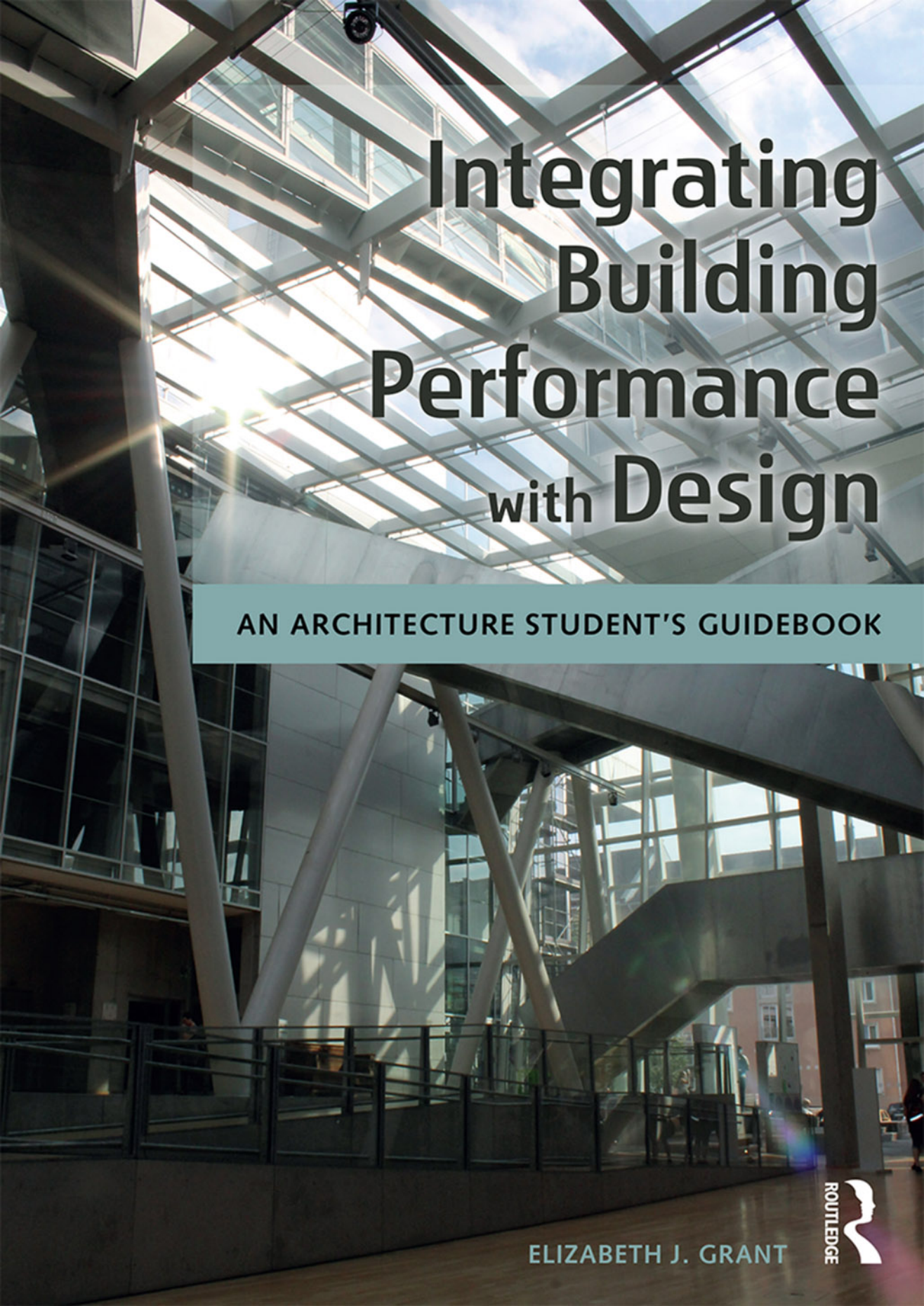
Integrating Building Performance with Design
AN ARCHITECTURE STUDENT'S GUIDEBOOK
ELIZABETH J. GRANT
ROUTLEDGE

Integrating Building Performance with Design

Integrating Building Performance with Design shows you the importance of designing for building performance early in your architectural design process. The book offers you simple tools and exercises, along with examples of built professional work and successful student projects illustrated by more than 100 full color images to help you with your work. Topics include site, solar orientation, thermal comfort, building enclosure, daylighting, passive heating and cooling, active heating and cooling, indoor air quality, stormwater, and rainwater harvesting.

