chapter 1

Many Minds

People don't like change. But make the change happen fast enough and you go from one type of normal to another…

—said by novelist Terry Pratchett's character Moist von Lipwig in *Making Money*

FROM MASTER BUILDER TO THE TWENTY-FIRST CENTURY: WHERE WE ARE AND HOW WE GOT HERE

The Master Builder

The Industrial Revolution had profound effects on human society, especially on how we build in our *places.* Only a little more than 150 years ago, local natural and human resources were the basis and the limit for what was designed and built. The resulting process was far different from contemporary practice. The architects of that time were called *Master Builders.*

Master builders were schooled through local apprenticeships, and the techniques and technologies they learned were developed from an understanding of local issues and passed down through generations. Mechanized transportation was limited, so people possessed an intimate knowledge of local materials, as well as workforce skills, economies, cultural imagery and traditions, microclimates, and soil conditions. They understood the flow of local resources and what local conditions could be limiting. The built environment was designed and constructed from a deep connection to each individual place, with the master builder conceptualizing the overall pattern and each artisan, craftsman, and journeyman then contributing layers of richness and diversity at smaller scales. What resulted were buildings and communities that truly were integrated with their environment and that lived, breathed, and grew to become timeless elements of their place.

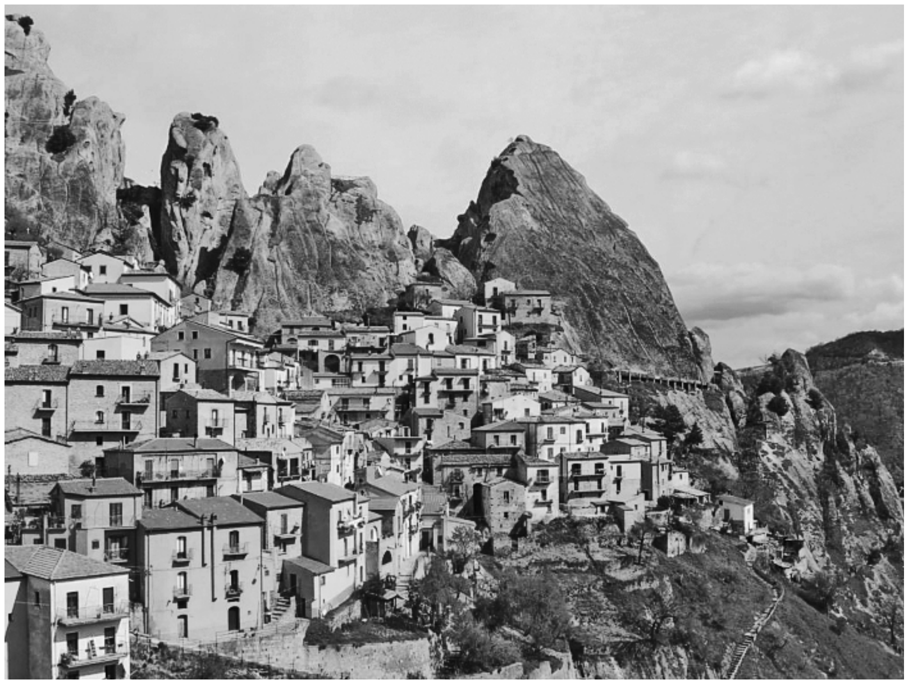
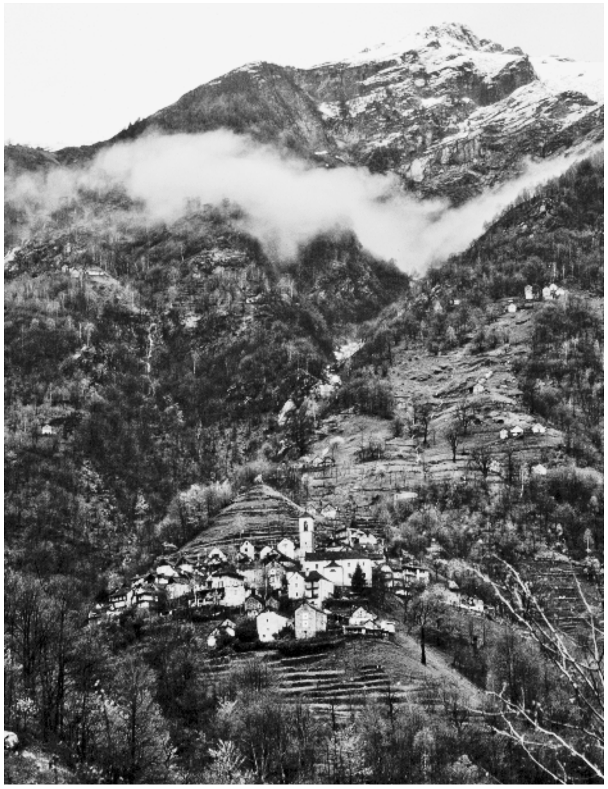


