Baths project, Peter Zumthor’s linear use of Vals quartzite and still water creates a sense of serenity and relaxation that is in line with the overall idea of creating a place for respite. Frank Lloyd Wright’s choice of concrete in Fallingwater House is not only a novel use of the then untested material, but also a statement to stand out from the surrounding lush natural environment.

<table>
<thead>
<tr>
<th>Concept Keyword</th>
<th>Possible Translation to Materiality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension/Release</td>
<td>Contrasting a rigid material, such as marble, with a loose and soft one, such as felt</td>
</tr>
<tr>
<td>Growth</td>
<td>Highlighting solid wood with very prominent grain, stained for effect.</td>
</tr>
<tr>
<td>Interdependence</td>
<td>Specifying a composite with a transparent matrix, showcasing the reinforcement.</td>
</tr>
<tr>
<td>Outreach</td>
<td>Ensuring uninhibited transparency, via the utilization of glass or acrylic.</td>
</tr>
<tr>
<td>Anti-Organic</td>
<td>Using molded concrete to produce angular/geometric volumes.</td>
</tr>
</tbody>
</table>

Fig.02/04 The concrete cantilevers in Fallingwater House sets a stark contrast with nature.
Another important consideration that affects user experience significantly is emotional response and assigned value. The famous adage, “form follows function” is one way to look at the design process. However, anticipating an emotional response, placing an emotional value, building memories and ownership around a product or space can be as important as its functionality. The end-user doesn’t always act on purely logical reasoning on how a design product functions. Most beloved spaces and objects have a story attached to them, and their function may not be a principal consideration. One might remember their underlit attic bedroom fondly because it gave them privacy and shelter during their sensitive teenage years. Linoleum kitchen flooring might be preferred by some demographics due to the associated sense of nostalgia. Custom made brass door handles might be completely unnecessary in terms of function but it signifies financial achievement and can improve overall user experience and enjoyment.

**VISUAL NATURE OF MATERIALS**

When perceiving materials humans primarily rely on their sense of sight. Within one’s field of vision, a material is conveyed first through optical perception followed by other senses. A key component of perception is the manner in which light strikes a material’s surface and the effect that ensues. The nuances of the visual perception of materials can be described using the following specific terms: color, hue, depth, light transmission, luster, reflection, shade/tone, tint, value, sheen, texture; these constitute a useful vocabulary for professional expression of one’s ideas.

An accurate understanding of what each specific term mean will enable the designer to communicate ideas clearly with their peers, providers, contractors, and even clients; minimizing the risk of misunderstandings and mistakes.
Light

Light is the principal requirement for visual perception. The incident light on a surface can be reflected, absorbed, or refracted in various amounts, defining general visual properties of a substance. Based on the amount of light permitted to pass through the material, or light transmission, a material can be referred to as opaque, translucent, transparent, or tinted. **Opaque** refers to a surface that completely blocks the passage of light. Even though transparent and translucent materials allow light to pass, **transparency** provides a clear view through, whereas **translucent** material diffuses light creating a frosty look. Tinted materials only let certain parts of the color spectrum to pass, creating the transparent or translucent material as well as everything behind it to be perceived as a certain color.

**Reflection** is the return of an incident light wave without total absorption. Every surface reflects light to an extent. Even the darkest material, currently Vantablack®, reflects 0.02%. The nature of reflection, whether diffuse or direct, provides valuable clues about surface quality.

For instance, polished steel will reflect light in a more uniform manner whereas brushed or sandblasted steel finish will in a more diffuse manner. **Luster** refers to the manner in which a material reflects light. **Sheen** is the appearance of gloss on a surface. The **shade/value** of a surface you perceive depends on the angle of light striking a surface. As the angle becomes more perpendicular the surface will receive and reflect more light. **Shadow** is an area deprived of light due to obstruction and can be perceived as an extension of an object that is casting it.

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Fig.02/06 Examples of transparent (A), translucent (B), and tinted (C) glass.

Fig.02/07 Vantablack® absorbs 99.8% of incoming light, to such an extent that surface detail can be perceived.

Vid.02/03 Video on identifying the effect of luster on various minerals.

Vid.02/04 Video on identifying the effect of luster on various minerals.
The glare in this environment is exacerbated by the contrast of the dark material around the windows.

Exposed to high-intensity light sources, reflective surfaces are prone to generating glare. For instance, polished marble flooring in an atrium would strongly reflect any light source; and any high-intensity source would create glare depending on the angle of the viewer. When openings are considered, if the framing material or surrounding drapery is darker, it might generate glare due to the contrast with outside lighting levels. Glare is not only uncomfortable but can be dangerous, requires special attention.