Elizabeth J. Grant is an associate professor at the School of Architecture + Design at Virginia Tech in Blacksburg, Virginia, USA. She is a registered architect and the Associate Director of the Center for High Performance Environments. Her interests include environmentally sensitive design, building enclosures, and building systems integration.

"Finally, an effective book on fighting the marginalization of performance in architecture. The author makes her arguments through tales from the trenches, humor, and erudite comments, and then goes on to explain how to achieve high performing buildings."

—Norbert Lechner, Professor Emeritus and Architect,
Auburn University, USA

"*Integrating Building Performance with Design* gives us compelling building stories about process, performance, and perceptions through the lenses of teaching and practice. Grant dissects, observes, and matches architectural expression with narratives of numerous case studies about the functioning of buildings and their services throughout the U.S. and Europe."

—Alison G. Kwok, Professor, Department of Architecture,
University of Oregon, USA

"As a practicing architect, I'm relieved to see an architecture educator helping prepare students for the profession by addressing and integrating building performance early in the design process in order to help with the translation of design concepts into functioning built structures. Architectural graduates who arrive to practice with only their sometimes too precious design concepts are of little practical use to the profession and in fact are delayed in their own development into practicing architects. Professor Grant's book, amply illustrated and written in an engaging, self-deprecating tone, provides such guidance to students in the evolution of their designs into buildings which is what our profession is all about."

—Peter Ozolins, PhD RA LEED AP, Peter Ozolins Architect, P.C.
Architecture & International Development, USA

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An Architecture Student's Guidebook

Elizabeth J. Grant

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This book is dedicated to my husband, David, and my daughter, Katya, the two greatest integrators I know, and to my Aunt Barb, *requiescat in pace*.

Contents

Acknowledgments

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Part I

1

Why Do You Need This Book?

There was recently a lively email exchange among our faculty regarding the granting of a scholarship from an alumnus who wanted to reward a student for the "sustainable" qualities of his or her design. Architecture faculty tend to be very protective of the education of their students, and, quite rightly, are careful about what sorts of awards they hand out for design work. Ultimately, it was decided that a faculty jury would choose a prize winner based on "work that demonstrates well-reasoned responses in architecture with the promise of enduring qualities." Which of course meant that we, the faculty, would need to determine precisely what that meant. That's when things got lively. Certain buildings, among them the pyramids at Giza and Gothic cathedrals, were held up as paragons of sustainability. Let's examine these claims for a moment.

Yes, the pyramids are sustainable, for what that's worth, except that pyramids are for dead (or immortal, depending on whom you ask) people and were built by armies of workers (or aliens, depending on whom you ask) with lots of labor and material. It can be argued that they aren't really buildings for mortals, they are giant gravestones for rich, famous demi-gods. They provide a comfortably cool space for the mummies they encapsulate, along with their dead cats, at enormous social and economic cost.

Likewise, Gothic cathedrals have been around for a very long time. If historical accounts and their interpretation can be trusted, these were financed in part through the sale of indulgences,[1] which is certainly not an acceptable or endorsed practice for funding contemporary ecclesiastical architecture. While there are obviously still buildings of great civic importance being designed today, it is difficult to compare them to the pivotal place held by the seat of the medieval church (Figure 1.1). Another reason cathedrals have been enduring is that because every time