Figure 1-1 The peaks of the Dolomiti Lucane mountains in southern Italy (in the Basilicata region) surround and protect one of the most beautiful villages of Italy, Castelmezzano. Dating from the tenth century, the town's organic development pattern works with, rather than against, the natural formation of the mountains, and the town's buildings are oriented in alignment with the mountains to shield inhabitants from cold northeast winds and to capture solar heat from the south. *Image courtesy of John Boecker.*

Figure 1-2 This view from one of the fourteen surviving thirteenth-century towers of San Gimignano, the famous Italian hill town in Tuscany, reveals the town's connection with its surrounding landscape and topography—its source for materials, food, and protection for more than 1,000 years. *Image courtesy of John Boecker.*



Understanding this process, modern architect Mario Botta recently offered this advice after designing buildings outside his native Ticino, Italy: "Build where you live." Those that have visited Ticino may recall the magical quality of the centuries-old hill towns nestled in the Swiss-Italian Alps. Built of native stone and local alpine wood, using indigenous practices and traditions handed down through generations, these towns feel organic—as if they grew out of the landscape, blurring the line between the built and natural environment, presenting a unified place. To this day, these towns remain largely self-sufficient, sustainable communities.

Many of the buildings and communities that we respect and envy today were created in this way and still thrive after centuries of vitality—so much so that many have become popular tourist destinations. Sometimes, theme parks are built to replicate these buildings and communities with the aim of capturing some hint of the life and the quality they possess. But that quality cannot be reproduced in this way, because it was generated specifically by individual master builders' intimate process of building with and within their own communities.

▲ **Figure 1-3** This picturesque Ticino hill town, located in southern Switzerland, integrates seamlessly with its Alpine terrain, the stone of its structures seemingly growing from the mountain upon which it nests. It is a distinctly Italian-style town that relies on the local hills for its farming and the adjacent river for hydroelectricity. *Image courtesy of John Boecker.*

▶ **Figure 1-4** The town of Alberobello, a UNESCO World Heritage site, contains an urban concentration of more than 1,500 Trulli dwellings, dating from the mid-fourteenth century that are still in use and were made from limestone blocks collected from surrounding fields. These indigenous structures could be quickly erected and dismantled, utilizing ancient mortarless drystone construction for their distinctive conical roofs that draw off the heat of their southern Italian climate. *Image courtesy of John Boecker.*

Figure 1-5 Matera, the "City of the Sassi" in southern Italy's Basilicata region, has been inhabited since the Stone Age and is a protected UNESCO World Heritage site consisting of nearly 3,000 cave dwellings and 150 churches carved into the rock ravine of the Torrente Gravina on which it is built, an ideal and well-protected canyon for prehistoric human habitation. *Image courtesy of John Boecker.*

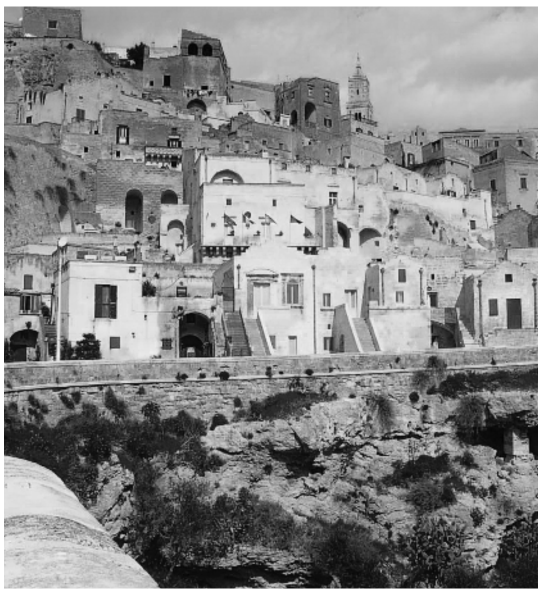


Figure 1-6 The cream-colored façades of Matera, built of local tufa stone bricks, are placed in front of the many natural grottoes and carved caves to serve as entrance structures. Rainwater collection in small pools and wastewater flows were managed for 9,000 years via an ingenious system of tiny canals until overcrowding between the two world wars rendered Matera uninhabitable. Legislation in 1952 mandated restoration of the Sassi, and many of the cave dwellings and churches have been restored, transforming Matera into a breathtaking "living museum." *Image courtesy of John Boecker.*

Figure 1-7 Since structures are constructed into the rock of the ravine's steep slopes, houses were layered atop houses, so it is not unusual to encounter chimneys when walking through this ancient town, before realizing that winding roads, gardens, and other structures rest on the roofs of dwellings below. *Image courtesy of John Boecker.*

When we experience the buildings and communities that were created within the master builder process, we can see how truly integrated that process was at every level. Each person that contributed to these structures was thinking and working from a unified schema derived from a shared understanding of local patterns. This cohesive intelligence ensured that each craftsman's individual contribution would be perfectly integrated within the whole of the built environment. Not only were they working from the same place physically and culturally, but these craftsmen were also in a sense working from the same mind.

