The Control of Complexity

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How can we design large projects without necessarily imposing uniformity and rigidity where variety and adaptability over time are desirable? How can the big project nevertheless do justice to the small scale?

There are good reasons to believe that variety and adaptability yield a better match between the built environment and the life it shelters. Moreover, the state of the art in building technology suggests that there is not necessarily a conflict between efficient production and variety of form. In fact, variety might be the logical outcome of efficient production.1

If neither the use nor the technical means dictate uniformity and rigidity of built forms, design skills may become the weakest link in the chain. The design of complex, varied forms that are adaptable over time and nevertheless easy to control and to build demands new methods and skills.

In turn, such new methods and skills must come from a good understanding of the structure of complex artifacts. And much can be learned from the study of environments with a high degree of spatial complexity to find out what their structure is and what processes could make them come about. In this context, the studies done by Fernando Dimyenko are most valuable. His meticulous documentation of vernacular environments of high density in cities like Santiago (Chile), Madrid, Cambridgeport, Córdoba, and others gives us a wealth of information that can be interpreted and studied. An interest in these environments has nothing to do with a romantic yearning for past conditions. We are not looking at them to copy but to learn how today structures of similar sophistication and resilience may come about in accordance with the means we have today. In a similar way, Maurice Smith of MIT has studied the Portuguese hill towns and found consistencies in dimension and spatial organization that are useful for present day designing. What we look for and what we are interested in here are systemic properties from which complex environmental organizations can be built.

In what follows, I will discuss a number of issues that have to do with understanding complex environmental forms and their design manipulation. These are, if you like, areas of knowledge and skill of interest in a search for new methods. They have been the subject of discussion and experimentation in my course on design methods in the postprofessional degree program (M.S. Architecture Studies) at MIT.

Transformation

First, and possibly most importantly, it should be...
noted that architectural form may result from a process of transformation. Suppose we set up, by way of demonstration, two columns and a lintel spanning them. This primitive configuration, when studied, leads to a number of alternative next moves. We may expand with another column and lintel. This may be done in alignment with the first beam or at an angle to it. Or we may repeat the portal at a distance parallel to the first, which would allow us to put planks from beam to beam and make a floor or roof. The choice of any of these steps leads to new alternatives.

This basic exercise gives us the ingredients of a design attitude. We see in the form at hand the moves available to us. We enter in a dialogue with the form. Our freedom is in choosing the next move; our skill is in choosing what leads us in the general direction we must take to satisfy a demand or a strategy; our knowledge and experience lie in being able to find many alternative moves.

The result of such a humble beginning, if the process is continued, can be very complex and very rich. But nothing in it needs to be done by happenstance, and all steps are accounted for technically as well as architecturally.

This very beginning is initially found difficult by many designers for a number of reasons. First, it can only be done from a knowledge of and interest in the way the building is actually built. Columns have certain properties, and these suggest next moves. There is a difference between a concrete portal or a steel one or free-standing columns with a lintel on top. All three alternatives are interesting to work with, but the moves we can choose from them are different. When the design is too abstract, anything goes. There can be no dialogue with the form. In short, one can only work this way if one believes a building can only be designed when one knows how it is built. I should point out here that the same knowledge about building allows us to generalize. For instance, we may decide later whether to use concrete or steel portals while we reject early on the free-standing column. The requirement that we design from a knowledge of the building system does not mean that we must decide everything now or cannot change our mind as we go.

A second difficulty students have with this exercise is that there is no program. They are asked not to think of any guiding functional demands. For those trained in a culture in which one justifies one's architecture functionally, this is difficult. Even designers who embrace the idea of an autonomy of the form find out how heavily their design
2. Thematic exploration of a contained form. The study focuses on the transition from the outside space of the courtyard toward the inside spaces around it, resulting in a number of different concentric spaces. From a class assignment by Sergio Pallaroni, M.S. Arch. St. program, Massachusetts Institute of Technology.

3. Thematic transformations of a section. Inspired by the "grove type" of the Benedictine monasteries in France during the Middle Ages, the various sections join into a directional building organization. From there, the same zones serve a different section principle called "housing galleria". The two section principles also share the dominant central space relating to smaller spaces on the periphery. From a class assignment by John R. Dian, M.S. Arch. St. program, Massachusetts Institute of Technology.
reasoning depends on pro-
grammatical premises. In the
approach suggested here, func-
tion becomes a variable
within a stable form. This
relationship will be discussed
separately later on.

