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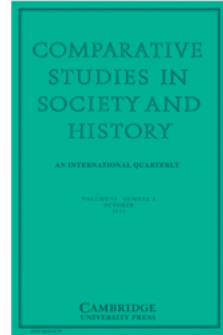
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# Rat Cities and Beehive Worlds: Density and Design in the Modern City

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## INTRODUCTION

Nestled among E. M. Forster's careful studies of Edwardian social mores is a short story called "The Machine Stops." Set many years in the future, it is a work of science fiction that imagines all humanity housed in giant high-density cities buried deep below a lifeless surface. With each citizen cocooned in an identical private chamber, all interaction is mediated through the workings of "the Machine," a totalizing social system that controls every aspect of human life. Cultural variety has ceded to rigorous organization: everywhere is the same, everyone lives the same life. So hopelessly reliant is humanity upon the efficient operation of the Machine, that when the system begins to fail there is little the people can do, and so tightly ordered is the system that the failure spreads. At the story's conclusion, the collapse is total, and Forster's closing image offers a condemnation of the world they had built, and a hopeful glimpse of the world that might, in their absence, return: "The whole city was broken like a honeycomb. [...] For a moment they saw the nations of the dead, and, before they joined them, scraps of the untainted sky" (2001: 123). In physically breaking apart the city, there is an extent to which Forster is literalizing the device of the broken society, but it is also the case that the infrastructure of the Machine is so inseparable from its social structure that the failure of one

Acknowledgments: Primary research for this paper, especially visits to the Calhoun archives at the National Library of Medicine in Bethesda, and at the University of Wyoming, Laramie, was made possible by the Leverhulme Trust/ESRC funded project, "The Nature of Evidence: How Well Do 'Facts' Travel?" at the Department of Economic History, London School of Economics (grant F/07004/Z). Edmund Ramsden was subsequently supported by the Wellcome Trust, via "History of Stress: Medical Research and Contested Knowledge in the 20th Century," at the Centre for Medical History, University of Exeter.

causes the failure of the other. The city has—in the vocabulary of present-day engineers—“failed badly.”

Written in 1908, “The Machine Stops” envisages a world in which mankind has approached the social structure of the bee. At several points the rooms are referred to as cells and the vast city as a hive or honeycomb. But if the bee was the paradigm *social* insect, the beehive world that Forster envisions halts apian development at larval stage, trapping each of its inhabitants into social isolation and zero-diversity conditions—identical experiences, lived alone in identical rooms. Cellular seclusion solves the problems of high population density. Forster’s bees never swarm. Yet no multiplication of such privacy would ever sum to a true community, and the model of the social insect made for a curiously asocial man.

Forster wrote “The Machine Stops” in counterpoint to prevailing technological optimism, especially that of his contemporary H. G. Wells (1954: 7). Even in the first decade of the twentieth century, there was a sense that an increasingly urbanized and mechanized Western society was steering itself towards realizing the sort of future described in “The Machine Stops.” Forster was not alone in asking: in the face of increasing technologization, how are we to live? In the face of increasing urbanization, what to do about the city?

Nor was he alone in seeing analogies between the city structure and natural forms. Of all the ways in which “The Machine Stops” is prescient, it is Forster’s special concern with the way in which the physical architecture of the Machine is integral to and *determinate* of the social architecture that would perhaps come to have the most enduring resonance; that is, the notion that architecture could to some extent *prescribe* a way of life. Humans structure their built environment, and that environment in turn structures the way in which they live. The recognition of this recursive relation taps into a theme that over the following century would come to affect the thinking of architects, city planners, human ethologists, psychologists, and ultimately totalitarian governments. And the beehive was no loose metaphor for this, but would repeatedly come to the fore as an analogue for human society, either as a dystopia that must be avoided (as in Forster’s case), or the template for a utopia.

With interest in the relationship between buildings and behavior blossoming, drawing connections between human civilization and the natural world without was seen as attractive and legitimate. The locus of dissent came to fall on which organism would be the model. In what follows, we will be focusing on two rival, though sometimes implicit models of how the city ought to develop from the late-nineteenth to late-twentieth-century United States, and examining how those disagreements were articulated through and informed by the use of rival natural templates.