The Siena Duomo

Medieval cathedrals are familiar examples of the type of powerful coherence that characterized the built environment of the master builder. Recently we had the opportunity to visit in Italy the Duomo di Siena (cathedral of Siena), originally designed by master builders Nicola Pisano and his son Giovanni, along with pupil Arnolfo di Cambio. The Siena cathedral was largely completed between 1215 and 1263, under Pisano's guidance, with layers of work integrated into his original conception by Donatello, Michelangelo, Gian Lorenzo Bernini, and others.

The Siena Duomo occupies the highest point in Siena and seems to grow right out of the landscape, adding a physical and spiritual pinnacle to the rocky plateau. The cathedral is built primarily of local marble that the town's inhabitants gathered from nearby quarries and carted back to town. These indigenous marbles create a consistent color palette of black and white stripes with green and yellow accents. The entire complex is beautifully integrated into its place—born of the place and the people that lived there.

Figure 1-8 The awe-inspiring Siena Duomo (cathedral) appears to have grown out of the plateau upon which it sits, integrating seamlessly with its surroundings as a pinnacle that towers above the medieval town built into the hills below. *Image courtesy of John Boecker.*

Figure 1-9 The striking Romanesque marble banding of the Siena Duomo's campanile (bell tower), which was added in 1313, extends the pattern of the cathedral's exterior materials. Almost all of the marble used for the cathedral was harvested by inhabitants of the town from local quarries. *Image courtesy of John Boecker.*

Figure 1-10 Daylight streaming in from the gallery windows of the cathedral's nave highlight the signature marble stripes of the Duomo's columns. *Image courtesy of John Boecker.*

Inside the Siena Duomo, a magical vaulted space is supported by ordered rows of stone columns and piers comprised of the same horizontal black and white stripes that dominate the exterior. On a recent trip, we noticed that only a few, seemingly randomly placed columns were not striped. After looking closely for a while, we realized that these anomalous columns were far from randomly placed but were located to establish spatial hierarchies within the overall space. This architectural cipher communicated a semiotics, a natural language within the whole that revealed additional layers of meaning.

The marble floor mosaics throughout the cavernous space within the duomo remain among the world's most exquisite, each conceived and executed by a master artisan within a consistent overall pattern, each telling its own tale within the biblical stories depicted. From 1372 to 1547, these fifty-nine floor panels were executed by Siena's top artists. On our trip, we chatted with an old man we met repairing a small area of this

Figure 1-11 The Duomo's mosaic floor panels depict Old Testament stories, framed by intricate patterns of local marble, composed by Siena's top artisans. *Image courtesy of John Boecker.*

Figure 1-12 Meticulously executed geometric mosaic flooring patterns throughout the Duomo evoke the colors of indigenous materials used throughout Siena. *Image courtesy of John Boecker.*

marble floor. He told us that he was a descendant of the original fourteenth-century master masons, who were trained locally in a craft lovingly sustained and nurtured through generations for over seven centuries. We watched as he honed the three-inch-thick marble pieces to fit together seamlessly, with hairline joints crisper than a jigsaw puzzle.

In the 1300s, the townspeople began the construction of a transept that would make Siena's duomo the largest cathedral in Christendom. This monumental addition was intended to continue the same pattern of the structure's spatial choreography, which begins at the end of a journey through the narrow, climbing streets of the medieval town. This effort was abruptly abandoned in 1348, when over 50 percent of the town's population fell victim to the plague. What remains is a ghostlike figural void that was conceived as a roofed interior space but left virtually untouched as an exterior, "urban" room for 650 years. The space is striking in its authenticity, and acts as a permanent commemoration of the place's history.

In its totality, this spectacular cathedral complex embodies more than 350 years of continuous work, all generated from an original thirteenth-century conception that was rooted in a deep understanding of the unique interrelationships of its place, integrating landscape, materials, workforce, cultural semiotics, traditions, art forms, local climate, habitat, and urban development patterns. Nearly eight centuries later, it still leaves us marveling at the awe-inspiring result, an

accomplishment almost beyond imagining today—and on the hottest summer day, it remains the coolest space in Siena for taking a quiet respite from the sun's heat.