It becomes evident when
working without a program
that we lack an appropriate
cvocabulary to talk form.
Most of our language when
discussing architectural form
is related to use. A broader
cvocabulary is needed to
discuss moves, directions
of moves, developments of
patterns, juxtapositions of
spaces, relations of elements,
and other aspects of form
making.

The third barrier for the
beginner is a feeling of
directionlessness. “How can
I design if I do not know what
the end result will be like?” is
a frequent complaint.
“Why would you need to
design if you already knew?” is
my response. The need for
a program is most keenly
felt when we do not trust the
form as something to work
with. There is nothing wrong
with having such an image,
but it is not a prerequisite
and may be hindrance.

We speak with other
people, we need not know
what the result of the con-
versation will be either. We
may come out of the conversa-
tion with a better sense of
the issue; in fact, we may have
changed our mind. When we
are concerned about “doing
our own thing” and feel we
must be on top of the form
all the time, we cannot relax
and trust the process. Once
students find out how one’s
dialogue with the form will
always bear the imprint of
one’s personality — whether
one likes it or not — the
complaint is no longer heard.

Theme
Designing in dialogue with
the form is like improving
on a theme. There can be
variations and transforma-
tions of the initial pattern.
We can elaborate, we can
add subthemes, we can shift
the theme by changing some
of the relationships among
components or by intro-
ducing new components.
The concept of theme leads
us to two important issues.
First, the theme allows us to
work together as the theme
emerges in the process. The
nice thing about the theme is
that it makes us communicate
together through the form. Indeed,
under ideal circumstances,
theeratic communication can
be without words. We could
simply supply a series of
transformations, and some-
one else could continue the
theme development.

Experiencing with thematic
developments this way makes
us appreciate the power
of implicit conventions in
designing. Much of what we
do is based on unspoken
understandings. We already
share many common values
and principles before a
dialogue starts. Making form
transformations in a thematic
way establishes such implicit
understandings and conven-
tions. Once the mechanism
is recognized, it can be
used deliberately to foster
feedback and cooperation in
the design process.

Second, the communicative
power of a theme is also
found in systems. A system
gives us a choice of elements
and their allowed relations
in space. It emerges when
we seek to establish rules.
By approaching systems
this way, we see their
thematically potential. A system
always allows variations of
form within the rules it
imposes; it can support the
thematically development of
a configuration. Thess, systems
thinking can be a means for
generating variety by fol-
lowing rules.

Theme and system both con-
strain what we do. In the system, constraints
are spelled out; in the
them, they are implicit. The
system is rules, the theme is
convention. A system usually
allows for many themes, but
it theme always implies
something systemic. Both
hold people together in that
they imply a group of those
who follow their constraints.
Indeed, both are, in their
own way, the product of
people agreeing on a set of
criterions. The explicitness
of the system makes it more
generally transferable. The
implicitness of the theme
is bound more to a social body.

By comparing themes and
systems, we find how their
rules and conventions give
design a social context. They
make people work together.
Working only by ourselves, we
may find implicit or
explicit rules that can be
used to master complexity.
But if we want to get closer
with others, rules become indis-
ensible. Without systemic
or thematic principles,
delegation of work to others
is very difficult and will
soon lead to confusion.
Moreover, if we want to
divide responsibility among
peers in a team, we must
agree on such principles as
well. By their use thematic
designing becomes a shared
adventure.

Thus, by starting from the
concept of theme, which led
to the concept of systems,
we begin to see designing as
something happening among
people. No one designs alone
in architecture anyway. We
will be less defensive if we
can explain the thematics
aspect of our work to others
because it allows them to
think along with us, and it
makes us free to change the
evolution of the theme or
choose a different theme
without loss of control.

The Nonthematic
Once the thematic is
understood as a means to
guide our actions and
connect to others, we realize
there is also the freedom
to deviate from the
conventions we follow. At
any point elements can be
introduced and moves can
be made that go outside the
theme. The thematic and the
nonhematic define each other because the special cannot exist without the conventional, and it is the tension between the two that brings out qualities of form. It is therefore important to understand that both the thematic and the nonhematic are part of the design effort and that both can be subject to agreements and rules. Since each one makes the other possible, we cannot argue which is more interesting. The way we orchestrate the thematic and the nonhematic is what designing is about.