Figure 1.1
The Cathedral of Notre Dame in Paris, France, 1345, is an enduring landmark. Image by Victoria Myers

they broke, someone fixed them. The whole history of the flying buttress is predicated on iterative design based on repeated building failures (Figure 1.2). The result is impressive and wondrous, but the means of achieving that result is not a method we would choose to replicate now, especially the failure part. Like the pyramids, they are great places to visit, but you wouldn't want to live there. They are cold in the winter.[2] They were conceived as religious primers for a largely illiterate populace, through their iconography, their spatial sequence and their dizzying verticality. Like

Figure 1.2
The flying buttresses at the Cathedral of Notre Dame are an example of an adaptation used to sustain a building form.
Image by Andres Jimenez Botero

the pyramids, they were not designed for the physical comfort of living people; they were designed overwhelmingly as houses for God.

If pyramid and cathedral design sounds like a great career aspiration to you, and if you can find that sort of client, I say, go for it! In our hearts, we all hope for those kinds of commissions, but they are few and far between. Though many would state that the chief role of architecture, like art, is to make us more vividly aware of our human condition and the aspirations of our age, I would argue that our primary and most frequent obligation as architects is to design buildings that delightfully accommodate human activity and don't waste materials, energy, and money in the process.

My biggest difficulty with the argument for the pyramids and the cathedrals as paragons of "sustainability" is that there is more to enduring quality in architecture than staying power. Concerning oneself with "sustainability" certainly need not mean a focus solely on energy efficiency, but it seems that, in our time, sustainable designs must at least consider impacts in this realm. I believe that architects' hackles go up when energy is mentioned because architects often assume that energy efficiency belongs in the realm of engineers.[3] That is not necessarily so, and architects are the best-equipped to make the argument that basic design decisions must precede and underpin all subsequent choices about building technologies. I am grateful that at my school, we do not have a course in Building Technology. Rather, our course is called Environmental Building Systems to reflect, in my mind, the more accurate placement of ideas about energy use and its impact on the environment. These ideas should be part of a systematic understanding of architecture, not something tacked on. Norbert Lechner employs his own pyramid, actually more of a ziggurat, in his *Heating Cooling Lighting: Sustainable Design Methods for Architects*,[4] which I use as the textbook for my class. His philosophy is that the building