Daylight and artificial light are two broad categories of light that create significantly different visual effects. The diameter of the sun is 109 times of Earth’s diameter. As a result, the rays of sunlight received by earth are parallel and the intensity is fairly uniform over large distances. This affects the nature of daylight shadows. On the other hand, artificial light can be emitted from a point, line, or an area outwards. The shadows are elongated and distorted. Depending on the initial power of the source there will be areas of comparatively more light, and intensity will be lost quickly. Shadows will also be softer, more diffused, they might lack definition. There can be multiple sources of light, which create multiple shadows with multiple intensities.

Shadows are instrumental to the perception of the 3-dimensional nature of a surface.

The designer can manipulate the spatial experience through the interaction of light and materials; they can break the monotony and create dynamism, create an ambiance to support the design intent, direct attention with light and define borders, or support wayfinding.
The perception of color enables the viewer to make sense of the intricacies of the three-dimensional environment around them. A single light wave reflected from a surface can be perceived as red, violet, and everything in between based on its wavelength. This perception is referred to as the color or the hue of an object. However, **hue is different from color** as hue refers to a broad color category whereas color encompasses several properties including hue as well as saturation, value, etc., referring to the actual combined wavelengths. For example red is hue and pink is the color. In most sources, the primary colors (red, blue, yellow) are referred to as hues, and in others secondary (green, violet, orange) and tertiary colors (blue-green, yellow-green, etc.) are also included. The basic idea of hue is to identify a color family by using a color with no variation in saturation, shade, tint, or value, intensity. There are various terms that define the nuances of color further. **Shade or tone** refers to the presence of black in a color or hue. On the other hand, **tint** is the presence of white in a color or a hue. **Value** is the overall degree of lightness and darkness of a hue. **Saturation** refers to the intensity of the hue, or oppositely desaturation is the amount of gray perceived.

**Fig.02/09** Sunlight casts parallel shadows and the light intensity is consistent, it does not fall off.

**Fig.02/10** Artificial light casts shadows that fan out and the light intensity drops exponentially.

**Fig.02/11** Hue refers to the broader color category. Here, pink is the color whereas red is the hue.

**Video** Video interview of Rem Koolhaas on the Melbourne Pavilion and use of light.
Depending on the medium color, mixes show different characteristics. **Additive color mixing** is combining light sources of different colors and creating a mixture that is moving towards white. One prominent example that exploits this principle is the pixels on a laptop or smartphone screen; any color is generated by combining red, blue, and green light of different intensities. Understanding how light mixes is important for establishing ambiance and creating effects.

On the other end, **subtractive color mixing** is combining dyes, inks, pigments, or colorants to achieve mixtures that are moving towards black, or dark as light is subtracted. It is specially important when considering achieving various colors with plastic pellets or paint.

There are a number of websites and software where you can find custom color schemes. You can also check artworks for inspiration. Designers should use color intentionally: *to establish form, create dynamism, generate interest, and ensure balance.* Controlling the proportions of color in an environment is also as important. The designer should ask which colors are dominating, which colors are supporting. *Limiting the color palette is often good.* The use of color should be deliberate and impactful, rather than turning into background noise and getting lost in the mix. Due to changing trends, certain colors become more popular at certain times. Many paint companies publish color forecasts to report the changing trends.

Color can be used in design for the following
purposes of attracting attention, grouping elements to indicate meaning, and enhancing aesthetics. Color can be utilized to drive the attention of users, but also an excessive use of color would weaken the effect. As a result, other design elements may become the target of attention. The designer can indicate or emphasize a relationship among different design elements. Meaning of color can be very subjective, where context and nuances are important, and the designer should anticipate the effect. Earth tones might indicate a sense of permanence, experience, rootedness, or the use of red might introduce a sense of dynamism and excitement. A lack of color can be tied to solemnity and spirituality, or a multiplicity of color ties to a sense of playfulness, youth, and energy.

**TEXTURE** ● **Texture** is a visual construct that has an approximate repetition and a sense of continuity among its parts, even though for some textures distinguishing this exact repeating visual unit might be difficult. Texture gives the viewer clues about the nature of a surface and finish, simplifies comprehension of surface topology, enhances spatial perception and sense of depth, introduces variety and interest, and as previously mentioned, it also implies tactility. Texture enables the viewer to identify the nature of a material, if it is soft or hard, slippery or rough, stretched or loose. Furthermore, based on previous experiences it is possible to establish a sense of scale with the use of texture and proportionally relate elements of an environment. Texture can have three-dimensional qualities. **Relief effect** is the perceived depth of a materials surface. Oftentimes the relief effect can be enhanced or dimmed by adjusting the direction of incident light and controlling shadows.