**Type**

Once the thematic is understood as something we can share, the concept of type can be brought into focus. When we study house types from different places and cultures, we find how they represent very complex combinations of systems. The type can be described in many ways, as a spatial system, as a combination of technical systems, as a system of facades and decorations. All descriptions can be valid and yet they do not exhaust the type. There is always another way to describe a type emerging in real life.

Types are shared properties within a culture. For example, builder, designer, user, is familiar with them. Yet types, such as the Venetian Gothic palace, the Amsterdam renaissance townhouse, the Georgian terraced house, or the Pompeian courtyard...

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4 Pompeii as an example of a continuous architectural field. The urban tissue shows variations of a house type. The house units are formed by the combination of atrium, peristyle, and garden, with cell-like rooms around them. Now how large houses have a larger atrium and peristyle, but that the size of the rooms is not much different with the size of the house, there are only more rooms. While all houses have an atrium, only the larger houses have a peristyle. Although their number may vary, the relations between the spaces that make the house is always the same, for instance the peristyle is always behind the atrium and both are surrounded by cell-type rooms.

This field can be read in both ways as discussed in the text. First, as a deployment of walls and columns, following certain continuous patterns across the whole field. See for instance the cells lining the streets. Second, as a combination of territorial units. Closer scrutiny shows that the latter are not the same as the house units by which we recognize the type. Openings in party walls, for instance, suggest the combination of two or more "houses" into one territory. Irregularities in party walls also betray exchanges of spaces from one house to another in the course of time.

Detail of the map in Overbeck, Pompei, Leipzig, 1866.
house, were never formally described by those who made and used them. Types only exist in a social body. Once we realize this, we realize that it is never explicit but allows a social body to produce very complex artifacts with a minimum of formal design and a maximum of efficiency.

As shared know-how within a social body, the type is known through acts, not through description. Indeed I found that students have no difficulty making a reasonable instance of a type after studying a number of examples for a day. However, being asked to describe the type produces much labor, long disputes, and little conclusive results. Each observer stresses another aspect. Each description is inevitably a reduction and therefore destroys the holistic power of the type. The type exists as long as we follow the conventions it implies: The living type need not be explained because it is already shared knowledge; hence its efficiency and coordinating power.

Field Deployment

Once the thematic development of forms is understood, we need not think of self-contained forms that grow and transform, but we can use the same approach for the creation of large continuous fields. The theme can work its way across the field, making instances and repetitions without ever repeating exactly the same form. In environmental design, urban tissues are examples of continuous thematic fields.

To control the deployment of such fields, a number of issues must be studied. One has primarily to do with tools: we need a formal geometry to help us organize such fields. The other has to do with a better understanding of complex forms; we need to know about their hierarchal structure.

Geometry

Geometry in design has to do with the placement of parts. It organizes where things go. To make the position of each part in our field unambiguous but manipulable, we need placement rules. These rules should facilitate the thematic development itself, making a link between theme and field. The formulation of such placement rules is accomplished by means of a grid.

A grid, by nature, is predominantly homogeneous and continuous. However, we may not want the field to be fully homogenous. The introduction of zones to which we designate particular properties allows us to articulate distinctions in the whole. The zone, similar to the way it is used in urban
6 Study in continuous field deployment. A. Plan and sections. B. The grid superimposed on the plan. Note that the two axes of the grid have different modules, producing a direction on the field. C. A semantic interpretation of the field. D. Distinguishing the different layers of the deployment. Long walls, combined with shorter perpendicular ones, as given in black, make a first layer. Subsequent layers are made by strings of short walls or pairs in two directions and two kinds of columns. From a class assignment by Miepnao Lew, M.S. Arch. St. program, Massachusetts Institute of Technology.
7 Study for a field deployment inspired by the settlement type found in Ladakh, northern India. A. Overview. B. Diagrammatic section of the house type and possible space negotiation between territories. C. Sections of the subsequent layers used in the development. Project by Solomon Benjamin, M.S. Arch. St. program, Massachusetts Institute of Technology.
legalization, is an abstraction of site conditions; it allows us to state what is, and what is not, allowed in a particular area. When our exercise is formal and not bound to a particular site, the zones themselves help us to establish “site conditions.” By attaching various deployment constraints to zones, the field is no longer neutral and must be responded to. Of course, in real site cases, the zones and the rules attached to them are expressions of conditions we note in the site.

