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Arcology and Arcosanti[1]: Towards a Sustainable Built Environment

David Grierson
Department of Architecture, University of Strathclyde, Scotland

Around the world, as cities reach unprecedented sizes, their increasing social and environmental problems need to be addressed if we are to avoid catastrophe. Paolo Soleri's arcology model aims at a more balanced relationship between urban form and efficiency of performance within a unique conception of the modern city. Since 1970 a prototype has been constructed at Arcosanti in the central Arizona desert to test the validity of the arcology model exploring such issues as the intensification in the use of space, higher residential densities, centralization, compactness, the integration of land uses, and self-containment of habitat. This essay describes both the arcology theory and the Arcosanti project and how the related ongoing work has wider significance in responding to some of the overlapping challenges that are involved in a movement towards more sustainable built environments.

"We do not inherit the earth from our parents, we borrow it from our children"
A Kenyan proverb

"…and we have no right, by any thing we do or neglect, to involve them in unnecessary penalties, or deprive them of benefits which it was in our power to bequeath."
John Ruskin *The Seven Lamps of Architecture*

I

Over one hundred and fifty years ago John Ruskin, in his treatise on reforming architecture, described the earth as a "great entail," belonging as much to those who are to come after us, as to us. We had no right, he suggested, either through our action or inaction, to deprive our children of benefits that we might otherwise provide for them. In the *Lamp of Memory* he gave expression to a sensibility that now echoes around the world and has in recent years gathered momentum. Although there are many, often conflicting, definitions of what *sustainability* is, or might become, the move towards the construction a more sustainable society, if it is be achieved at all, will be founded upon a redefined relationship between the built and natural environments.

Throughout the 20th century the switch from a spread out pattern of human settlement to one of concentration in urban centers has spawned a built environment that has transformed the natural environment and contributed, in large part, to the current environmental crisis. Although the process of urbanization has occurred at varying rates throughout human history (Davis, 1965) the speed and nature of growth in cities in recent years, and the scale of environmental impact, is such that our own place in the history of the built environment is unique. Since the middle of the 20th century the population of the world's cities has soared from 200 million to almost 3 billion. This process is set to reach

a significant stage in 2006, when for the first time in human history, one half of the global population (an estimated 3.3 billion) will live in and around cities (United Nations, Population Division, 1995). Although physically they occupy just 2% of the earth's surface, cities consume most of the world's natural resources, produce vast amounts of waste, and are the main source of pollution throughout the world.

In the developed world, urban environments consume so many resources that they are dramatically reducing the global resource base, or natural capital, on which we depend. They account for around 78% of the carbon emissions from human activities, 76% of industrial wood use, and 60% of the water tapped for use by people (Brown, 1999). In their current form, as cities grow they need to draw on more and more of the earth's capital. The ecological footprint (source of resources and sites of waste disposal and pollution) of cities like London, Tokyo, and Paris extend far beyond their physical boundaries (Rees & Wackernagel, 1996). The amount of land needed to generate the resources to sustain the population of London (e.g. with food and timber), for example, is only slightly less than the entire land area of the United Kingdom (Girardet, 1996). In the developing world's fastest growing cities (Phoenix, Los Angeles, and San Diego in the American Southwest) up to 85 metric tons of natural resources are consumed per person per year (World Resource Institute, 1996). This level of consumption represents a truly massive scale of environmental alteration. Extending this kind of resource intensive economic model to developing nations, as is now occurring around the world, is simply not environmentally sustainable.

Currently, on average, about three-quarters of the population within developed nations live in cities. Although some are still growing rapidly, this is mostly due to urban-to-urban migration. However cities in undeveloped parts of the world are now growing five times faster. Over the next 20 years the fastest growth rate will occur in Asia and Africa. During this period Asia's urban population is expected to increase by a staggering 1 billion people (United Nations Development Programme, 1997). By then it is expected that there will be 33 mega-cities (a city with a population exceeding 8 million) in the world. Twenty-seven will have emerged within developing nations. Twelve will be in Asia. Only one—New York—will be in the United States. There will be none in Europe.