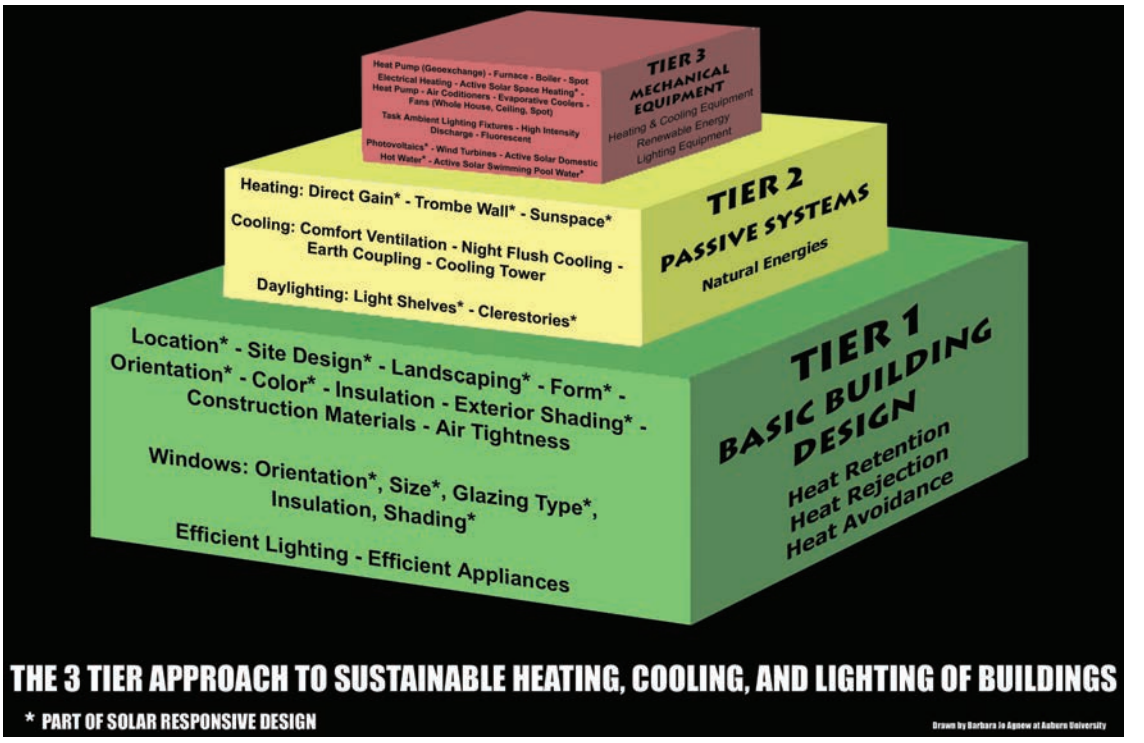

Figure 1.3
Norbert Lechner's approach to sustainable design involves considering basic building design before passive and active systems. Image by Barbara Jo Agnew, permission to use granted by Norbert Lechner

itself needs to do most of the heavy lifting before active and even passive systems are employed (Figure 1.3).

The faculty discussion I began with continued with one of our faculty sending the rest of us, and the donor of the scholarship funds, links to the description of Baumschlager Eberle's office in Lustenau, Austria as an example of a building potentially satisfying the aforementioned "sustainability" criterion. The building is touted in numerous articles as technology-free; it is even named "2226" because it maintains a temperature between 22° and 26° Celsius (72–79° Fahrenheit) with purely passive means. The best and most vociferous of these articles is published in *Detail Online*.[5] What a marvel! What a new and fantastic idea! However, when one reads past the glitzy lead paragraphs into the meat of the article, one learns that the building has triple-glazed windows, vacuum-insulated panel insulation over its operable vents, and a building information management system to control said vents. Yet, somehow, it is described as being a "manifesto against technology overkill." I would argue that the building is "sustainable" precisely because of these technologies and wouldn't be otherwise. Of course, and more importantly, it uses strategies that we all should know are prudent from the start: a reasonable fenestration percentage, or percentage of the wall that is glass, of 24 (Figure 1.4)[6]; enough insulation for the climate (Figure 1.5); and thermal mass in its exposed polished concrete floors. John

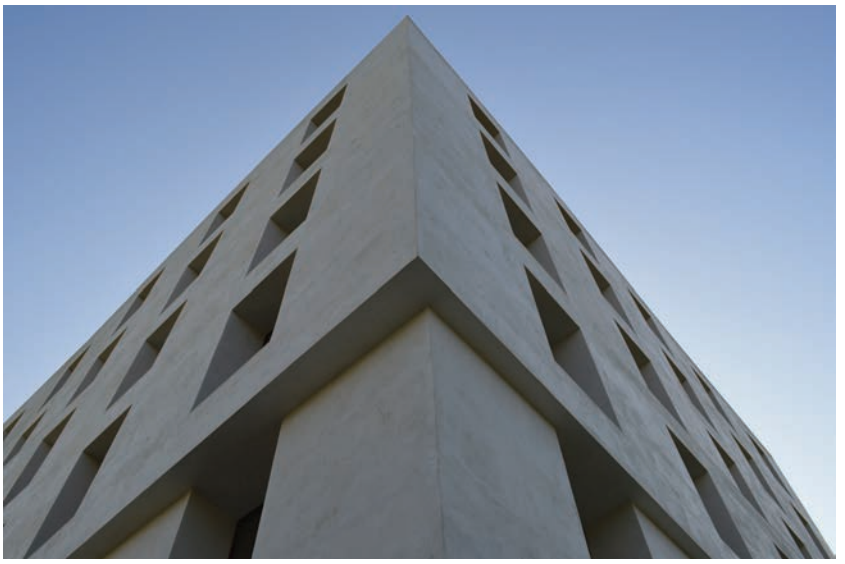

Figure 1.4
The building named 2226 by Baumschlager Eberle in Lustenau, Austria, 2013, has triple-glazed windows sized to prevent excessive thermal gains or losses.
Image by Joanna Brindise