THE AGE OF SPECIALIZATION

With the Industrial Age came advancements that removed many of the limitations that had kept the master builder management structure in place. The evolution toward global transportation and communication meant that building materials and other resources need not be locally available and could come from anywhere. As new materials and technologies were rapidly and increasingly introduced, specialists were needed to resolve and implement the complex aspects of electricity, lighting, ergonomics, heating, cooling, ventilation, municipal waste systems, water supply, automatic climate control, smart buildings, and more; and each of these systems is now designed by different and separate professionals, and optimized in isolation.

▲ **Figure 1-13** A journey though Siena's organic labyrinth of narrow medieval streets offers countless hidden and sudden views, a spatial choreography culminating at this final portal, which frames the Duomo's campanile, before arriving in the exterior space of the would-be transept nave. *Image courtesy of John Boecker.*

▶ **Figure 1-14** Looking back on the arrival portal to this exterior space reveals an "urban room" as it was in 1348, when the plan to create an interior space expanding the Duomo was thwarted by the arrival of the Black Death. *Image courtesy of John Boecker.*

Where we once had one mind—a unified intelligence—conceptualizing and integrating patterns born of the place and its people, we now involve anywhere from dozens to hundreds of disparate companies, organizations, and individuals in designing our buildings and their components. In other words, we entered what might be termed the Age of Specialization. We have fragmented the whole into myriad separate pieces.

In short order, we moved from a time of commonsense integration into a period—now more than a century and a half long—of "it's-not-my-job" specialization and "this-is-not-my-area-of-purview" disintegration. On a recent project, for example, we worked hard to convince the civil engineer that we needed him at our first predesign, goal-setting integration meeting with the owner and all members of the design team. He said, "Well, why do I need to come? You guys haven't started designing; there's nothing for me to do yet." But with some support from the owner, we were able to convince him to attend this all-day, team goal-setting session. Early on that day, after spending a couple of hours walking through site issues and discussing preexisting site forces, conditions, flows, constraints, and opportunities, the civil engineer got up to leave, saying "OK, the rest is not my job—I'm only responsible for everything five feet from the building and beyond. You guys do whatever you want inside that…just tell me where I need to hook up your systems."

This is not to say that good work is not being done. Each specialist possesses tremendous skill for designing and optimizing the systems and components for which they alone are responsible. However, our design process is such that only pieces are optimized and not the whole. Each of these professionals is designing fully within the silo of their discipline, and the interaction between each discipline is usually kept to a minimum—limited to ensuring, for example, that the electrical engineer's supply system provides adequate power to the mechanical engineer's specified heating, ventilating, and air-conditioning (HVAC) equipment. The optimization of the building's individual systems is primarily done in isolation, based on rule-of-thumb conventions that target abstract, generalized standards. These systems are then assembled into a building.

STOP AND REFLECT: OUR CURRENT PROCESS

Siloed Optimization

We often ask our clients at the very inception of a project to reflect on today's design and construction-delivery methodology. Let's see if this sounds familiar: The project starts when the architect meets with the owner to discuss the program for the building to determine the required spaces, as well as their sizes and functions, and the relationships and proximities between them. Once this program has been documented, the architect produces a series of iterative sketches over weeks or months and presents them to the owner until they agree that everything is the right size, in the right place, and "looks good," essentially completing schematic design. These drawings are then sent to each member of the team of professionals assembled: the HVAC engineer, the electrical engineer, the plumbing engineer, the structural engineer, the civil engineer, the fire-protection consultant, the landscape architect, and others—all of whom are specialists within their disciplines, possessing tremendous acumen and skill in optimizing their systems.

The optimization of each individual system is done primarily in isolation, based on rule-of-thumb conventions and standards. Then, after each system has been designed, the drawings are sent back to the architect, who *ostensibly* coordinates everything—making sure that ducts do not run into sprinkler piping, structure, and so on. The architect then issues a final set of design documents, which results in an estimate for a building that more often than not is over budget, so we resort to "value engineering." You likely have heard the joke that value engineering is neither—since it is certainly not about value nor does it require engineering. In other words, the building is made cheaper by cutting out pieces, reducing scope, or both, often by plucking away any "green" components that appear to represent low-hanging fruit, because they were conceived as an additional layer of desired elements—in essence, eliminating things that the owner originally wanted. Once the project is back on budget, a final set of construction documents is created in the form of a large stack of drawings and a much larger stack of bound-paper specifications, which we then issue for bidding.