These cities are growing in number and size because they provide, generally, greater health, social and economic benefits than rural areas. But along with the benefits of urbanization have come environmental and social problems of staggering proportions. There is no historical precedent for changes of the scale and speed we are now witnessing and there is little guidance as to the magnitude of problems that such growth might pose. The environmental by-products of large and concentrated poor urban populations pose direct threats to health and to the quality of city life caused by problems such as air pollution and ozone build-up. Many people now live in life-threatening conditions. Today more than 600 million people in the undeveloped world are living in cities without adequate shelter. At least 220 million of the urban poor lack any access to clean drinking water and more than 420 million do not have the simplest latrines. Between one and two thirds of the solid waste generated in these cities is left to pile up in streets and drains, contributing to flooding and the spread of disease, adding to an enormous toll of largely preventable deaths. In 1995 polluted air in 36 cities in India alone killed some 52,000 people. 1.1 billion people live in urban areas where air pollution exceeds health limits (Hardoy, Mitlin, & Satterthwaite, 1992).

The transition to an urbanized world continues to have a profound effect on the physical arrangement of cities, their resource consumption, and their environmental impact. Throughout the last decade a cluster of United Nations conferences and conventions, beginning with the Earth Summit in 1992, have discussed the continuing deterioration of the ecosystems on which we depend for our well-being, and identified a common need to develop a global partnership for sustainable development. Recognizing that conditions in the world's cities, particularly those in undeveloped nations, had reached crisis point, the Habitat II (the 'City Summit') Conference, held in Istanbul in 1996, concluded with a global call to action to improve the quality of life within human settlements in cities around the world. Paragraph 4 of *The Habitat Agenda: Istanbul Declaration on Human Settlements* identified a need to confront problems such as:

- unsustainable consumption and production patterns, particularly in industrialized countries;
- unsustainable population changes, including changes in structure and distribution, giving priority consideration to the tendency towards excessive population concentration;
- homelessness;
- increasing poverty;
- unemployment;
- social exclusion;
- family instability;
- inadequate resources;
- lack of basic infrastructure and services;
- lack of adequate planning;
- growing insecurity and violence;
- environmental degradation;
- and increased vulnerability to disasters.

A pro-growth development paradigm has underpinned the formation of the built environment throughout the 20th century. The Club of Rome's *Limits to Growth* report (Meadows, Meadows, Randers, Behrens, 1972) highlighted an inherent fundamental flaw, pointing out that global growth in population numbers, resource use, waste production, and pollution is exponential. While this kind of growth displays a gentle and gradual curve for a long time it rapidly shoots up in a very short period of time. What might seem like a manageable rate of resource use and waste disposal can quickly result in dangerously low levels of available resources and dangerously high levels of pollution. Environmentalists now question whether the rapid growth of cities in recent years can be sustained. They argue that in order that the quality of life of their inhabitants be maintained, let alone enhanced, the aggregate impact of cities on the environment—a product of the relationship between population, per capita consumption or economic activity, and energy/material flow per unit—must be radically reduced.

II

Sustainability involves a move from a current condition of unsustainable activity towards a process of improvement and increased quality. Essentially the term is used to indicate a change of attitude towards prioritizing ways of life that are in balance with the current renewable resources of the ecosystem and the biosphere. How we might better understand the nature of this balance and its relationship to the built and natural

environments, thus helping to inform decision-making at various levels, is the subject of ongoing research. Although we are unclear about how much damage has already been inflicted on the biosphere a precautionary approach is proposed as a practical way forward. In the face of inherent uncertainty, risk is not an appropriate approach. Failure to maintain a viable biosphere will be catastrophic and irreversible (McDonach & Yaneske, 2002).

