1 / HOW MAY WE APPROACH TRULY GIGANTIC CONSTRUCTION PROJECTS

The intricate and context-specific adaptation that shapes every detail differently is a necessary structural feature of all life. You cannot have a single organism or a forest without it. You cannot have a living building without it.

But even the sympathetic reader will have asked himself if this adaptive care, described in many of the foregoing chapters, can actually be implemented at reasonable cost and at reasonable speed and in reasonable quantities. Can this be done today? How are we to have this quality in the modern industrial world?

In the traditional world, labor was cheap, time was elastic. Craftsmen could spend weeks, months, years patiently shaping each stone, or brick, to fit a wall, and could make each part with loving care so that it fit, perfectly, into the harmony of the whole.

In the modern world, labor is expensive, money is all-important, and time whizzes by; speed is most essential of all. Much building production hinges on mass production and assembly of millions of identical components. How then — realistically — in the modern world can we get the subtle fine detail of adaptation, variation, and harmony which makes every component slightly different, and yet do it at the break-neck speed of modern giant projects and in the colossal quantities required for the largest projects? Can there really *be* living structure in this modern world?

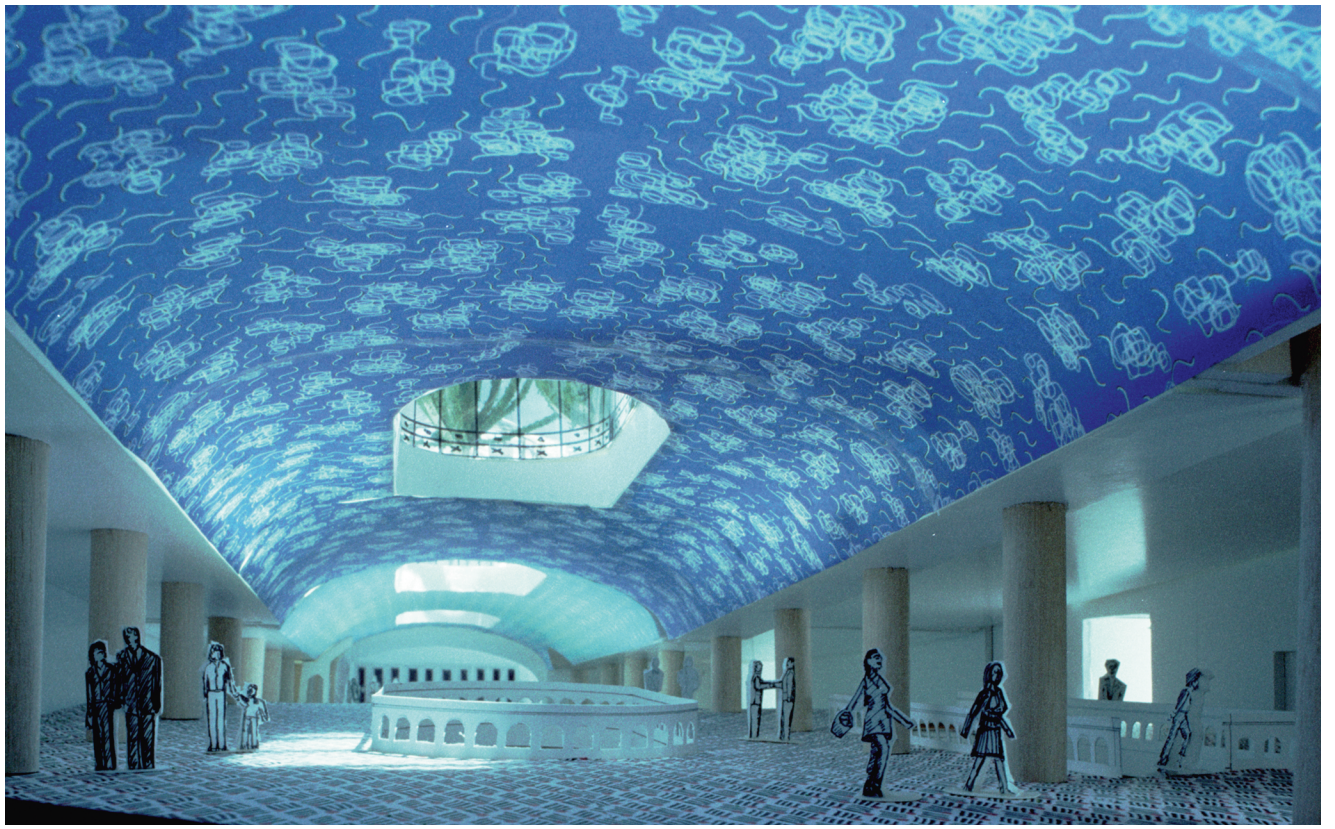
A person reading the overall approach to design and construction described in THE NATURE OF ORDER, especially the approach described in this volume, may say to himself, "Well, all this is fine for small buildings, intimate neighborhoods, and so on . . . but it is, in principle, inconsistent with the scale of airports, massive downtown high-rise buildings, museums, opera houses, and so forth. It has too little to say about the mass production of components and the production of giant buildings which especially characterize our modern age."

