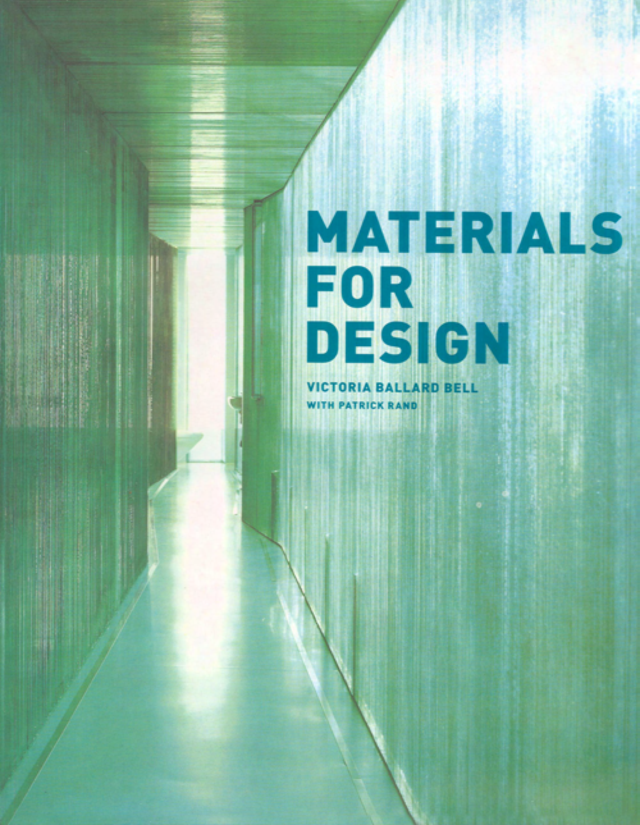

MATERIALS FOR DESIGN

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Introduction

Architecture schools typically separate the required Materials and Methods course and the design studio, creating the impression that the two have little or nothing to do with each other. This misconception goes well beyond the academic realm, as the erroneous distinction between the "what" and the "how" of architecture is seen all too frequently in professional practice. Materials are often chosen at the end of the design process or even during the generation of construction documents for a building design, as if they are a mere afterthought, a color of paint applied to the building after the design has been formulated. Whether in the classroom or in practice, to consider design without regard to material can only result in a less successful building project.

The need exists to reintegrate these components of architectural education. The rise of design/build programs in the United States such as the Rural Studio at Auburn University, Studio 804 at the University of Kansas, and the Basic Initiative Program at the University of Washington have demonstrated the effectiveness of a holistic learning pedagogy that combines design, materials, construction methods, programming, and even community service. In Europe, the ETSAM in Madrid has a program in which students go to Central America, South America, or Africa to build houses for those in need; the Bartlett School and Oxford Brooks University in the United Kingdom also offer similar programs. All of these programs teach students decision-making skills and the understanding that what they design is critical to a project's success. Design/build students learn immediately that their choice of materials can be a powerful and didactic tool to this end.

The argument for an education that reconnects these subjects is effectively made by Ernest Boyer and Lee Mitgang in *Building Community: A New Future for Architecture Education and Practice*. They present seven essential goals for the education of an architect based on their research of accredited programs. One goal, "a connected curriculum," criticizes the separation of design from other, more technical coursework. To effectively teach young designers the practical and technical as well as the theoretical and artistic, these must be learned hand in hand.

This book offers just such an alternative by showcasing projects that marry an architect's design intention with the qualities of a material, a synthesis called *materiality*. Chosen to form a cohesive approach, sixty case studies presented here inspire, encourage, and push the use of materials in the design process.

That such a marriage between material and design is only now being made explicit is not surprising. Materials have been used to express statements for years, but it is only recently in our history that *how* we use them—not to mention the onset of an entirely new palette of material options—has begun to advance and revolutionize architecture. Prior to the twentieth century, materiality spoke more to place, to locale, and in a way was more purely definitive as to what a building should look like: architects tended to use materials that were available and plentiful in their location and thus uniquely representative of that place, such as the indigenous woods used for the saltboxes and meeting houses of New England in the 1700s, or Thomas Jefferson's use of the red clay of Virginia to make the distinctive bricks that defined his buildings in the early 1800s. In the northeastern United States in the 1870s and '80s, Henry Hobson Richardson used stone to convey an idea of monumentality and permanence.