The widespread interest in theories, ethics, and practice concerning sustainability indicates an increasing concern about the adverse impacts that conventional models of development have had on the environment, in both the developed and undeveloped parts of the world. Today, as urban environmental problems have been brought more sharply into focus (Commission of the European Communities, 1990), sustainable development is being described as a fundamental goal. The term has been used in recent years to catalyze debate concerning the relationship between economic growth and the natural resource base on which it depends. It was provided a global definition by the Brundtland Commission report (World Commission on Environment and Development, 1987) as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The definition implies that a balance can be found between how much development we are able to make while still preserving the environment to the extent that it can sustain an acceptable quality of human life in the future. It is not about the environment *per se* but involves a more complex, holistic, and systemic approach that mediates between social, economic and environmental processes and cuts across disciplines and subject areas. By suggesting that environmental protection and continuing economic growth can be seen as mutually compatible, it attempts to displace the *limits to growth* argument.

Although often criticized as being vague and even contradictory, the concept of sustainable development has, in recent years, begun to achieve political priority status among government institutions seeking a planned response to urban environmental problems. Alternative ways of re-thinking and reforming the built environment within a rapidly urbanizing world are now being considered. Within the academic and policy literature emerging around the notion of sustainable cities, a number of different models have been developed which represent different views of how such environments might be realized (Haughton & Hunter, 1994). Some advocate the re-designing the physical fabric of the city in order to improve resource efficiency and bring about more self-reliant settlements. This approach involves the frugal use of energy and natural resources while working within the carrying capacity of the local region. It also implies that the ecological footprint and energy budget for human settlements are vastly reduced. A move towards a smaller, more compact settlement pattern interspersed with productive areas for collecting energy, to grow crops for food, fiber and energy, and recycle wastes has been suggested as the way forward. The compact city idea is now being promoted as a major component of the various strategies emerging to tackle these problems (Breheny, 1992). The rationale for its implementation lies in a set of benefits that are seen as the outcome of more compact urban forms in which travel distances are reduced lessening fuel emissions, rural land is saved from development, local facilities are supported, and local areas become more autonomous.

III

The Italian born architect Paolo Soleri (1919 -) has dedicated much of his life to defining

a different kind of urban environment. His model builds upon his work in the area of architecture and human ecology dating back to the 1940s. His thinking is holistic in the sense that it crosses traditional boundaries between subjects like architecture, ecology, biology, urban design, sociology, environmental studies, and art. The scope of his early work was focused on the production of a theoretical model for a new physical landscape, what he calls a *neonature*, designed to support biological, human, and social evolution while containing human societies along with all their material goods. The model stands in opposition to urban sprawl with its inherently wasteful consumption of land, energy, time, and human resources, and advocates the need for a more balanced relationship between morphology and performance within a unique conception of the modern city. His approach recognizes the need for the radical reorganization of sprawl into dense, integrated compact urban structures in which material recycling, waste reduction, and the use of renewable energy sources are part of a strategy aimed at reducing the flow of resources and products through the urban system. Soleri refers to the new structure as an “arcology” (the fusion of architecture with ecology) to underline the conceptual basis, both in the discipline of architecture and the science of ecology. The concept was first published in the 1969 book *Arcology: The City in the Image of Man:*

> Such a structure would take the place of the natural landscape inasmuch as it would constitute the new topography to be dealt with. This man-made topography would differ from the natural topography in the following ways:
>
> - It would not be a one-surface configuration but a multilevel one.
> - It would be conceived in such a way as to be the carrier of all the elements that make the physical life of the city possible—places and inlets for people, freight, water, power, climate, telephone; places and outlets for people, freight, waste, mail, products, and so forth.
> - It would be a large-dimensioned sheltering device, fractioning three-dimensional space in large and small subspaces, making its own weather and its own cityscape.
> - It would be the major vessel for massive flow of people and things within and toward the outside of the city.
> - It would be the organizing pattern and anchorage for private and public institutions of the city.
> - It would be the focal structure for the complex and ever-changing life of the city.
> - It would be the unmistakable expression of man the maker and the creator. It would be diverse and singular in all of its realizations. Arcology would be surrounded by an uncluttered, open landscape (Soleri, 1969, p. 13).