On the one hand, there was what we have called “the beehive worlds.” While Forster found the prospect dismal, the beehive city was not universally

considered undesirable. For some, the beehive exhibited a natural state of maximal efficiency, integrating the organization of social relations with the built environment, and offering a model towards which humanity might aspire. Among these was Swiss-born architect Le Corbusier, who had spoken in Forsterian terms of the house as “a machine for living,” and drew up plans for flattening the Marais district on Paris’ right bank and replacing the old city with open grassland on which would stand evenly spaced tower blocks; a plan which, as Juan Ramírez (2000) has also noted, yields a scene very much like a field of beehives. In America, Frank Lloyd Wright suggested condensing edgeless and sprawling cities into a single “mile-high tower,” largely to avoid the contamination of his central ideal of leafy suburbia. In the late twentieth century, followers of Le Corbusier and Wright such as the architects Paolo Soleri and Kenzo Tange would plan enormous cities that concentrated populations into orderly and often super-dense conditions. By these reckonings, density meant efficiency, and the aim of architecture and city planning seemed the achievement of a beehive world.

Yet even from within these attempts to sanitize and modernize the inner city, an alternative animal model emerged, one that would come to challenge the fitness of the beehive ideal, and to question the ability of humans to live in the manner of the social insects. That animal was the rat, hitherto a symbol of all that was wrong with the city—dirt, corruption, degeneracy. Yet as animal ecologists charged with controlling urban rat populations came to understand more about rodent behavior, what they learned would cast doubt on the suitability of high-density housing for human habitation. Further laboratory experiments generated a spectrum of aberrant and destructive behaviors emergent under conditions of elevated population density—violence, pansexuality, maternal neglect—and the rat came to stand as the city dweller’s unlikely ally against high-rise block housing. For all the gains in efficiency and cleanliness the new housing projects had over the ramshackle slums they replaced, a social malaise seemingly emanated from these new estates. With Gomorrah resurgent in Detroit, New York City, and St. Louis, designers and planners now sought to employ these “rat cities” to buttress their conviction that high-density living was inimical to human welfare.

So over the question of what to do with the modern city in the twentieth century, two distinct animal models came into competition. On one hand, there was the bee, which came to stand for efficiency and order and the gains available in communal activity. Opposing this was the rat, a potent symbol of disorder, decay, and waste, the very elements of the urban existence that the beehive world was to replace, but also an adaptable survivor, more individual, and, vitally, more prone, like us, to suffer psychological damage in conditions of elevated social density. By analyzing the competition and transit between these models, we will explore the important yet neglected role of the behavioral sciences in the development of urban planning and architectural design. Much

has indeed changed since John Maass (1969: 8) was able to declare that while psychology “goes to the deep roots of architecture ... almost no work has been done by architectural historians along this difficult line.” Yet for practitioners of the discipline such as Anthony Vidler (1999) and Carla Yanni (2003; 2005), considerably more work needs to be done.<sup>1</sup> Almost nothing has been written, for example, on the historical role of architectural and environmental psychology except disciplinary histories and reflections by psychologists themselves (see Coleman 1985; Sommer 1997).

We argue that animal models and analogies developed in the laboratory and field came to inform the agenda of urban planning and architecture. While there has been at least one excellent study of the use of biological analogy in architectural theory, few have followed (Steadman 2008: xv; 1979).<sup>2</sup> Yet if we are to understand the enduring influence of, and shifts within, biomorphic design we should examine it not only in aesthetic or functional terms, as the mimetic imitation of natural forms and processes, but also in terms of how these borrowings often embed a moral order, concerned with the nature, organization, and control of human behavior. Historians of science argue that animal models serve as *objects of translation*, generating truths that are of relevance to the human world and enabling boundary crossings between disciplines, professions, and communities. It is through exploring the shift from the anthropomorphic bee—the compliant model citizen and as industrious worker, to zoomorphic rat—governed by an innate and aggressive mammalian biogram, that we identify and further examine the shift from a Modernist optimism about fixing the failing city through the science of engineering, to a ecological pessimism that our very technological proficiency may prove our undoing. What we document are shifting attitudes toward the city through nature as either a model to be imitated, or a state from which we are struggling to emancipate ourselves.