Figure 1.5
The windows seen from the interior of 2226 display the depth of the super-insulated wall section. Polished concrete floors provide thermal mass.
Image by Victoria Myers

Straube makes an argument for these approaches most beautifully in his article "Can Highly Glazed Building Façades Be Green?"[7] The reason I am writing this book is that many architects don't understand the primacy of these concerns, or, even if they do, they ignore them in favor of visual effect. To be fair, our profession is so guilty of greenwash and wary of point-based rating systems with their own inherent flaws, as vituperatively argued by Joe Lstiburek in "Prioritizing Green—It's the Energy Stupid,"[8] that the minute a building is called "sustainable," we cry foul. It is time to bring true sustainability out of the margins of architecture, and architectural education, once and for all.

A Word About the Word "Technology"

This book is about integrating building performance with design. Often, this effort is misconstrued as applying "technology" to design, as if shielding living space from extreme temperatures, or capturing rainwater from a roof surface, is somehow a "technical" activity. Part of the problem is with the connotation of the word "technical" which has often come to mean "technically demanding or difficult."[9] The recent trend toward embracing biomimicry, or biomimetic architecture, puts the lie to this idea. In a world where termites can build an elaborate system for shading and ventilation, and beetles can collect fog and channel it for drinking water,[10] surely all "technical" solutions are not too demanding or difficult for architects to consider. It is true that students, when first introduced to these ideas and their manifestations in other buildings, tend to replicate them without an understanding of the principles behind them. In their eagerness to incorporate these intrinsically useful strategies, they may apply them to their designs in a stick-on fashion. This tendency can be overcome through greater familiarity with and understanding of the concepts underlying the use of these strategies.

However, let us go one step further, and break down the word "technology" and reclaim it for architecture. "Teknos" is the Greek word for "art or skill" and "logos" means the "the rational principle that governs and develops the universe."[11] I think that is something to be celebrated. The art or skill of discussing the rational principles that govern and develop the universe would be a handy thing for architects to have. This book endeavors to demonstrate that art, and give you the skills to use "technology" to support your architectural intent.

The Marginalization of Performance in Architecture

An example of the marginalization of performance in architecture was delivered virtually to my doorstep in the form of a small hut, built by students to be temporarily occupied for a fundraiser. It was constructed carefully, with elaborate joinery, a sleeping platform, a partial plywood enclosure, and shelves (Figure 1.6). After it rained the first time, a piece of translucent plastic sheeting and a blue tarp were lashed rather haphazardly to the top of the structure (Figure 1.7). I, and a group of building envelope consultants visiting my office, found it curious that a reasonable level of detail had been achieved in the constructive, spatial, and functional realms, when so little attention was paid to the bare necessity of the roof. The tarp was an afterthought, installed with no slope provided. Over the next few weeks, green pockets of water had formed as the tarp slumped into the holes between the overhead wood members (Figure 1.8).

There is clearly nothing wrong with using simple materials for simple purposes. For example, Shigeru Ban designed beautiful, inexpensive housing for earthquake victims in Turkey, using similar tarps as roof membranes. The film *Shigeru*

Figure 1.6
A temporary structure built by students has elaborate detailing and well-developed programmatic zones.

Figure 1.7
A tarp, viewed here from the underside, is used as a roof membrane on the temporary structure.

Ban, an Architect for Emergencies[12] describes the outcome well. The difference was his understanding of the primacy of the need to keep people warm and dry. His architecture provided these basic human comforts, allowing his temporary structures to serve much longer than anticipated.

Figure 1.8
Standing water remains in depressions made by the weight of ponding water on top of the tarp.

What Happens When You Ignore Building Performance?

I am faced every day with examples of what happens when building performance, particularly building integrity, is ignored in service of a seemingly higher goal. You, too, need only look beyond the surface of the buildings you encounter to start discovering these in your own community. By way of illustration, let me tell you about a church and its courtyard.