Soleri’s model sees in the contraction and greater sophistication of the city (including all its equipment, machinery, infrastructure, services, etc.) both the efficient possibility of achieving more with less and the chance of reaching new levels of human development. A key function of the model is to facilitate a breakthrough to these new levels.

Soleri believes that the architect's task of ecological design should be directed towards the attainment of the progressive transformation of human existence. Inspired by the priest and paleontologist Pierre Teilhard de Chardin's (1881-1955) *point Omega* hypothesis (Teilhard de Chardin, 1959), Soleri believes that these environments can be instrumental in human evolutionary terms. He asserts that by adopting a more frugal lifestyle inside an arcology, its citizens would have the potential not only to do less harm

to the planet but also to develop themselves spiritually (Soleri, 1981).

The approach clearly presupposes a radical revision of existing social, cultural, political, and economic structures. Soleri points out the direction that must be taken within the *complexity - miniaturization - duration* (CMD) paradigm.

> 1. COMPLEXITY. Many events and processes cluster wherever a living process is going on. The make-up of the process is immensely complex and ever intensifying.
>
> 2. MINIATURIZATION. The nature of complexity demands the rigorous utilization of all resources—mass-energy and space-time, for example. Therefore, whenever complexity is at work, miniaturization is mandated and a part of the process.
>
> 3. DURATION. Process implies extension of time. Temporal extension is warped by living stuff into acts of duration, that is, the eventual "living outside of time." (Soleri, 1983, p. 17)

Since all of nature complies with an imperative involving these three fundamental principles, Soleri argues that the human habitat must be also be designed to conform. Sustainability, in arcological terms, thus becomes part of an evolutionary process. He points out that in nature, as an organism evolves, it becomes more complex and tends towards a more compact and miniaturized form, or system. Since more events can occur in a more complex system he argues that successful and sophisticated (sustainable) human settlements must follow the complexity/miniaturization/duration path in order to become more lively containers for social, cultural, and spiritual development (Soleri, 1973).

Soleri's methodology was developed within the Mesa City Project (1958-67) where a series of relationships between human ecology and urban design were explored.[2] In 1969 he published *Arcology: the City in the Image of Man* and sketched out giant structures that would dwarf the Empire State Building and were located in the most inhospitable environments imaginable. The 31st generation arcologies had names like *Novanoah II* (a city for 2,400,000 to float on coastal waters or open sea), *Stonebow* (200,000 people above a ravine or canyon), *Theology* (with a population of 13,000 set within a cliff), *Arcube* (a city of 400,000 people located on flatlands), *Hexahedron* (a city of 170,000 on any topography), and *Asteromo* (70,000 people living in space).

Later, in response to the growing energy crisis of the mid-70s, the architectural concept of the first generation structures was split in half exposing the core of the structure to the sun. This next generation of arcologies described some highly significant related effects; it gave greater priority to the main source of renewable energy and placed the arcology model much more firmly into its own ecological niche. It also served to reinforce the relationship between architecture and ecology through the concept of the *energy-city* wherein the entire settlement is conceived as an instrument for energy conservation and environmental sustainability, to be highly efficient in the processes of production and consumption. Six major (and simple) architectural *effects* were described, collectively under the "Two Suns Arcology":

> The *greenhouse effect* is a membrane that seals off an area of ground that can be cultivated, extending the growing season to practically twelve months, and also saves a great amount of water. … With the "greenhouse," one has intensive agriculture, limited use of water and extension of seasonal cycles. This is the *horticultural effect.* Then there is the *apse effect.* Some structures can take in the benign radiation of the sun in winter months, and tend to cut off the harsh radiation of the sun in the summer. By the *chimney effect,* which is connected with the greenhouse effect, one can convey, passively, energy through the movement of air and heat from one area to another. So we have these four effects; there is also the capacity of masonry to accumulate and store energy—*the heat sink effect.* With relatively large masonry, one can store energy during the warm hours of the day, and give it out during cool or cold hours of the night. The intent is to see if these five effects can be organized around what I call the *urban effect*.[3] The urban effect is the capacity of mineral matter, to become lively, sensitive, responsive, memorizing. … If we were to co-ordinate those six effects together, then we definitely could save on resources like land, water, time, energy, materialism, and have a better ecological sanity. (Soleri, 1985, p.137)