In turn, a focus on architecture and design has much to offer science studies. While the history of science has shown great interest in animal *models* and *metaphors*, it has largely neglected to examine model *environments*. And while there has been a growing interest in the physical design of laboratories, hospitals, and asylas, the focus remains tied to a particular institution. Further analysis is needed of how the information developed in these sites travels elsewhere, such as from laboratory to city, and how the physical design of these spaces enables or disables the movement. In this sense, the experimental architectures of the rodent laboratory serve as *spaces of*

<sup>1</sup> Much of what has been done, by Murphy (2006) for example, has focused on the effects of the physical environment on physical health, on the problems of chemicals, lighting, air circulation, and so forth. Considerably less historical attention has been given to the effects of architecture on psychological health and social behavior.

<sup>2</sup> For a much-needed study of the influence of the concepts and methods of animal ecology on the early development of human ecology, see Jennifer Light (2009).

*translation*. This is both in terms of the influence of natural forms on human spaces, that is, *zoomorphic* or what architectural critics call “biomorphic spaces,” for example a building shaped like a termite mound; and conversely, the influence of human architecture on the design of animal enclosures—what we call “anthropomorphic spaces,” such as the kennel or dovecote as a miniature of the master’s house. Thus we seek to provide much needed symmetry—it is the rat *pens* and the *beehives* that are of interest, after all, not just the rats and bees.

#### BUILDING THE BEEHIVE

Analogies between beehives and human habitation have long been made, and Ramírez (2000) has usefully traced the influence through the history of architecture, from Gaudi’s explicit imitation of form to Le Corbusier’s implicit imitation of function. *Who Was the First Architect? Or Bees and Bee-Hives*, published anonymously in 1874, argues, “The bee is fully entitled to all respect and consideration as an architect,” and that the beehive is a “beautiful little city” (1874: 11, 27). The arrival of reinforced concrete and steel construction in the late nineteenth century brought renewed strength to those connections. For the first time, it became possible to construct buildings at a scale that approached (and has latterly exceeded) the ratio of bee-to-hive, and with this came the will to furnish their interior layout with a similarly repetitious monotony. Louis Sullivan, foremost architect of the early skyscraper, described its structure as an “indefinite number of stories of offices piled tier upon tier, one tier just like another tier, one office just like all the other offices, an office similar to a cell in a honey-comb” (1947: 202–13). The system is atomistic, undifferentiated: the size of the individual office unit would determine the size of the structural unit: “We take our cue from the individual cell, ... and we ... make them look all alike because they are all alike” (ibid.: 207).<sup>3</sup>

The beehive metaphors also feed into and out of a new ideology surrounding work. Scholarship by George Lakoff and Mark Johnson (1980) has stressed the importance of the semantic field in exposing broader value systems, and Claire Preston notes how the bee’s role as “nature’s workaholic” combines industriousness with a submission to authority and collective purpose. Those attributes ascribed to the bee describe an idealized employee: “private, modest, secret, retiring, unindividuated, seeking no more than to be an anonymous and identical cog in a wonderful natural machine” (Preston 2006: 11). Katherine Solomonson considers these repeated analogies with the beehive important: “Because the beehive was a traditional symbol of thrift and industry,

<sup>3</sup> Unsurprisingly, references to the skyscraper as a human beehive are not difficult to find, and writers on the office building consistently availed themselves of the analogy. Early in his career, Lewis Mumford had called the skyscraper a “honeycomb of cubes” (1924: 168), while Wiley Corbett calls tall buildings “great beehives of activity” (1926: 39).

the hive metaphor lent itself to the discussion of the tall office building in terms of efficiency and economy in design” (2001: 208). Sullivan’s designs thus not only maximized profits, but also presented the very *appearance* of efficiency.

So for Henry Van Brunt, Sullivan’s Masonic Temple (1891–1892), with its identical rows of windows, was “typical of an industrial hive of democratic industry” (quoted in Solomonson 2001: 208). The association between the skyscraper and the beehive was irresistible, a concrete statement of the Modernist ethic, summed up in Sullivan’s famous declaration: “form ever follows function.”<sup>4</sup>

The beehive-model was not universally popular. Trystan Edwards, in his influential *Good and Bad Manners in Architecture*, described the office block as suitable only for “some very tedious and retrograde kind of bee.” “There is no need,” Edwards urged, “for architects to seek inspiration from the honeycomb” (1924: 38–39). Reviewing Edwards’ book, Geoffrey Scott pushed such concerns aside, arguing instead that the office-block model did not go far enough. As Scott saw things, the “individualism of our streets is disastrous. We need more control in our civic architecture.... We need discipline and a plan” (1924: 84). In its repetitious geometry, the new architecture offered just such a template for macro-organization, a means of bringing to the modern city “power, stability and coherence” (*ibid.*). And indeed, the beehive model was increasingly employed to plan not only single buildings but also the city as a whole, stacking and organizing whole populations in the same way office workers were stacked and organized.