The Abyss Between Design and Construction Professionals

For the sake of argument, let us say that the scenario above describes a twenty-million-dollar building. How many people were involved in the building design process from the beginning of the programming effort to the day the bidding documents are put out on the street? Definitely dozens, even hundreds, if we include all of the equipment manufacturers and product representatives involved. How long did the process take? A year? Eighteen months? Two years? By doing the math, it is easy to see that what is embedded in that set of bidding documents equates to hundreds of thousands of person-hours of research, analysis, decision making, and documentation. And then what do we do? We give construction professionals (who typically are not involved in the design process) four weeks to bid on these documents, which really means two weeks or even one week, based on our conversations with contractors.

Not only are we giving contractors only a week or two to understand hundreds of thousands of hours' worth of information, but we are also asking them to put a *price* on that understanding and, further, to commit contractually to meeting that price. Then, we select the *lowest bidder,* which essentially means that we end up awarding the construction contract to the team that understands the project the least!

It gets worse. If you look around the room you are in right now, it is likely that you will see dozens of products. The chair you are sitting in, the pants you are wearing, the cup you are drinking from. Every one of these products is produced dozens if not hundreds or tens of thousands of times, built over and over again with plenty of opportunity to work out the bugs and quirks, usually accompanied by some level of quality control. However, in the case of a building—likely the most expensive product a person will buy in his or her lifetime—every single new building is entirely unique. It has never been built before. It will never be built again—even if it is a prototype that is being site adapted, the team of professionals is different, making it an absolutely unique product. Furthermore, every one of the products in the room around you was designed and constructed by the *same entity*. Our buildings, though, are designed by one set of design professionals and constructed by an entirely different set of construction professionals, with no interaction between the two of them whatsoever until construction begins. Not only does an abyss exist between these two sets of professionals, the contractual arrangement between the two actually renders them adversaries! It seems that we have created a perverse construction-delivery methodology from beginning to end.

This conventional process creates buildings that are no more than the sum of their parts—and sometimes less. The most striking innovations remain unleveraged, as any improvement that occurs is confined to its silo and secluded from the whole. The process more closely resembles assembly than integration. And because the assembly is, in a way, blind, we often face redundancies, unnecessary costs, and a great deal of wasted time and effort.

It is not surprising, then, that data from the Lawrence Berkley National Lab from a 1998 study indicates that 90 percent of U.S. buildings have either systems controls problems or nonfunctioning HVAC components upon occupancy and during the first year of operations. Further, 15 percent of our buildings are actually *missing* components that were in the construction documents and purchased by the owner in the construction contract. This is no secret to design and construction professionals. In fact, of the hundred thousand or so design and construction professionals to whom we have presented in the last ten years, when asked "When was the last time you were involved in a project that, after it was constructed and occupied, had no HVAC problems?" only one person has ever raised his hand. This person got us very excited, so we said, "Tell us about your HVAC system." He replied, "There wasn't an HVAC system. It was a cabin in the woods."

Doing Less Damage by Adding Technologies

The very system by which we certify our green buildings is illustrative of the assembly-like nature of our process. When utilizing LEED® (the U.S. Green Building Council's Leadership in Energy and Environmental Design Green Building Rating System), we whip out the LEED scorecard and begin assessing which credits are applicable and achievable. We walk the team through a credit-by-credit analysis, asking the architect, the engineers, and design team members to think about how they can make their systems and components greener by meeting the requirements of the applicable LEED credits. We ask them to consider how they can reduce the environmental impacts associated with their work in order to reduce automobile use, site disturbance, stormwater runoff, heat-island effects, and water and energy consumption. Each team member identifies and commits to the points that are achievable from within their discipline, and at the end of the day we add our points up to see whether we can target a silver, gold, or platinum rating.

Each project team member is then assigned LEED credit responsibilities, and each begins designing his or her system with the mission to achieve the identified LEED points assigned to them. For example, these responsibilities on a typical LEED project might generate the following activities:

The *Civil Engineer* adds the design of a retention basin to hold a greater percentage of stormwater on site and reserves several parking spaces for carpooling.

The *Landscape Architect* adds trees to the south side of the parking lot for shading, a bike rack, and more areas for vegetation, as well as native planting materials that do not require permanent irrigation; the landscape architect also changes site pavement materials to lighter colors.

The *Plumbing Engineer* specifies low-flow lavatory faucets, waterless urinals, and a high-efficiency domestic hot-water heater.

The *Mechanical Engineer* adds energy-recovery units, variable-speed fans, carbon dioxide sensors, and air-conditioning components that contain non-hydrochlorofluorocarbon (HCFC) refrigerants, and designs a ground-source heat pump system for heating and cooling.