In this chapter I shall therefore describe a new form of production which we may call *high-speed adaptive production*, and discuss some of the conditions which may allow us to obtain beautiful and intimate results, even in the most gigantic projects. We shall aim to achieve this goal by careful harvesting of high-speed mass-production techniques, personal technique, computer-aided technology, new ways of managing and dividing items within a giant project to create the best effect — all ways, in short, which are economically feasible in our time and will be in the future, as ways of creating things with a depth and intimate relation to ourselves that seemed impossible in the 20th century.

2 / HIGH-SPEED ADAPTIVE PRODUCTION: TECHNICAL PROBLEMS THAT MUST BE SOLVED

I shall show in this chapter that it is possible — I do not say easy, but I do say certainly *possible* — to conceive new forms of on-site fabrication which allow every part to be just right, without upsetting the enormously high-speed production that is today considered necessary for giant projects.

To grasp fully the significance of the concepts which have been described in Book 2 as they have impact on giant projects, it is necessary to develop altogether new production processes especially for the largest building projects. These need to be based on concepts of production able



Concourse of the underground Megaron Musikis Atheni, in Athens, using a new form of production in which a giant project is built by methods that unite uniqueness of detail, personal quality and adaptation of components, with high-technology machine methods. Christopher Alexander, Randy Schmidt, Demetrius Gonzales, Bankoku Sasagawa, 2001.

to deliver the multiple adaptations and uniqueness promised in Book 2, while maintaining standards of speed, cost accounting, high quality, efficiency and time control.

The processes must deliver high-volume, high-efficiency production that were typical of 20th-century mass production while *also* delivering a new standard of uniqueness, love of art and craft, and careful adaptation of detail and variety which was common in the production of the pre-industrial, pre-literate centuries a thousand years ago.

To accomplish this seeming tour-de-force, it will not be sufficient to try for some kind of *mixture* of the two systems of production. Rather, what will have to be provided is a new form of process, a uniquely 21st-century and ultra-modern form of process, different from those of the 20th century, and also vastly different from those of the 12th century: a new kind of process, altogether new, in conception, detail, execution, and conceptual structure.

We are to witness the idea, therefore, of an entirely new, ultra-modern form of process and production not seen before in human society.

Some of the key features of the new process configuration which are to be discussed include the following:

- *Extensive use of computers.*
- *Extensive use of handcraft and hand-eye sensitivity translated to component manufacture through computer-intense technology linkage.*
- *Partial prefabrication undertaken to allow detailed on-site adaptation and adjustment.*
- *Off-site production.*

Interior of the main concourse for the Athens Megaron, looking towards the opera house and the atrium in front of it. The floor designed for this concourse, reflecting computer methods, speed, and efficiency of production, is shown on page 573.

- *Off-site testing of partially completed configurations.*
- *Use of ultra-high-technology cutting and forming equipment.*
- *Further adaptation on site at time of installation.*
- *On-site modification of pre-formed components.*
- *Adaptation in off-site mockup facilities.*
- *Subtle adaptation of shape, color, geometry, and form of components as the on-site space develops in shape and degree of completion.*

In the next few pages, I shall consider this kind of new adaptive process in a form worked out for a specific project, a huge underground complex of public spaces in Athens involving more than two acres of floor area in the public concourses alone.

The existing Megaron of OMMA (the Organismos Musikis Megaron Athini) is the largest Concert Hall in Athens, and was to be extended further by a vast extension including underground opera house, concert hall, conference center, library and so on. I was approached by the president of OMMA, and was told that he had a personal passion for the marble floors of the early medieval Italian churches and wanted to do something similar for the floor of the new Megaron. I was introduced to him as someone who understood these early Italian floors, and who might conceivably be able to make what he wanted in a 21st-century form. I wrote to Mr. Lambrakis and described something of my own passion for the Italian floors and my experiments over the years in making comparable marble floors by ultra-modern means. I told him I would make calculations and preparations for production by high-tech means, spanning both California and Greece.

The floors and ceilings of the music library lobby in the new Athens Megaron.

The luminous ceilings visible in these photographs are fabricated by the technique described on pages 576–77.

3 / SLOWLY CREATED HARMONY IN A MASSIVE PROJECT: THE EXAMPLE OF THE ATHENS MEGARON

The techniques we developed relied extensively on our collaboration with marble cutter Larry Berk, Watsonville, California. As we entered the project, I was astonished to find out that the total area of the floors OMMA wanted in the building was about two acres: some 8,000 m^2 of multicolored marble floor, many times what had ever been built in a medieval example, yet still including thousands of tiny pieces, each adapted in shape, form, and color, to its particular circumstances.