These effects were combined in a series of designs for second-generation arcologies, including *AirDam*, *India Village*, *Maryland,* and *Regina.* Within these proposals the entire form of the urban structure as well as a huge area of south-facing greenhouses containing vegetable gardens, are designed to maximize the use of solar energy while reducing dependence on external energy sources.

IV

Within a second generation arcology, material recycling, waste reduction, energy conservation, and the use of renewable energy sources, like sun and wind power, would offer the basis of a strategy for sustainability that aims towards a more efficient process of urban production and consumption (Grierson, 2000). The drawing together of diverse city functions into mixed-use, self-contained arcologies would encourage cultural intensification and social integration within their boundaries, while freeing up the surrounding hinterland to remain natural.

We can see within the Two Suns approach a theoretical response capable of confronting many of today's urban environmental problems. These include the inefficient use of land, air and water; pollution caused by technological society; energy and natural resource depletion; the distribution and consumption of resources; food scarcity; the loss of quality of life through waste; the affluence and opulence and the physical and social segregation of people, things and activities; and the increasing problems of social alienation and exclusion. These are among the key issues that have begun to concern contemporary urban planners and architects working on urban sustainability, such as Peter Calthorpe (1993), Herbert Girardet (1992), Richard Register (1987), and Richard Rogers (1997). What sets Soleri apart is that he has been proposing a methodology for an ecological model in urban design for more than 50 years and at the same time trying to illustrate it through the arcology projects. Perhaps more significantly, over the last four decades he has been attempting to build a prototype in the semi-arid desert region of central Arizona in the United States to test his ideas. Since construction work began in 1970, Soleri, with

the help of a dedicated community of volunteers, has designed, built, and inhabited Arcosanti (meaning *architecture before things*) as an urban laboratory. The laboratory attempts to confront problems associated with:

- population expansion and land use,
- social integration,
- self-containment of habitat,
- urban transportation,
- food and energy production,
- and the habitat's impact on natural resources and pollution.

Soleri argues that our ecological sanity is dependent on centers of life so intense as to contain the vast bulk of the planet's population and all its paraphernalia. Through an adherence to the CMD paradigm, arcology is therefore dedicated to the "old" notion of containment as opposed to the relatively recent phenomenon of (a car-driven) diaspora. The "City in the Image of Man" metaphor articulates this idea of self-containment. Without self-containment the city cannot act effectively with the surrounding natural environment. In contrast to sprawl, Arcosanti offers a working prototype for a new kind of city that is designed, built, and inhabited as a three-dimensional, highly concentrated urban structure. Its compact design allows agricultural land and biologically diverse habitats to remain preserved beyond the city's perimeter. A permanent experiment in urban intensity, when complete Arcosanti will house an environmentally benign community of five to six thousand people on only 15 acres of land—equating to a population density of around 350 people per acre, 10 times the population density of New York City.

Set on the edge of a mesa above the Agua Fria River in the middle of an 860-acre nature preserve containing orchards, agricultural fields, canyons, and high desert hills, the compact structures face toward the sun to gather its energy. When complete they will stretch no more than quarter of a mile on any one side but will rise to as much as thirty stories. Inside, these structures will contain the economic, cultural, and social infrastructure normally scattered around a modern city, while providing residents up to two thousand square feet of living space per family. A series of orchards will line the north side of the structure, creating a unique fusion of urban and agricultural environments. Outside there will be expansive views of another three thousand acres leased from the state of Arizona, to be kept as undeveloped open space. An integral part of the design will be five to seven acres of south facing sloping greenhouses, an "energy apron" acting as a central system for producing food and collecting energy to support the prototype town.