In Europe, bold statements of materiality were being made by the mid-nineteenth century. Henri Labrouste used iron, a material new to large public buildings, in his Bibliotech Ste. Genevieve in Paris (1850). The use of iron at that time was a proclamation that this was a building of high technology. Joseph Paxton's Crystal Palace, an exposition hall in London built just one year later, was a modular cast iron and glass building that used its materials to symbolize industrial, technological, and economic superiority. The large areas of glass and cast iron were an expression of materials and intention and were a precursor to the glass curtain wall.

The twentieth century saw the rapid development of these early seeds of materials and design intentions integrating together as one. The early purveyors of modernism used materiality in this way to help support their ideals. Auguste Perret began using reinforced concrete throughout France in the early 1900s as a representation of a new architectural style, not just a new material to replace stone. He designed a garage for Renault in 1905 and the Theatre des Champs-Elysees in 1913, both in Paris, as well as many other public and industrial buildings in France. Erik Gunnar Asplund's Stockholm Library (1918) also exemplified a new monolithic and clean-lined look of concrete. In the United States, Frank Lloyd Wright used unprecedented poured-in-place concrete for the Unity Temple in Oak Park, Illinois (1906), as well as for the more notorious Fallingwater in Bear Run, Pennsylvania (1934). Le Corbusier, a pupil of Perret's, used concrete to achieve the monolithic and sculptural qualities he strived for at a time when concrete was not considered a common building material. Through his villas and religious and civic buildings erected in America, Europe, Asia, and Africa, he reached a new level of sculptural architecture utilizing the properties of this single material, when no other would have achieved the desired effect.

Likewise, Mies van der Rohe was able to push the use of glass and steel to provide a level of purity in construction and a minimalist quality in space. As modernism was refined, materiality continued to support the design intentions of those willing to look at materials in novel ways. One can think of Pierre Chareau's use of glass at Maison de Verre (1932), or more generally of Alvar Aalto's love of wood or Eero Saarinen's obsession with concrete.

Postmodernists of the 1980s promoted an alternative approach to materiality: they chose to deny it as a part of architecture. The use of faux veneers and imitation materials expressed a style that showed little regard for an ethic of truth to material. As these materials flooded the construction market, the distinction between what is real and what is false became harder than ever to identify. Architecture's approach to materiality had spun 180 degrees since that of the early modernists.

Today, materiality is an exciting and quickly expanding concept in the construction process. Global corporations like DuPont and Weyerhauser are continually generating new materials and new uses for existing materials. Industries that once serviced a small segment of products are now engaged in much more in-depth research and development of new materials that are more effective, more efficient, and more environmentally sensitive. Once merely a tool for architects and largely confined to the realm of engineering, materiality has now become an instrumental methodology for a clear and bold design statement.

The wealth of innovations in this realm has made materials an enormous field of study in itself. The use of plastics, for instance, has exploded with every technological advance, while the more traditional materials have stayed in demand as well. The wide range of colors and sizes of concrete block, for example, offers an exponential increase in selection. "Green" materials— those that are sustainable and sensitive to our environment—have also become mainstream. In some ways it is almost impossible to write a comprehensive book on materials today with the ever-changing and ever-growing advancements taking place across the board. It is almost impossible to keep pace with the latest and newest types of materials being introduced to the construction field.

Materials have also entered into a new realm of distinction with this onset of advancement in engineering and technology. We are at a point in history when technology allows for the "design" of specific materials to fit the unique needs of a building. Frank Gehry's signature metal panels are a great example: each is individually engineered for its precise position in the building. Such technology has introduced a period of new expressionism in the glory of materials and their qualities. Materiality has now become a mature philosophy in the field of architecture: How are materials expressed in a building—are they surface or structural, modern or vernacular? What kind of materials are appropriate? How does the structural material relate to the enclosure materials, or are they same?