Figure 1-15 A cabin with a fireplace in the Adirondacks is free from any HVAC problems. *Image courtesy of Todd McFeely.*

The *Electrical Engineer* adds a few more (but lower wattage) exterior cutoff luminaires in the parking lot, some photovoltaic panels, a few more energy-monitoring sensors, and also specifies individual lighting controls and high-efficiency compact fluorescent lighting fixtures throughout, tied to photocell sensors and dimming ballasts for daylight harvesting.

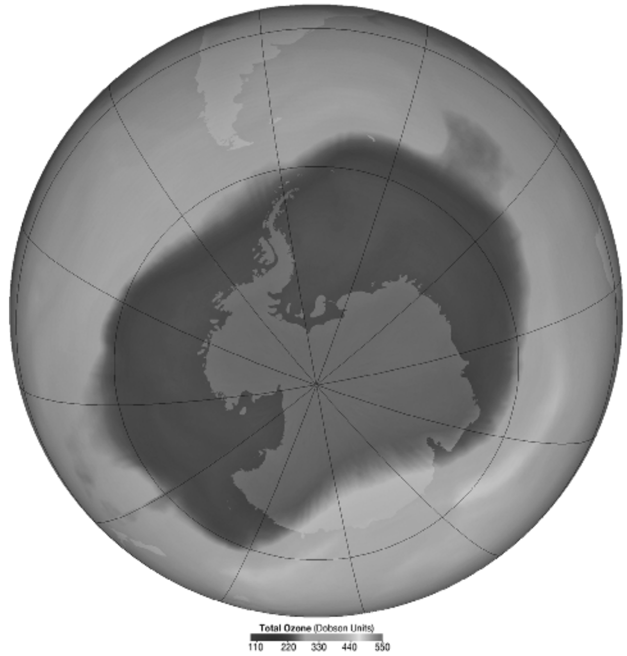
The *Architect* adds insulation to the walls and roof, several skylights for daylighting, a vegetated green roof, a few more windows comprised of triple-glazed systems for high performance, and specifies "greener" materials, such as drywall made from 100 percent recycled content.

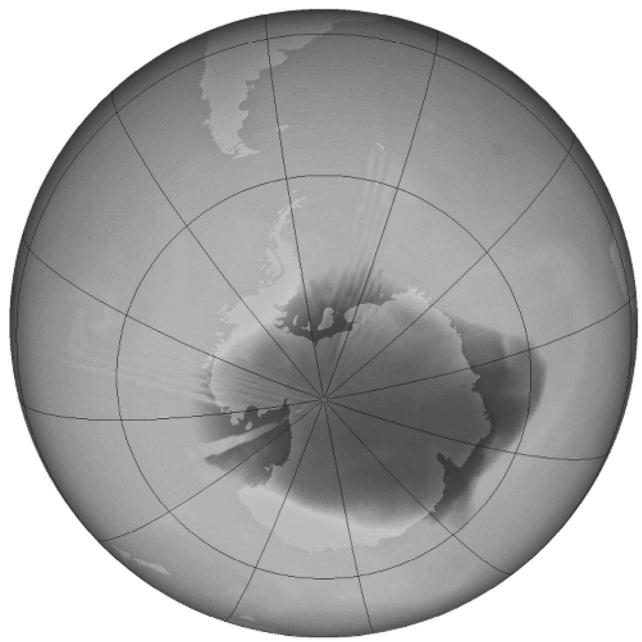
The *Interior Designer* selects paints with low or no emission volatile organic compound (VOC) content, high recycled-content carpet, certified wood finishes, and rapidly renewable cork flooring.

The *Owner* commits to hiring a commissioning authority, a construction waste manager, and an indoor air quality testing agency.

Once all these technologies are added and the building is constructed, we have a successful green building that does less damage to the environment. Hundreds of these buildings are being constructed as you read this—they are doing their part by hurting the planet less. But where does that leave us? If you have a planet filled with millions and millions of buildings that do *less* damage, you still have not solved the problem. With thousands and thousands of talented design and construction professionals working with brilliant minds and genuine caring, we need to accomplish more than simply doing less damage—we need to do better than just slowing our way down our collision course.

There are many problems that arise with this unholistic, unintegrated approach, the most significant of which is the lack of a clear leverage point or an accepted and established methodology for changing the way that we build. Given the magnitude of the challenges that we





▲▲ **Figure 1-16** The largest ozone hole over Antarctica, recorded as of September 2006. *Image courtesy of National Aeronautics and Space Administration (NASA).*

▲ **Figure 1-17** This image of the ozone hole in December 2007 offers hope that the Montreal Protocol on Substances that Deplete the Ozone Layer, which entered into effect in 1989, is having a positive effect. *Image courtesy of NASA.*

face, it will take nothing less than a massive transformation to get us out of this mess. How might that transformation occur? Where in our current design process exists the point at which we might intervene to create large-scale change? The answer, simply, is that it *does not exist* within the current process.