Social integration is a main goal at Arcosanti and points to the reshaping of the entire urban landscape and along with it the culture that such a landscape supports. Our information age offers society an unprecedented opportunity to bring together the main components of life, but the habitat that we have constructed for ourselves during the last century is alien to such integration. Therefore, Soleri argues, it needs to be reconfigured. Arcology advocates mixed use in its purest form—accommodating a variety of uses within one structure. In an attempt to reintegrate people within their community, Arcosanti is designed as a mixed-use complex, containing homes, offices, schools, parks, and a cultural center. The belief is that a close interaction of city functions and people will induce a greater sense of community. The integration of living, working, and recreation become a very natural part of things at Arcosanti. It is something that is to be

experienced in everyday life.

Many civilizations throughout history have had to deal with restrictive eco-systems. The 1969 arcologies were located on marginal lands, far from main transportation networks, many poor in resources. Since these may be the sort of reserves where future cultures will have to settle (leaving fertile lands free for increasing crop cultivation) the task has been to demonstrate the viability of the self-containment of a community on such inhospitable land. Arcosanti's semi-arid location in the desert presents particular challenges to settlement but by adopting a higher concentration of land use deriving from a mixed use development it demonstrates an effective method of altering the impact of a settlement on the natural environment.

Rather than accept the logic of two-dimensional cities, since 1970 Soleri has used Arcosanti to rethink modern urban planning and explore the idea of *urban implosion*—wherein the habitat's infrastructure contracts and intensifies in order to become more efficient, ecological, and sustainable. The ecological significance of the first generation arcologies derives mainly from the elimination of the motorcar, and the reclamation of all the space that is normally associated with this form of transportation. Inside an arcology walking would be the main form of transportation. Typically today's cities devote up to 60% of their land for car functions such as roads, car parks, showrooms, garages, petrol stations, repairs, and junkyards. Eliminating the car from inside the arcology and reserving it for use outside dramatically reduce that figure leaving the land free for other use. The unique character of Arcosanti will derive, in large part, from the prohibition of the motorcar and the widespread use of pedestrian walkways, lifts, escalators, and moving platforms. Because of its compact nature most journeys by foot will take about 15 to 20 minutes (about the same time as it takes, typically, to walk from inside a shopping mall to the outskirts of the car park in cities like Phoenix and Los Angeles). Like many critics of car dependency Soleri is not against the technology *per se* but against our complete reliance on it for transportation. While he acknowledges planning efforts that aim to produce more efficient land use patterns thereby reducing the number and frequency of car trips, and the introduction of fuel-efficient technology in car design and manufacture, Soleri contends that such improvements fail to attack the core of the problem. They are, he says, simply "a better kind of wrongness." By virtue of its compact design, Arcosanti would allow cars to be relegated to service areas on the periphery or reserved for travel between communities.

Arcology aims at a degree of autonomy and self-reliance, rather than self-sufficiency. Self-sufficient communities, which aim at total self-provision of food and energy and the complete recycling of wastes, are, according to Soleri, "extravagant and devoid of sense." There is no way the earth or anything in it, he argues, can be perfect because it is a small part of a much larger system. The arcology concept is directed instead at a more restrained and judicious use of resources via the power of complexity and miniaturization and the discipline of frugality. The degree of self-reliance in food production has changed as the arcology concept has evolved. In *Mesa City* the settlement was designed to be entirely dependent on the produce of the surrounding hinterland and on traditional agricultural practices. With the development of the *Two Suns* approach food and radiant energy are produced within south-facing greenhouses located within the city. These are designed to support the city's population at a minimum level. Other produce is imported from outside to supplement the goods and services provided on this self-reliant base (e.g. electricity from the main grid). All Soleri's projects after 1958 have explored methods of

generating and harvesting energy from renewable sources and have aimed at transforming the urban structure into an *energy machine*. In the *Two Suns* approach the city is conceived of as a complex in which living, working, and learning are integrated with food and energy production. The city becomes both consumer and producer. *Apses* and *exedra* (semi-circular edifices—developed from the apse form) that respond to the Sun's trajectory as energy devices and large expanses of greenhouses are attached to the city, and used to generate heat and electricity as well as to grow food. These help define the urban structure as an *energy city*.