Zones and grids are tools developed for the specific needs of thematic development of larger fields. As such, their discussion is inevitably technical in nature and only of interest to those who engage in such deployments. Grids have a bad name in architectural circles mainly because they are confused with dull and repetitive gridlike forms. But we must not confuse the tool with the form. As a tool, used with appropriate position rules, the grid allows for the generation of extremely complex and varied arrangements. It is the arrangement we ultimately see, not the grid.

In a broader context, zones and grids are of interest because they constitute a new geometry in design. Geometry has always been the hallmark of architectural skill. Where ruler and compass allowed the Renaissance architects to produce formal organizations of a predominantly self-contained kind, we seek a geometry of fields, and one that is by itself continuous—albeit varying from place to place—allowing us to make formal arrangements of a different nature.

Hierarchy

We are all familiar with the notion that rooms make the house and houses the neighborhood and neighborhoods the town. Large things are made out of small things, and complex forms are inevitably hierarchical in structure. But to make the idea of hierarchy useful in design, we need to be more precise about this concept. In the analysis of complex forms, two kinds of hierarchies must be distinguished. When we say that the small makes the larger we refer to a part-whole hierarchy, a hierarchy of assembly. In building we may say that the bricks make the wall and the walls make the house. Here the wall is a part of which a house may be built, and the bricks are the parts of which the walls are made. But when we say that the furniture makes the room or the houses make the neighborhood, we speak metaphorically. We cannot assemble a room out of furniture or a neighborhood from houses. We can, however, place and arrange furniture in a room, and we can build and demolish houses in a neighborhood.

Appreciating the importance of making the higher level. In this way the highways make a network in which secondary roads can be deployed, and office buildings make structures in which partitioning systems constitute floor plans. It is this innate flexibility that enables complex artifacts such as cities to change and adapt over time and allows us to inhabit buildings in different ways.

Second, because the levels are realms of intervention, we find these hierarchies defined in terms of control. A level exists because there is a party out there that operates on it. In complex artifacts, we discover the levels of intervention by trying to change things. In fact, our general distinction between interior designers, architects, urban designers, and city planners reflects the reality of control hierarchies.

Knowledge of control hierarchies can be utilized in continuous architectural fields one level at a time. In urban design, we first make the road network and next arrange the buildings in the block. In buildings, we first deploy, for instance, the larger structure of columns and floors and next distribute façades and infill walls. Each deployment on one level allows alternative deployment on lower levels. Once this principle is recognized, we can use it more fully. The large field need not be a juxtaposition.
8A Study for Fort Point Channel, Boston, based on schematic field deployment of predetermined building types. Overview.

8B Sketches for building sections arranged in the zoning of fig. 8A. From the thesis project by John R. Dike, M.S. Arch. St. program, Massachusetts Institute of Technology.
tation of already vertically integrated entities, such as houses next to one another, but can be the deployment of walls and columns over the whole field, followed by facades over the whole field, to be followed by unit walls over the whole field, followed by kitchens and sanitary equipment over the whole field. Thus we begin to see the field as a horizontally organized layer after layer of distinct deployments. In each layer, we need not repeat a same combination ever but can stay with thematic variations. When all layers are in place, the result can be extremely complex and varied. Yet each instance is fully under control, and local changes are possible on each level, and each time we can test its impact on lower levels.

Capacity

We recognize a room’s function by the arrangement of furniture and equipment in it. Given the location and dimensions of a space, we may decide, for instance, that it can be used as a bedroom or as a study. We can test this by arranging the furniture in the same space in two different ways. This is how we call the “function” of a configuration (in this case the configuration of walls making a room) can be expressed by another configuration of a lower level. The concept of “function” as it is used in architectural design is linked to the relationship between two levels of intervention. We can explore the “capacity” of what we produce on one level to hold configurations on a lower level. In a similar way, the urban designer may demonstrate how buildings can be built by other parties in the context of the streets and public spaces he has laid out.

Seen this way, the concept of function becomes part of the transformational development of the complex form and we learn about function by the study of the relation between levels of intervention. When we decide that a certain space must have a certain function, we mean that this space, when it is designed, must be able to hold an arrangement of objects that stands for the use we have in mind. This arrangement must conform to norms we deem representative for this use. We may, for instance, call a space a “one person bedroom” if it can hold a bed, a closet, a chair and a table, all arranged in appropriate relations.