THE CALL BEFORE US

As our collective values have shifted toward the pursuit of sustainability, great innovations have been made. Thousands of the best and brightest professionals are devising ways to improve the efficiency and reduce the impact of what they design. But we are still designing within a process that belongs to the Age of Specialization, and thus our solutions and approaches to sustainability are as fragmented as ever. When a technology is proposed as a solution to a green building issue, we are in effect saying that we have the answer for you. But do we? Have we even asked the right question?

These are urgent times. Depending on which reports one reads, we have only a little or almost no

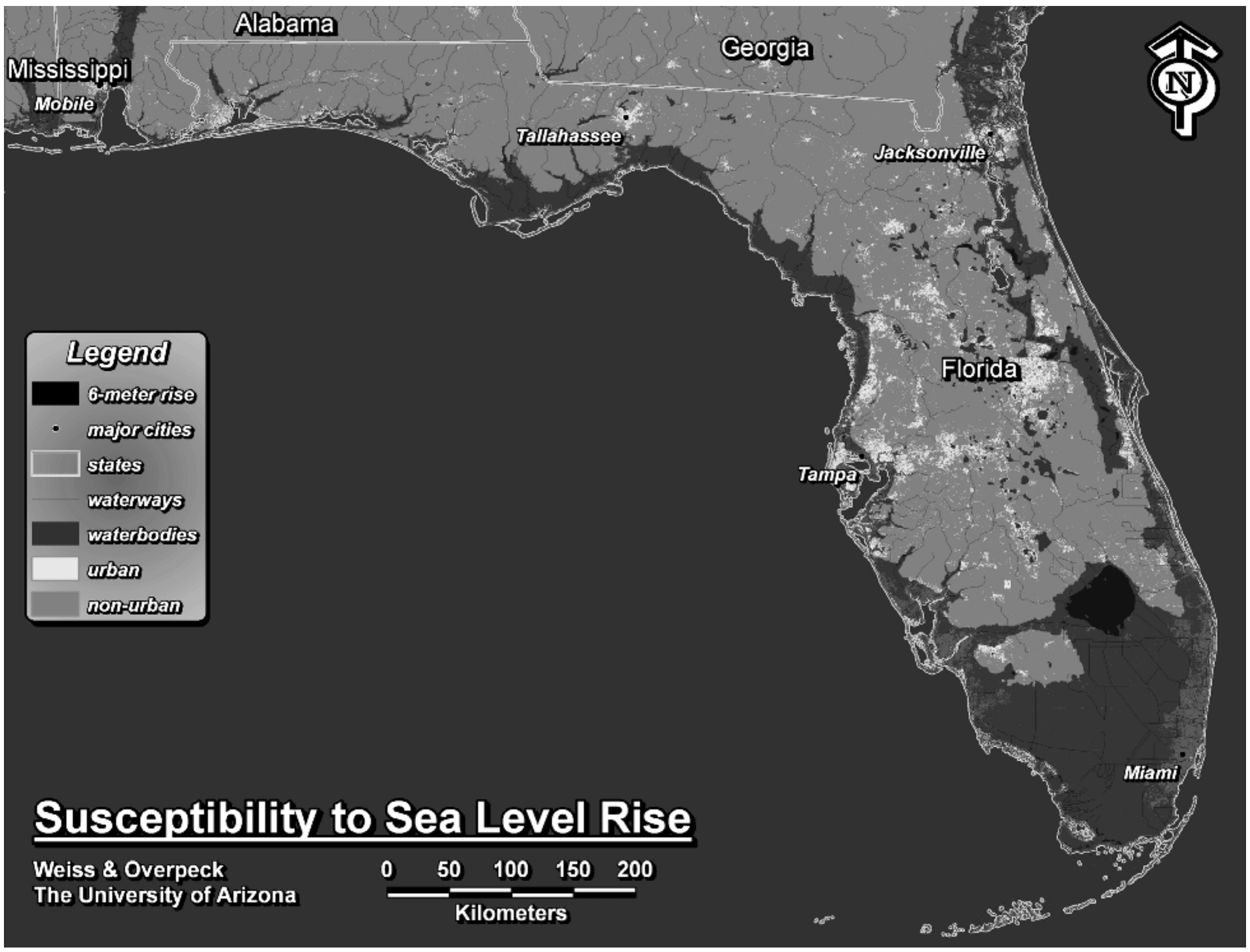


Figure 1-18 Computer simulations of rising sea levels resulting from global climate change, such as this image of Florida, indicate that millions of people residing in coastal areas around the world may be displaced. *Image courtesy of Weiss and Overpeck, University of Arizona.*