One of the most fantastical of these city plans was concocted by the American entrepreneur King Camp Gillette. Before he accrued a vast fortune from the disposable razor blade business that still bears his name, Gillette planned a utopia that would counter the chaos and “disease” of individualism (Roemer 1976: iii).<sup>5</sup> In 1894, he published his proposal as *The Human Drift*. Critical of the tradition of “scattered cities and towns” (1976 [1894]: 16), Gillette’s idea was radical: relocate almost the entire American population to a single vast city, what he called “the great and only ‘Metropolis.’”<sup>6</sup> Sixty

<sup>4</sup> Sullivan’s design philosophy owes much to the influence of Herbert Spencer (and Spencer’s, in turn, to Lamarck). For both, structure was the consequence of function (Steadman 2008: 148–50). Sullivan was also concerned with moral degeneration but optimistic that better citizens could be produced through design. Not only would a beehive-like office building facilitate more efficient working practices, but more efficient workers. Form did not simply follow function, but was bound up in such a way that the correct form could generate the desired function.

<sup>5</sup> As Roemer (1976: xv) explains, Gillette intended to build his utopia through the unification of all industry into “one vast operative mechanism”: a “World Corporation.” For Gillette, small business bred competition, strife, confusion, and fragmentation (*ibid.*: xviii).

<sup>6</sup> Metropolis would be built between Lake Ontario and Lake Erie, a site chosen principally for its proximity to Niagara Falls, which would serve as the city’s source of power and fresh water. Metropolis would make London, New York, or Vienna “look like the work of ignorant savages” (Gillette 1976 [1894]: 75).



million residents would be housed in twenty-four thousand identically luxurious apartment complexes, all laid out over a hexagonal grid to make distances between points as short as possible.

Gillette's decision to employ a hexagonal (rather than orthogonal) grid is something that in 1904 Charles Lamb would utilize for his own planned city, and it is the same pattern that Austrian Rudolf Müller would later propose as an alternative street plan for redeveloping sections of Vienna. As if anticipating Le Corbusier's calls for a structural Year Zero (the architect's answer to Ezra Pound's mandate: *Make It New*), Lamb called for the city to be made afresh: "What can be done when a city is already built, is still growing, and when the general plan is unsatisfactory? This, probably, is the most vital question which can affect any community" (1904: 9). Müller's scheme is more modest, but the parallels with Lamb and Gillette are arresting (compare Figure 1 and Figure 2). All are motivated by the same sense of efficiency. And in each case, it is difficult to pick apart how much the beehive analogy is an imitation of form, and how much of function. Müller writes: "When one places city blocks together in the form of a hexagonal honeycomb and