Arcologies, through a blend of energy conservation and land use efficiencies together with waste recycling systems, could maintain the ecological integrity of the region while placing fewer demands on the environment in terms of land, water, soil, fuel, and other resources. By reducing the demand for petrol-based transportation systems, air quality could be radically improved. Non-pollutant, passive solar energy systems such as wind turbines, photovoltaic cells, and solar cooling and heating would further help to reduce water, air, and land pollution. By combining various passive energy strategies within a single integrated urban system, Arcosanti aims at a theoretical and architectural synthesis in which philosophical, ecological, and theological ideas are "woven into the physical structure of great beauty and integrity and which, at the same time, is a structure of stunning frugality from the standpoint of energy conservation" (Skolimowski, 1975, p. 33).

V

While following in the tradition of the 1960's libertarian counter-culture communes and the more recent eco-villages movement, the community at Arcosanti is unique in that its motivation lies primarily in the production of ecological architecture. The main focus of the community has been in building the project's various concrete structures using an earth-casting construction method based on ancient craft techniques. These structures now define the living, working, and learning processes of around one hundred residents. As well as ongoing construction work, residents are involved in a variety of activities ranging from project development, research activity, exhibitions, drafting and design work, conference organization, to wind-bell production and site maintenance.

Arcosanti is now officially listed on the state map of Arizona as a small town. As such it is faced with the challenges of daily existence but, at the same time, its aim is fixed firmly on the future. By trying to anticipate it, and moreover attempting to plan for it, the community strives to keep the road to the future open while recognizing that paradise here on earth can only ever be an imaginary condition. With each passing year Phoenix creeps ever closer to Arcosanti**.** It is conceivable that, in the not-too-distant future, Arcosanti will be another of its suburbs.

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Endnotes

[1] *Arcology* is a fused word adopted by Paolo Soleri to describe both a theory of urban design rooted in the discipline of architecture and the science of ecology as well as a physical structure designed according to arcological principles. Arcosanti is the name given by Soleri to the 30th arcology published in 1969 in *Arcology: The City in the Image of Man*. Arcosanti was designed to be an experimental complex providing a testing ground for arcological concepts. Like *arcology*, *arcosanti* is a fused word of Italian origin. *Arco* refers to architecture (or the arch), *cosa* is a widely used word meaning *thing*, and the annex *nti* suggests a certain permanence or timeless quality. Together the name suggests a non-material (or spiritual) process at the heart of architecture—"architecture before things."

[2] Mesa City was a theoretical regional plan to house 2 million people on around 55,000 acres (about the size of Manhattan Island) on an isolated and pre-flattened desert plateau. Developed as part of Soleri's ongoing research in the field of "architecture as human ecology," Mesa City was specifically aimed at introducing the idea of "corposity into the urban morphology, a premonition of the arcological concept" (Soleri, 1969).

[3] The *urban effect* is described as a universal effect involving the transformation of mineral matter into mind via the potentially unlimited power of complexification and miniaturization. Soleri says it is that fundamental phenomenon in which two or more particles of physical matter begin to interact in ways other than statistical or fatal, that is, in ways that are organic or living.

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David Grierson <d.grierson@strath.ac.uk>, Ph.D. is an academic, and a former resident of Arcosanti. He is currently Director of Design Studies for the Building Design Engineering (BDE) course and Deputy Director of the Sustainability and Environmental Management Unit (SEMU) at the Department of Architecture, University of Strathclyde, Scotland. He has recently lectured and published on various aspects of the Arcosanti project in Amsterdam, Brno, Glasgow, Massachusetts, Manchester and Prague.

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