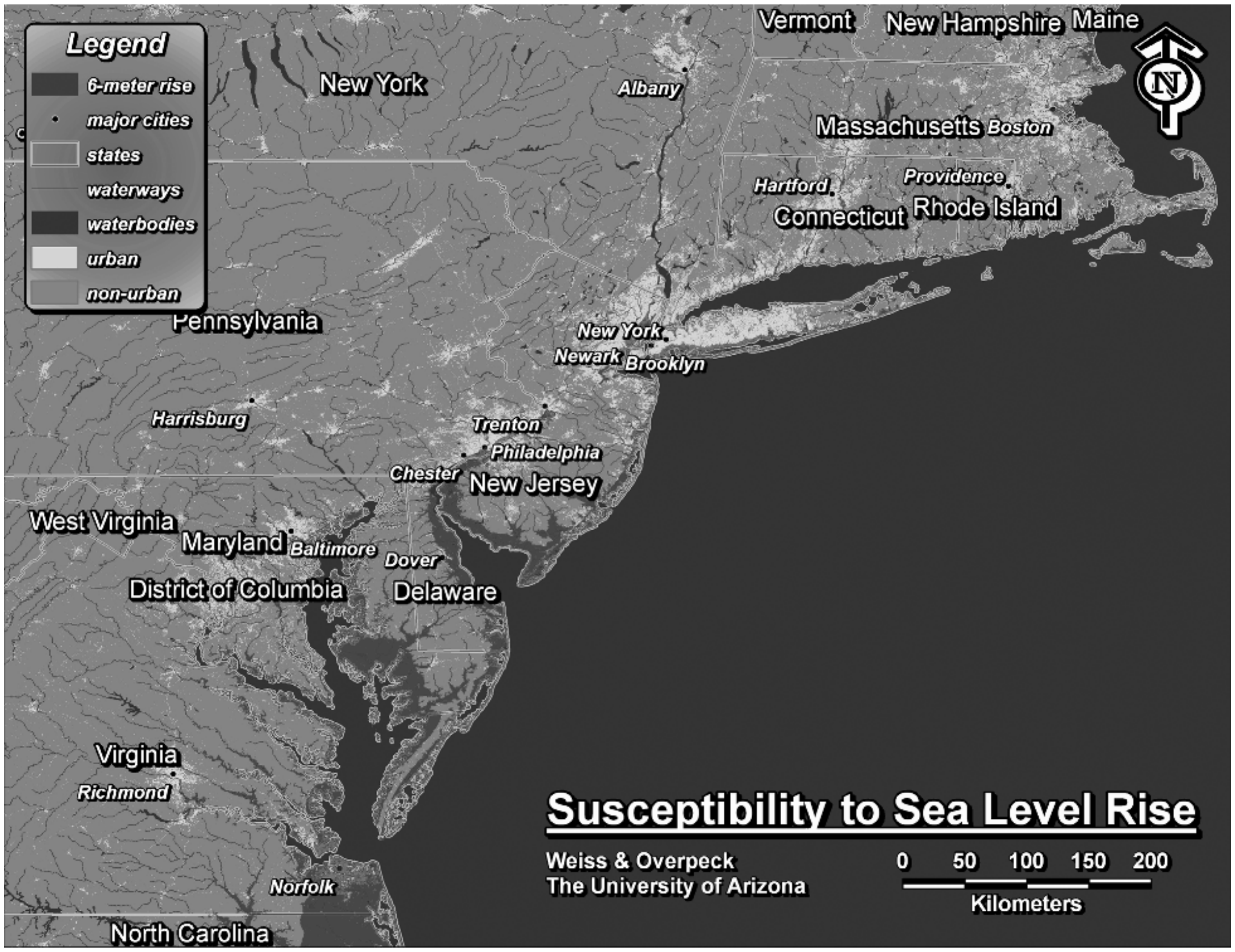


Figure 1-19 On the East Coast of the United States, rising sea levels could wipe out many major urban and residential areas. *Image courtesy of Weiss and Overpeck, University of Arizona.*

time left to change. There is a call to action before us—change the way that we build, or the Earth will change it for us. If one part of the building improves, it remains just that—an improved part. We are working brilliantly toward creating highly efficient *pieces* of buildings, but the world's most efficient HVAC system, unintegrated with the whole, is but a drop in the bucket compared to the magnitude of change that we need to create. The process by which the master builder produced such enduring and vital places has been lost, for the practice of development has become far too dynamic and complex for such a process to function. Even understanding the systems within a single building has become too complex for one mind, one person, to grasp completely. What is being called for is a new process of integration for the many minds devoted to each project and a new process for building the more complex systems that we inhabit.