This book is organized to serve as a basic reference and examination of five materials that have pushed this philosophy—glass, concrete, wood, metal, and plastic. These materials, unlike traditional masonry, have properties that are still being discovered and exploited in new ways. Each chapter begins with a basic material primer, a brief history, design considerations, and a summary of the various types and/or production methods. The content has been selected to give the reader a basic understanding of the material.

These introductions are followed by case study projects offering examples of some of the best and most inspired uses made by architects from around the world in the past few years. The case studies have been selected by a survey of contemporary practices for whom design intention and materials have been successfully joined. Projects range from small to moderate in scale, allowing a focus and clarity of expression to yield an understanding of the building in its entirety and as a didactic prototype for the young designer. These architects love materials and are not concerned about deviating from the norm. There are examples of a material being pushed to new and experimental heights, such as the Aluminum Forest by Micha de Haas, a building made almost completely of aluminum. There are examples of a mundane material being used in a new or different way, such as the Springtecture H project by Shuhei Endo, where corrugated metal is curved and looped to create spaces. There are the more modest projects where experimentation meant creativity, such as the Rural Studio's Masons Bend Chapel, which used car windows as glazing. These projects make an expression not only with the types of materials used but also in how they are put together. The construction detail drawings for all of these projects have been highlighted because this is where we learn most about the designers' ideas in putting their buildings together as well as their unique philosophies regarding materials. This is where we begin to understand how a material is connected, how it needs to be treated, and how it relates to the other materials in the building.

When a material is used in new and unexpected ways, or where its characteristics are presented in an unconventional condition, the level of design is raised. ARO's use of glass in its Soho loft is mesmerizing, as it is utilized structurally, counterintuitive to what we are accustomed to seeing but furthering the design's intention toward open space; the properties of glass were used in a creative manner in order to achieve a design solution. The result is an engaging and innovative stair that appears to float in space. Likewise the use of precast concrete in the Retirement Home built in Basel, Switzerland, by Steinmann & Schmid Architekten exemplifies the way in which thoughtful design and a proficient understanding of a material creates a practical and beautiful building. O'Connor & Houle Architecture uses a white polycarbonate to skin their 50 Argo Street house to give the owners varying levels of translucency and privacy. Elsewhere, Despang Architekten is always sensitive to the synthesis of materials and design, such as their use of a prefabricated structural wood system designed for the ILMASI School in Garbsen, Germany. *Materials for Design* aims to inspire designers to think of materials as a palette from which to imagine how an idea or concept can be crystallized and realized with the use of a material. This book is dedicated to all of us who love materials and to all of us who love to design. The two belong together.

ILMASI School

GARBSEN, GERMANY // DESPANG ARCHITEKTEN
PREFABRICATED FIR WOOD PANEL, GLUELAM BEAMS

INTENTION

This school for physically and mentally handicapped children accommodates approximately one hundred children, all with distinctive needs and challenges, and forty teachers. The designer's goal was to create a passive and serene environment for a large educational program. A series of low wood buildings with shed roofs and a series of distinct courtyards meander on the site with an almost natural sense of always belonging there. Through the use of wood, the landscape, and the courtyards, this building creates a link to nature and a calming character by creating a variety of subtle connections between the internal and external spaces.

MATERIALITY

An unusual prefabricated load-bearing wood panel is used for most of the enclosure. Fir lumber with a vertical profile is used to sheath most walls and ceilings, a dark stained oak is used for doors, and floors are wood parquet or stone. The senses of the occupants are meant to be productively stimulated by the tactile richness and the play of light over the vertically textured wall surfaces. These surfaces are also intended to enhance acoustic quality within the school, and are durable enough to withstand the anticipated wear. The designer also reasons that fire threat is reduced because the wood is more massive in this project than in conventional light frame construction. Sprinklers were nonetheless installed as a precaution.