Although we cannot make a lower level arrangement before the higher level context is in place, the expectations we have for lower level use can guide higher level design. The function does not dictate the space, but we can demand that the capacity of the space hold a certain function and test it by inserting an appropriate lower level arrangement. Coming from
the higher level, we may produce a spatial context and ask ourselves what uses it may have: we explore its capacity by projecting in it a variety of alternative lower level arrangements representing different uses.

Thus, what we usually call "function" when discussing the uses of spaces is part of a more general concept called "capacity," which applies to all levels of the complex form. We can study the capacity of a facade to hold windows and doors, the capacity of an office floor to hold arrangements of partitioning walls, or the capacity of a lot to hold a building.

The concept of capacity can be applied to the layered field deployment discussed earlier. Each pass across the field with a lower level system is a comment on the capacity of what was already in place. When, for instance, we first lay out a field of boxes using different bay widths in various combinations, we may next study the capacity of bay combinations in the field for holding subdivisions by infill walls and other elements and make such lower level decisions while we go across the field once more. Capacity studies, therefore, can be conducted locally for each part of the field.

It is easy to see, then, how we can work from the bottom up as well as from the top down. We might, for instance, start from lower level considerations and first determine the capacity of different bay widths before we choose two or three for deployment in the field. In most design processes, we combine the upward and downward approaches.

Territory

So far we have only discussed the control of physical systems. Of course we deploy them with architectural space in mind and transform them through the manipulation of material elements.

To distribute elements in space, we first must have access to the space in which they go. Territory is space controlled by one party, which must have the ability to keep things (and people) out. This is the basis of all use of space. We cannot dwell somewhere unless we have certainty of some territorial control.

Territory, defined this way, is not the same as architectural space. The house, as an architecturally defined volume, for instance, may not define the territory of its inhabitants simply because it stands in a garden and the territorial boundary is at the curb where the lawn begins. A fence, to give another example, may be a territorial boundary but it can also be just a barrier to keep animals from wandering away.

Territory as a token of inhabitation is always an interpretation of a given physical organization. When a culture is familiar to us, we are very adept at reading territorial clues. We read easily signs of inhabitation such as plants placed on a doorstep, the room's door age, the towels and umbrellas arranged on the beach and avoid the emptiness of occupying.

We know instinctively the difference between a ceremonial gate and one that defines a territorial boundary.

From a methodological point of view, territory is an independent variable relative to the physical arrangement it inhibits. Given such an arrangement we always can project a number of plausible territorial interpretations. This is true on all scales of the environmental form because territories have their own hierarchy, distinct from the dependency hierarchies we discussed earlier. In each territory we find included territories. In the condominium, for example, individual households are included territories. The common space is public space of the larger territory. Indeed, in all cases, a territory contains two kinds of spaces: those occupied by the included territories, which we call "private" spaces, and the space left free to be shared by the inhabitants, which we call the territory's "public" space.

Thus, we can have public space on all levels of the territorial hierarchy. For instance, the public space in the condominium is, in turn, private when we step out into the street. The concept of public space is therefore a relative one, and it is this relativity that accounts for the confusion of terms we often encounter such as "public," "semi-public," "private," and "semi-private."

This is not the place to elaborate on the theory of territoriality in environmental design, but enough has been said to make a few points. The territorial organization as a separate variable is methodologically useful. Once a territorial organization is determined in a given field, we can, within each territory, deploy lower level arrangements to serve this territory. Thus, territorial organization divides a field into self-contained areas guiding further development. Not all lower level development, given a first deployment as context, needs to be divided into territories, but each such division frames lower level arrangements.

Territorial structure reflects patterns of inhabitation. Seen this way, the territory is the most general expression of use and function, and it interprets indeed the given context in a manner similar to the way a lower level arrangement interprets it functionally. We could say that an arrangement of the furniture in a room is a
functional interpretation, but it also reflects a termin-
ral interpretation in the larger context of the house. 
Conversely, as we have seen, a territorial interpretation of 
the floor plan will "frame" the arrangement of furniture 
in the rooms.