On a beautiful summer day, the courtyard is benign enough. It provides a serene garden to be viewed from the chapel, which is often the place used by families prior to funeral services. It is a lovely backdrop to the altar of this chapel and has been faithfully maintained by the church members (Figure 1.9). However, when seen in plan, it is the perfect storm. And all it takes is the perfect storm for it to fail. All of the roofs covering the portions of the building surrounding the courtyard slope toward it. This means that there are four downspouts emptying into plastic pipes that must run under the building and into the storm sewer system. These are fine, as long as they are not clogged. If they are clogged, they can back up and dump water at the weakest point in the system, which is often the less-than-watertight junction between downspout and drainage pipe.

Figure 1.9
A church courtyard is a restful spot for prayer and meditation and is maintained by the congregation.

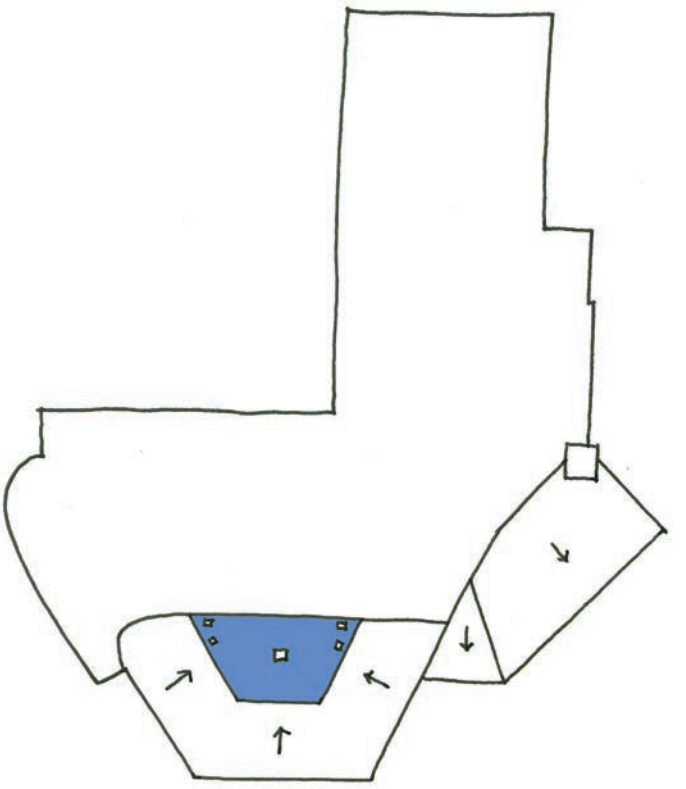

Figure 1.10
This diagram shows how four downspouts and an area drain route water off the roof and out of the courtyard.

Additionally, rain falling into the courtyard itself is essentially landing in a big, vegetated bathtub, which must itself be drained (Figure 1.10). This courtyard was fitted with such a drain, but over the years, the persons landscaping the area forgot it was there. Most casual gardeners don't expect to have to work around a drain when planting at grade. So, it inevitably was covered up by gravel, soil, and vegetation.

During a pounding summer thunderstorm, the spaces adjacent to the courtyard became flooded when water rose above the threshold of the door by which it is accessed (Figure 1.11). It was only then that the parishioners dug out the forty-year-old blueprints and rediscovered the area drain, and regarded the four downspouts that discharge into the area with any particular interest.

Perhaps there was no good way around this, in this case. The courtyard was claimed outdoor space that allowed light to simultaneously penetrate the sanctuary and the chapel and other ancillary spaces, all of which have strong adjacency requirements in this program. The exterior of the building, visible from a major thoroughfare, was designed as an unbroken façade; mighty fortresses are not generally punctuated by downspouts, so these were hidden in the courtyard. But this tiny piece of land could ill afford to be inundated with runoff from all of these sources at once, and it requires great vigilance to prevent this situation from recurring (which