The interior and exterior faces of the walls have an identical materiality and appearance, despite being made in significantly different ways. Both use vertically profiled fir wood as the material, but the structural panels on the interior are made by subtracting or rabbeting the corner of each piece of lumber, whereas the outside faces are non-structural, and are made by adding small pieces of fir to a plane of like material, making its overall thickness less than that of the structural panel.

01 Building section
02 Exterior view
03 Wood siding assembly
04 Transparent wood screen
05 Window detail

TECHNICAL

The load-bearing panels consist of 2.36 x 5.19 in. (60 x 130 mm) fir boards nailed face-to-face to form a dense plane of wood. These panels support an upper floor and roof, serve as thermal mass in the building, and are exposed as the interior wall finish. More than 14,000 sq. ft. (1,400 sq. m) of wall area was made using these fir panels. The client wished to avoid using non-renewable construction materials and to utilize a material of local origin.

Fir is not a species of wood that is intrinsically resistant to biological attack. The architect therefore took precautions to prevent moisture intrusion and other prudent measures to lengthen the life of the assembly. Outside of the structural wood panel is a sophisticated strategy to provide thermal insulation and moisture control of the exterior walls. Thermal insulation is provided by two layers of wood framing and insulation, oriented vertically and horizontally to avoid any continuous members conducting heat from inside to outside. Inside of this insulation is the vapor barrier; outside of it is the air barrier.

Lessons from masonry cavity walls are applied to the wood exterior veneer, which acts as a rain screen in this building. The ribbed wood exterior face of the wall is supported on a series of horizontal furring strips that maintain a cavity behind the veneer, through which air and moisture can freely move. The wood veneer repels most of the weather, but the backup cavity provides a second avenue for it to exit before reaching critical elements within the assembly. The air barrier bounds the cavity toward the interior, preventing air infiltration and discouraging moisture from entering the insulation layer. Vents at the top of the cavity and weeps at the bottom permit air and moisture to move without marring the outside appearance.

Glue laminated wood beams span some of the courtyards to support a translucent ETFE plastic foil roof treatment. These structural elements are consistent in material with the wall materials, and are slender so that the quantity of light into the courtyard and adjoining spaces is abundant. Where screens are desired, such as over some windows, next to stairs, and around exterior mechanical equipment, the designer used a variation of the basic ribbed wood wall treatment. Screens are made by omitting either 50 or 66 percent of the pieces of wood, producing voids in elevation but still knitting the screen together with the adjoining solid wood walls.

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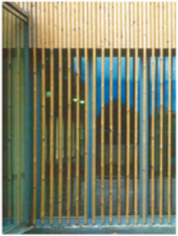

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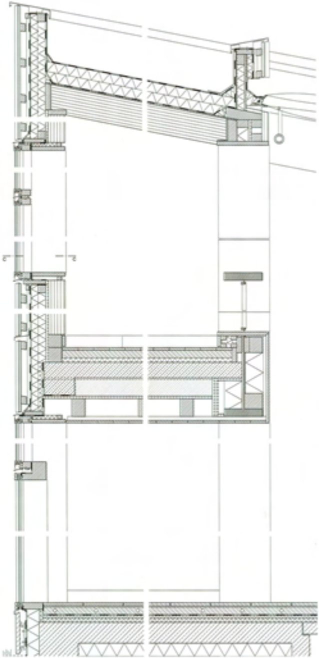
06 Wall section
07 Roof assembly
08 Plan detail at window

Wall assembly
- 1.18 x 1.18 in. [30 x 30 mm] pine strips
- .79 in. [20 mm] pine boarding
- 1.57 x 2.36 in. [40 x 60 mm] pine counter-battens [all pine members thermally treated]
- Windproof layer
- 2.36 x 2.36 in. [60 x 60 mm] wood bearers
- 2x 2.36 in. [60 mm] rock-wool insulation
- .79 in. [20 mm] oriented strand board
- 2.36 x 5.12 in. [60 x 130 mm] rabbeted stacked planks, oiled [with 2 per cent white pigment]