In the design process, we should consider not only the 
territorial structure of 
habitation but territorial 
divisions among designers. 
The field can be given a 
territorial interpretation to 
guide the division of design 
responsibility within a larger 
team. Each designer will 
have a "territory" in which 
to make design decisions 
within the "public" space 
that is the joint responsibility 
of the team. Such divisions of 
design responsibility in a 
large project are most 
successful when the design 
territories correlate closely 
with the expected territories 
of use. This division of work is 
prefered to an arbitrary 
segregation of a field where 
there is no "public" space to 
relate individual design 
efforts and interface 
conditions lack clarity. It 
is also an alternative to 
dividing the work in layers 
such that each design party is 
responsible not to a part of 
the field but to a layer across 
the field. In the design of 
most complex environmental 
forms, a judicious combina-
tion of such "horizontal" and "vertical" divisions of 
the form for the purpose of 
delegation of design 
responsibility is best.

Final Remarks
This quick survey of 
methodological opportuni-
ties in the design of complex 
environments can, of 
course, be no more than a 
sketch. What has been said 
may seem familiar to the 
extent that it gives more 
formal expression to 
concepts we deal with 
regularly: control hierar-
chies, territorial organization 
and division between public 
and private space, capacity 
analysis, type, and theme. 
Methodology should indeed 
always confirm what we 
already do in the sense that 
it can only be successful if it 
facilitates common practice 
and gives us power to deal 
with problems we are 
already confronted with.

At the same time, these 
familiar elements can be 
brought into a new 
perspective by applying two 
interrelated concepts not 
normally equated with 
design: change and control. 
By looking at the architec-
tural form as an instance 
of a continuous process 
of change, we become 
interested in the mechanisms 
of transformation. That we 
can learn from change is not 
new. In all observations, 
scientific and otherwise, 
change and movement reveal 
the structure of what is 
designed, making, and 
inhabiting the environment. 
We have to deal with human 
constructs, and hence the 
complexities we observe 
are of our own making.

Therefore, the structure we 
find is a reflection of patterns of 
control. We begin to see 
the complex form as a social 
artifact, and its hierarchical 
and territorial structure is, 
ultimately, a product of 
convention.

Such conventions we find 
reflected in the concepts of 
theme, system, and type. 
All three make us see form 
as shared, reflecting values 
we hold in common. A theme is 
what we design when we 
want others not only to 
understand what we do 
but participate in the 
development of the form. 
A system is the product of 
formal rules accepted by all 
who use it. A type, as we 
have seen, is a complex form 
principle, containing many 
themes on various levels, 
which lives outside formal 
description in the social 
body that applies it.

Thus the concepts on which 
find a reflection of the methodological tools 
discussed here run some-
what against the grain of 
traditional design attitudes. 
We tend to stress the 
consistency and immutability of the 
architectural form and 
do not readily take change 
into consideration when 
designing. We have not been 
taught how to share our 
designing with others. The 
myth of the master decid-
ing everything is a fiction of 
authority—based on skill 
and experience—with 
centered control of 
decision-making. We need 
new attitudes that allow the 
qualities of daily life in the 
environment—variation in 
spatial development, thematic 
richness, and adaptability over time—to 
support our architecture in 
an efficient way. Without 
such qualities, environmental 
forms will maintain the 
poverity and rigidity we all 
don't desire.

NOTE
Evidence of how efficiency can 
produce variety instead of 
uniformity can be found in 
recent developments in 
housing technology in the 
Netherlands. Builders, 
architects, and developers, 
now cooperate for the 
introduction of infill systems. 
These systems comprise 
interior partitioning, kitchen 
and bathroom equipment 
and the plumbing and wiring 
that makes equipment work. 
Industriallzed infill systems, if 
designed correctly, yield 
considerable savings in on-site 
labour and overall construc-
tion time. The dwelling's shell 
(called "support") and its 
upfit are treated as separate, 
complementary, systems. The 
shell offers independent 
dwelling territories which can 
have their own utili 
configurations. The result is 
that no two dwelling plans 
need be the same for reasons 
of efficiency. See also N.J. 
Hubskom, "Reconnecting 
Variety and Efficiency in 
Large-scale Projects in: Large 
Housing Projects, Design, 
Technology, and Logistics, 
ed. Margaret B. Sevcento, 
pp. 46-53. Designing in 
Islamic Cultures, S. Cambridge, 
Mlk. Aga Khan Program for 
Islamic Architecture.