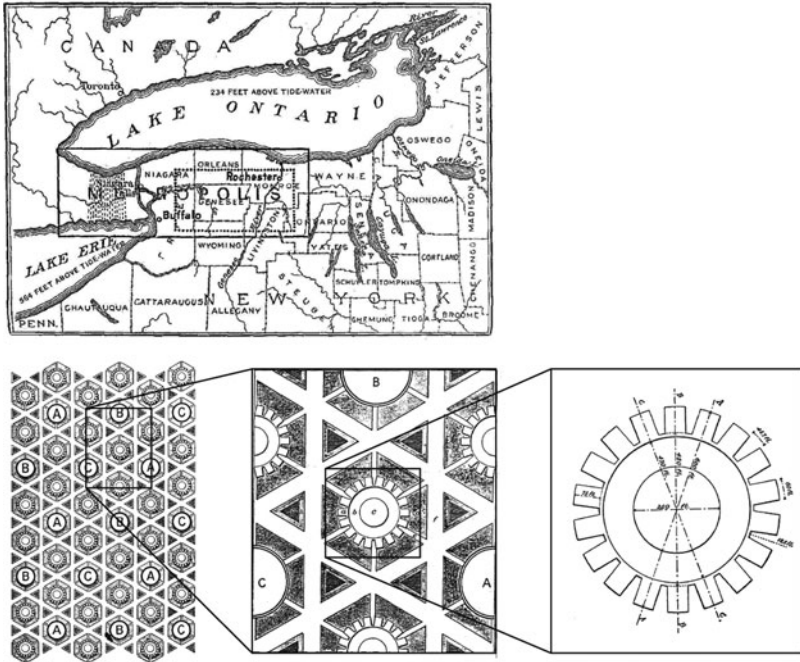


FIGURE 1 Location and plan views of Gillette's "Metropolis," from Gillette (1976 [1894]). Published by New Era Publishing Co., Boston, MA. Reprint by Scholars' Reprints and Facsimiles.

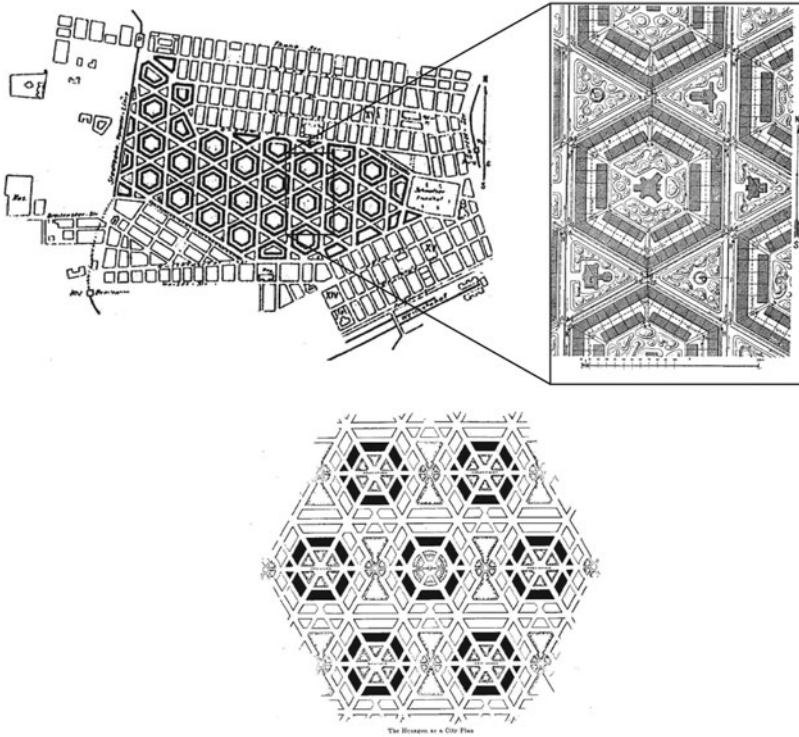


FIGURE 2 Müller's plans for an Austrian suburb (1908); Lamb's "City Plan" (1904)].

the streets organize the city blocks in place of partitions, these streets then pass everything in a regular broken form, whereby the shortest connecting lines between two points enclose the parts of the city" (1908: n.p.).

Although Modernism's products with their stark flat planes, right angles, and simple geometry seemed the very antithesis of natural forms, the growing concern for efficiency brought with it recognition that nature provided a model if not in morphology then in methodology. The evolutionary paradigm set nature as the most efficient of designers, whittling over millions of years to approach a near-perfect synthesis of form and function. Nature's baroque façade concealed a distinctly Modernist design ethic: every design feature was figured into a ruthless cost-benefit analysis, such that even apparent decoration shielded a functional role. Thus nature-as-model offered not decorative shapes to copy over extant, but a method of organization. And it is in this respect that the beehive presented itself as a template for the modern city.

The honeycomb cities with their hive-like apartment complexes of cells were not, their designers would insist, simply acts of nature-emulation, but analogously engineered solutions to analogous problems. The author of *Who Was the First Architect?* hints at just this when suggesting that the “hexagon is a far more useful figure for a bee’s cell than triangle, square, or circle. It affords the greatest strength, and necessitates the least waste of space” (1874: 49). Hexagons emerge as the consequence of least effort: a hexagonal grid is the most efficient way of arranging circles of equal diameter, and circles or cylinders with plastic edges will deform to a hexagonal “honeycomb.” For the bee, hexagonal tubes are materially more economical (using significantly less wax than triangular or square tubes, and structurally rigid through multiple angles of deformation). But structural economy was not the beehive’s only attraction.