Floor Assembly
- .87 in. [22 mm] smoked-oak parquet
- 2.44 in. [62 mm] screed
- 1.38 in. [35 mm] impact-sound insulation
- 4.72 in. [120 mm] reinforced concrete slab on 5.51 in. [140 mm] filling
- .79 in. [20 mm] chipboard
- 3.94 x 5.51 in. [100 x 140 mm] timber beams between steel
- I-beams 11.81 in. [300 mm] deep
- 1.18 x 1.18 in. [30 x 30 mm] softwood bearers
- .79 in. [20 mm] softwood bearing



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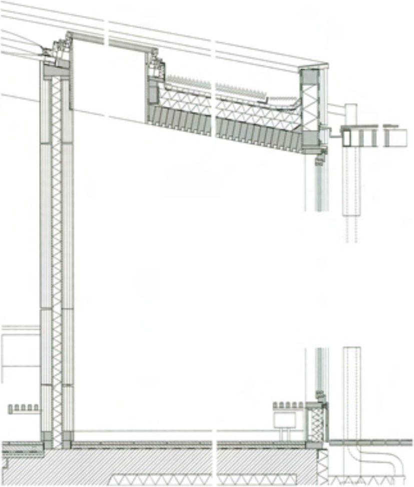

Roof assembly
- 3.15 in. (80 mm) substrate soil layer
- 2.76 in. (70 mm) water retaining drainage layer
- Plastic roof sealing layer
- 7.09 in. (180 mm) two-layer rock wool insulation
- Bituminious sealing layer
- 2.36 x 7.09 in. (60 x 180 mm) rabbeted stacked planks

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Tram Stations

HANOVER, GERMANY // DESPANG ARCHITEKTEN
MODULAR STEEL FRAME, APPLIED SKINS

DESIGN INTENTION

For the World Expo 2000, the City of Hanover built a series of tram stations that were to be easily mass-produced, with a standardized steel structure. They were also to respond to individual locations using a variety of materials dressing the steel frames. Thirteen stations service this street-level urban rail system throughout the city. An overall urban analysis of the infrastructure along this rail line was completed by the designers to understand the size, density, and character of the areas around these stops. The stations form a "sequence of notes" along the rail line, evoking specific characteristics and associations at each location. In some stations local residents and businesses collaborated in the design, enhancing the link with the host communities. The material variety is also intended to aid residents, tourists, and passengers in identifying the different stops.

MATERIALITY

A basic steel framework was designed to form each tram station without appearing as the dominant material in any of the structures. Each location is distinguished by its unique veneer—exposed materials attached to but not contributing structurally to its backing. In some stations the cladding is a closed skin such as stone, brick, or concrete panels, while in other stations it is a translucent or filtered skin such as glass, wood slats, or metal mesh. The consistent frame for the waiting blocks and platform establish the theme for the rail line as a whole.

The primary structural system for the waiting blocks at all thirteen stations is a modular steel frame, made of conventional steel sections. It is a consistent armature upon which various service components and cladding systems can be applied. It consists of a steel plate attached to the rail platform with three square, hollow steel sections, to which steel angles are then affixed. Prefabricated elements are then attached to this basic framework. Each station has a glass awning in front and some combination of ticket machines, posting boards, and seating areas, depending on the needs of each location. The stations are adjusted dimensionally based on the size and shape of their materials and the anticipated number of users. The variety of materials is clearly a communication and graphic tool for this series of prefabricated structures to distinguish each by its use, location, and contextual character.

These stations demonstrate the universal capability of the steel frame, valued for its certainty of physical properties, its durability, and the ease with which it can be shop-fabricated. It is well matched to the "kit-of-parts" approach taken in this design. Shop fabrication of the consistent platform and enclosure frames is coupled with onsite execution of the variable cladding, optimizing both machine and hand processes.

Normal mild steel is vulnerable to oxidation in the atmosphere, especially in urban or industrial environments. It must therefore be protected either by paint or other protective coatings, or clad with other materials to minimize its exposure to hostile environmental forces. This project clearly expresses the capabilities of steel while also recognizing its vulnerabilities. The cladding that protects the steel frame becomes the dominant expression.