**Perception of texture** is affected by light intensity and direction, size of the visual units comprising the texture, the contrast between units, the reflectivity of the surface, and the distance of the viewer. Context is key in texture perception. The visual environment surrounding a texture profoundly affects its perception. The term texture should not be mixed with pattern. **Pattern** is very consistent and predictable whereas texture have random variations, appearing more natural in comparison. For example, wallpaper pattern typically refers to a
consistent graphic application on the other hand a wallpaper texture refers to a more varied and stochastic visual.

**OTHER VISUAL COMPONENTS** Usually, movement in design is an implied component. The *suggested movement* of surface materials creates dynamism and directs attention. On the other hand, movement can be literal too. Some materials can move in reaction to wind, for instance, movement of drapery with a slight breeze might enhance the ambiance. Motion can be introduced and controlled through sensors and automation. Movement can also imply the movement of the viewer. A space can be revealed through movement. Distance determines the perception of movement in the fore-, mid-, and background.

This effect is called *parallax depth* and it can be used to create depth in space by utilizing varying textures on fore-, mid-, and backgrounds.

**Rhythm** is crucial in creating a sense of coherency and grouping elements. Due to the repetition aspect, every texture inherently has an implied rhythm. Rhythm should especially be a consideration when using materials in combination.
Monotony is an important concern when working with materials. For example, when finishing large surfaces with a single material. Unless dictated by a strong concept, seeking a sense of balance when specifying materiality and minimizing a sense of monotonicity is key. In order to control the build-up of monotony, it is possible to break down large surfaces to create rhythm and dynamism. Texture variation can also be utilized, by including different finishes of the same material to break the monotony.

Symmetry is often taught as something to stay away from as symmetrical compositions are visually less sophisticated and the repetitive nature often lacks interest. However, there are times symmetry would come in handy as a conceptual tool. For example, if you intend to express equality and justice a perfectly symmetrical composition may be the answer.

**COMPOSITION**  The design elements and principles covered until now are the foundation for good visual composition practices. Balance is a key aspect of visual composition. The designer has to be able to use form, materiality, texture, color, light, structure, movement in conjunction with contextual information to create balanced dynamism. However, one should also be careful as too much balance will hinder interest; imbalance sometimes is a good tool for conceptual expression.

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**Fig.02/20** Vassily Kandinsky’s Composition 8 is a good example of achieving a complex and dynamic balance.
Even though the sense of sight is very important for the perception of materiality, it is a combination of sight, smell, sound, and touch that fully determines how a material is experienced. A hierarchy is present on the immediacy of each, and also the ability of how far each sense can reach. Nonetheless, each sensation augments the other and forms a robust perceptual construct; while providing aid when one of them is weak or missing. For instance, under dim light, an individual will rely on the sense of hearing and touch to direct themselves, as the visual stimuli would be unreliable.

**Haptic sensations**, or sensations related to touch, can be defined broadly as the tactile impression of interacting with materials, products, or finishes. Due to the number of nerve endings and purpose appropriateness, hand and feet are the primary sources of tactile information, even though the whole body contributes to forming the overall sensation. Thermal sense is also part of haptic perception, besides three-dimensionality, roughness, wetness, flexibility, etc. There are two crucial concepts related to thermal sensation that can help the designer better specify materials: conductivity and emissivity.

**Conductivity** in this context is the capability of a material to transfer heat through its body. **Thermal bridges** are the result of a conductive material creating a path of least resistance for heat transfer. The more efficient a material is in transferring heat from a hot to a cold region, the colder it will feel to the touch. For example, metals feel cold to the touch not because they are actually cold, but because they drain away heat efficiently. In reality, they most likely have reached equilibrium with the environment and at virtually the same temperature as everything else around them.

**Emissivity** is the ability to radiate thermal energy to the environment. A blackbody is defined as the perfect emitter; on the other hand, a shiny surface will have zero emissivity. Even though a shiny aluminum railing isn’t actively sucking heat away from the environment, it has zero emissivity and will almost always be cold to the touch. On the other hand, a dark stained smooth oak railing will feel warmer and inviting. With an understanding of these concepts, the perception of warmth can be manipulated via materiality.

The impression of cold and warmth can even be determined by looking at an image as the viewer already has sensory expectations based on previous experiences.

Materials can be finished in different ways to create varied sensory experiences. Granite can be hammered, flamed, honed, or polished – each different process leads to a different sensation to the touch. Moreover, the part of the material that is exposed might also define the texture, therefore tactile response, e.g. using top grain, split grain, or bonded leather.