In very preliminary calculations, knowing the level of detail and number of pieces, I calculated that this floor would probably contain some 400,000 pieces of various colors and shapes.

In the original Italian floors made in the 12th century such floors were made laboriously, each piece cut and laid by hand, even a very small floor taking months and years for the craftsmen to make. It was this slowness, the slowly created harmony and painstaking care, which made the floors so beautiful. Built today, anything made that way would be prohibitively expensive since labor rates (relative to materials) have increased so much (from 10% of the job cost in the 12th century to about 60 or 70% of the job cost for a project of this kind in modern times). It would also be prohibitively time-consuming; this new floor we were asked to make for a major concert hall in Athens had to be made under economic conditions of modern labor rates and under the pressing conditions of our modern attitude to time.

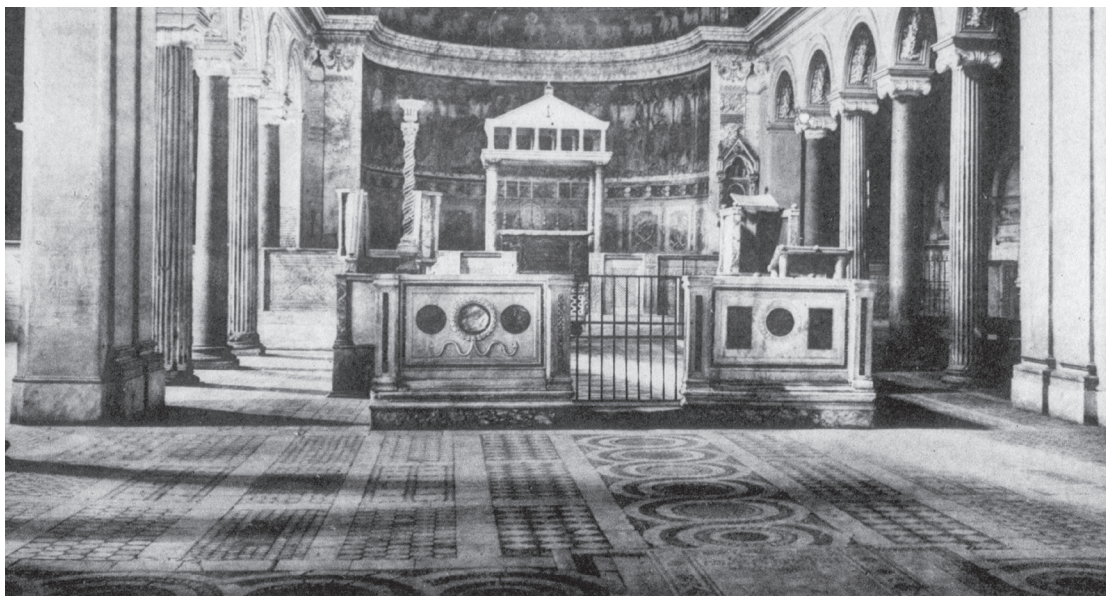
Indeed, when I asked how long we would have on the job to *lay* the floor — recognizing that the building was a $150 million project with four huge general contractors and massive efforts going into place every day — I was told that we would be allowed continuous access to the slabs for only two

months to complete and install our part of the work. The whole floor, all two acres of marble and all 400,000 pieces, had to be completely laid, ground, and polished in two months.

We were thus facing, in microcosm, the massive problem which has persistently faced large-scale construction in the modern era. Because of labor rates and time pressure, construction has to move in very large volumes and at a massive rate, otherwise it becomes too costly in time and money. During the 20th century, as a result of these conditions, work was typically crude, governed only by the capacity to go fast and cheap — and this led to the devastating loss of personal quality and of local order and adaptation which the four books of THE NATURE OF ORDER are all about.

The question is, under our modern conditions where labor rates *are* high, and where the need for speed *is* pressing: Can we hold cost constant and yet construct large works in a way which is profound, personal, detailed, and loving — yet still respectful of these necessary conditions that are nowadays imposed by the modern era?

4 / THE CORE OF THE SOLUTION: A COMBINATION OF LARGE NUMBERS, HIGH SPEED, MINUTE ADAPTATIONS, CRAFT, AND COST CONTROL



A beautiful floor from the basilica of San Clemente in Rome, made about 12th century. The apparent roughness of this floor is far from random; its roughness is necessary to achieve the coherence and complexity of the overlapping figures in the design. In principle, such a floor design CANNOT, IN PRINCIPLE, be made well from modular components.

In conventional late-20th-century methods, a problem of this kind was typically solved by using mass-production components and trying to get variety and complexity by random arrangement and combination of these mass-produced components. However, this sort of technique, though it did occasionally create an impression of something lavish, was not able to capture the stunning beauty of the medieval floors, simply because that beauty relied on inch-by-inch vari-