For Modernist architecture’s most famed exponent, Le Corbusier, it symbolized the imposition of order over chaos. As he reflected when envisaging his “City of Tomorrow”: “If you were to look down from the sky on the confused and intricate surface of the earth, it would be seen that human effort is identical throughout the ages and at every point. Temples, towns, and houses are cells of identical aspect, and are made to the human scale. One might say that the human animal is like the bee, a constructor of geometrical cells.” Drawing closer, however, revealed not order and regularity, but disorder, chaos: “We may admit at once that in the last hundred years a sudden, chaotic and sweeping invasion, unforeseen and overwhelming, has descended upon the great city; ... The resultant chaos has brought it about that the Great City, which should be a phenomenon of power and energy, is to-day a menacing disaster, since it is no longer governed by the principles of geometry.”

The urban “invasion” Le Corbusier saw was of people without a plan. As a result, the organization of the city had not followed the rigorous, geometrical way of the bee, but what he characterized as “the pack-donkey’s way,” meandering along in its own, “scatter-brained and distracted fashion.” While the donkey, seeking to “avoid the larger stones, or to ease the climb, or to gain a little shade” is also taking “the line of least resistance,” it does so as an errant individual seeking to fulfill its own, transitory needs, not as a planner engineering a structure for the good of the collective. “The city is crumbling,” he argued “it cannot last much longer; its time is past. It is too old.... We are, all of us, aware of the danger now (1929: xxiv).

Le Corbusier also notes how the cities we do have are ill suited to their current purposes: the plans are very often built over the original layout, and the results are the crowded slums of today. Although the planned cities of Roman conquest and Imperial France (the favorable links to autocratic states are non-incidentals) had “exorcised” overcrowding, cities since then had failed to remain vigilant, and “imperceptibly, as a result of carelessness, weakness and anarchy, and by the system of ‘democratic’ responsibilities, the old business of overcrowding began again.” It was this municipal inability or

unwillingness to impose order that Le Corbusier saw his plans as correcting. With his followers, the “Rationalists,” known affectionately (and, for our purposes, ironically) as the “Rats” (due in part to their self-proclaimed propensity for challenging the more traditional, anti-urban, established order), Corbusier celebrated the “cell” as the crucial unit of the successful city. The cell was simple, ordered, decisive, clean: “a sensitive instrument ready to serve man.” Every person would be provided with just enough space to ensure his or her “happiness.” The cells would be stacked one upon the other to comprise large residential blocks arranged in a geometrical system. By so doing, the centers of the city would be ordered so as to decongest their traffic, while at the same time their density could yet be augmented: density being the lifeblood of the city, a source of its power and creativity. The populous would be provided with all that it craved—density and space, excitement and discipline, crowds and peace—each cell provided with “wide windows opening onto a dream landscape *conquered* by height” (1967: 233). For Le Corbusier this “machine for living” would overcome the existing “chaos of New York,” where individuals lived “holed up like rats” seeking shelter from the “sinister” and “pell-mell streets” below (*ibid.*: 230).

#### RAT CITIES: FROM RODENT UTOPIA TO URBAN HELL

From the outset, resistance to the beehive world fused aesthetic and sociological arguments. Critics did not always object to large buildings per se. Sullivan’s greatest protégé, Frank Lloyd Wright, celebrated his master’s Wainwright Building as a fitting answer to the problem of height: “Here was the ‘skyscraper’: a new thing beneath the sun, entity imperfect, but with virtue, individuality, beauty all its own. Until Louis Sullivan showed the way, high buildings lacked unity” (1949: 95). Unlike previous tall buildings, the Wainwright embodied for Wright the “organic ideal,” an ideal that he would seek to instill within the architects at Taliesin, his own “hive of inspired industry” (1931: 42). But if Sullivan had shown how the skyscraper could be a thing of beauty, that message was lost on the generation of architects that followed. In its place was a competition for sheer size, a drive to build “tall, taller and tallest” as “proof of American progress and greatness.” For Wright, this embodied the same tragedy, tyranny, and waste as St. Peter’s in Rome, or the Capitol in Washington, D.C. (*ibid.*: 83, 86). Meanwhile, the Modernists, in resisting the “senseless sentimentality” of those such as Ruskin, had forsaken beauty altogether, and were now “sterilized by a factory aesthetic” (*ibid.*: 40).