Variations in cladding at each station convey the character of that particular community, respond to local materials, or adjust to the levels of vandalism anticipated in different urban situations. Among the toughest cladding treatments used was woven stainless steel mesh, further protected by an anti-graffiti coating. It is quite durable, but when illuminated from within the volume, it changes from a rugged, closed-skin expression to a more delicate translucent membrane. Another station uses pre-patinated copper, whose green hues resemble the landscape of its suburban district, and whose careful joinery recalls the sheet copper craftsmanship found on some traditional residences in the area.

TECHNICAL

This frame-and-skin system allows for a great variety of exterior expressions to be used interchangeably. The skin materials are not chosen for their structural properties but for their scale and visual qualities on a building, and for their weathering resistance. The veneer materials are typically secured using concealed metal clips, anchors, or wires. Secondary frames or infill walls are used within the steel frame to support the veneers.

Each cladding system in this project called for a special strategy to secure the cladding to the steel frame due to differences in cladding thickness, weight, and compatibility with steel. For instance, to avoid bimetallic corrosion, copper cladding was isolated from the steel frame using a wood-sheathed substructure. All fittings were designed so that the cladding can be repaired or replaced. Many of the fittings were custom castings or fabrications using metal.

The physical, technical, and haptic qualities of a wide range of materials were tested under laboratory conditions before being selected by the designers. Sustainability was also a contributing factor to the design. Materials were chosen that were recyclable or renewable resources, or which have a long service life. The stations have since performed well, with less demand for repairs than expected.

01 Stations diagram
02 Metal mesh station
03 Copper station
04 Brick station
05 Glass block station
06 Glass station
07 Glass station

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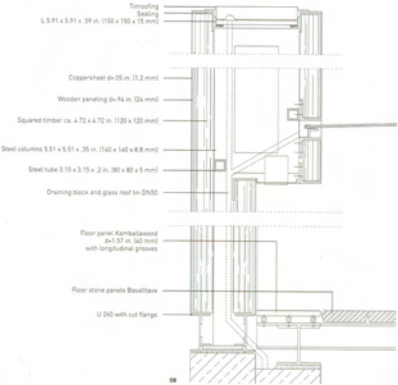

08

08 Copper cladding detail
09 Glass connection detail
10 Concrete station detail
11 Metal mesh station detail
12 Station series

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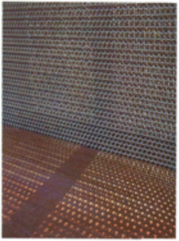

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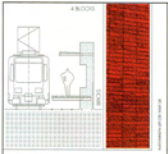
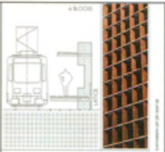
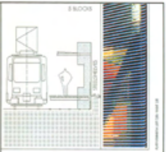


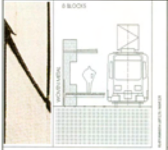
STATION FREUNDALLEE



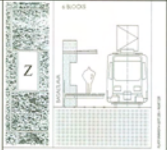
STATION BÜNTEWEG



STATION WIROHBERGE

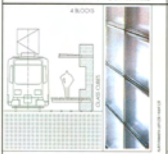


STATION KERSTINGSTRASSE



STATION PRESSEHAUS

STATION WÜLFERODER STRASSE



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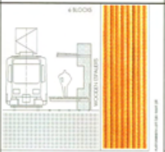

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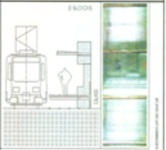
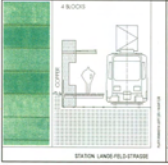
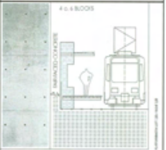


STATION IN DER ENTHORST



STATION LANGE-FELD-STRASSE

STATION EMSLANDSTRASSE



STATION STOCKHOLMER ALLEE