But Wright’s was not as a purely aesthetic objection. He saw in these bland high-density environments the seeds of more troubling social problems. The city was being built to satisfy those with a “herd mentality,” and had since been further “infested with the worst elements of society as a wharf is infested with rats” (Wright 1931: 101). Extending the skyscraper model to the entire city not only reflected the interests of the mob mind, but it also foisted that mentality

on others. Wright saw the city's residents becoming standardized "like an army," pigeon-holed as a unit or factor—"337611, block F, avenue A, street No. 127"—"soon you will see every domestic function fitted for and onto only some box. Great mansions? Yes—plenty of them. But there were only bigger, more extravagant boxing. The box better brushed and stuffed—that's all" (1949: 45). The consequences, Wright feared, would be devastating. All the crowding, congestion, and super-concentration would lead to distress, high blood pressure, insanity, vice, docility—to the "Machine-made moron" (1931: 111). If the herd instinct was carried to its logical conclusion, the death of the city was inevitable.

Others shared his sentiments. For left-wing biologist Lancelot Hogben, the beehive reflected not the realization of a higher, collectivist ideal, but quite the contrary, it had led to a breakdown in the social order. When reflecting in 1939 on the rise of National Socialism he had suggested, "Totalitarianism of the German type is in part [a] response to the hopeless monotony of life in the beehive city of modern industrialism" (1939: 68). For H. L. Mencken, much of the fault was to be laid at the feet of Le Corbusier: "When they begin to live in houses as coldly structural as step-ladders they will cease to be men, and become mere rats in cages.... To say that the florid chicken-coops of Le Corbusier and company are closer to nature is as absurd as to say that tar-paper shacks behind the railroad tracks are closer to nature" (1931: 165).

The reference to "rats in cages" was significant. Where Le Corbusier's "machines for living" would replace the disorganized squalor in which men survived "holed up like rats," for Mencken, it was the very standardization of the urban environment that, by attempting to bring man closer to nature, would drive him farther from it—like a docile lab-rat. One can detect in Hogben and Mencken a shared concern about the effects of a "rationalized" urban and industrial world on the behavior of its citizens. Yet for each, the consequences differed: for one, a retreat into violence and barbarism, for the other, withdrawal and isolation. These alternative outcomes would soon become united in the rat, as it became the preeminent model for understanding and controlling humanity's predicament in the built environment.

Paradoxically, the emergence of the urban rat as a model through which to *critique* modern design initiatives came from attempts to further sanitize and rationalize the urban environment: rodent control programs. The association between the rat and urban degeneration was more than symbolic. The rat would have real, quantifiable import as an experimental animal, a means of providing scientific proof that density was dangerous.

With the support of the Rockefeller Foundation and City of Baltimore, a rodent control project at Johns Hopkins University had been established in 1942 (Keiner 2005). War meant that loss of foodstuffs and the threat of disease were of especial significance, while concerns grew that the rat was a potential biological weapon, a covert means of spreading bubonic plague

through the American population. Researchers soon discovered that even after being decimated by improved methods of poisoning, rat populations would recover through time. A more effective approach proved to be *ecological*. Restricting access to nesting sites and food sources increased competition for resources and reduced the number of rats that could survive in a given area. The shift in emphasis from rat poisoning to “rat proofing” was reflected by a change in leadership from psychobiologist Curt Richter to ecologist David E. Davis.

While there were numerous ways to make an urban environment less habitable for rats, for Davis the most effective method of rat-proofing was to eradicate slum-housing altogether. The Rodent Ecology Project could contribute more than the reduction of rat populations, as Davis explained: “The beauty of this ecological method of control is that it improves the housing and living conditions of the human population, in addition to reducing the rat population ... replacing dilapidated unsanitary structures with clean, modern, substantial ones ... when whole blocks of tenements were razed on Manhattan’s East Side to make room for Stuyvesant Town, the rat population was reduced by many thousands. The same may be said of the numerous other replacements of slums with modern apartment developments.”<sup>7</sup>

Inspired by the high-density designs of Le Corbusier, Stuyvesant Town received its first residents in 1947, and by the early 1950s was proving a successful venture. Stuyvesant was in the Lower East Side adjacent to an impoverished area once known as the Gas House District (due to the large and leaky gas tanks dominating the streets), home to a particularly violent criminal fraternity that included the notorious “Gas House Gang.” With the construction of Stuyvesant’s large apartment complexes, unwanted residents, both rodent and human, were driven out.<sup>8</sup> So having been employed to use ecological methods to improve the urban environment for human beings through reducing rat populations, Rodent Ecology Project members began to see how their research also addressed problems of human ecology, and might be used to remedy more than just the vermin problem.

Architects and planners proved sympathetic, and widespread support for Le Corbusier-inspired projects of urban design continued into the 1950s. High-rise buildings were seen by many as the most effective way of coping with an ever-increasing concentration of people in cities, while at the same time preserving space for parks and outdoor amenities (Alexiou 2006: 38). In 1951, the *Architectural Forum* ran a story entitled “Slum Surgery in St. Louis,” praising

<sup>7</sup> David E. Davis, “The Fitness of the Environment” (1950), p. 12; Rodent Ecology Project Report, Rockefeller Foundation Archives, box 58, series 1.2, Rockefeller Archive Center.

<sup>8</sup> For some, no doubt, this extended not only to the significant criminal fraternity that once dominated the area, but also to the poor and non-white who were restricted from the project. For a critique of the selection of residents on the basis of “desirability,” and the high density of the project, see Mumford’s essay, “Prefabricated Blight,” first published in 1948.

plans for a \$58 million public housing project in St. Louis, Missouri consisting of twenty-six eleven-story apartment buildings. As the editors proudly declared, Pruitt-Igoe would replace “ramshackle old houses jammed with people—and rats” (ibid.). However, unlike Stuyvesant Town, it would soon become synonymous with urban decay, and as it did so, critics turned to some of the more unexpected results of the Rodent Ecology Project.

Scientists on the project were faced with a puzzle: why was it that rat populations stabilized at a certain level? Concerned with further understanding the underlying social and biological forces that influenced rat population dynamics, Davis had employed John B. Calhoun as his research assistant, and supervised the graduate research of John J. Christian. Both turned to the laboratory, adopting a simple yet powerful methodology. In 1947, Calhoun enclosed a small population of wild Norway rats in a quarter-acre pen near his home in Towson, Maryland, and let them breed. Protected from predation and supplied with ample food and water, the population grew rapidly. Extrapolating from the size of an individual laboratory cage, Calhoun calculated that the size of the pen would theoretically support up to five thousand adults. But after two years their numbers had never exceeded 200, and stabilized at around 150. Seeking an explanation for these surprisingly low population densities, Christian had turned to the work of Hans Selye (Christian 1950). Selye, based at the University of Montreal, was becoming renowned for his work on “stress.” Based on laboratory experiments with rats, Selye had posited a “General Adaptation Syndrome,” in which the adaptation of adrenalin for flight or fight responses would prove maladaptive under certain conditions. Prolonged stress would cause a near-constant state of adrenal alertness, leading in turn to a breakdown in bodily systems, identified by adrenal hypertrophy, atrophy of the lymphatic structures, and the ulceration of stomach and duodenum. Christian had found similar physiological symptoms in his rats, and applying Selye’s insights, posited *stress* resulting from high population density as the cause (ibid.: 1961). Likewise, Calhoun had adjusted the supply of food and water to accommodate, but it was seemingly the lack of space that had become a problem. Calhoun believed that rats in the wild favored a unitary social group of ten to twelve adults. With increased population density and no territory into which new groups might expand, unwanted social contact between groups occurred with increasing frequency, leading to territorial squabbles and a gradual breakdown in the social order (Calhoun 1962; 1963a; 1963b; 1971).

For both Calhoun and Christian, the relevance to humans was immediately evident: life in crowded environments could be detrimental, even devastating, for mammalian populations. Others agreed, and both men found their work of interest to institutions dealing with the control of confined *human* populations: Christian went on to work at the Naval Medical Research Institute, while Calhoun was employed first at Walter Reed Army Medical Center, and then,

in 1954, at the National Institute of Mental Health. Both dedicated themselves to the study of crowding in rats and mice, and both addressed a problem fundamental to animal ecology: the role of density in regulating mammalian populations. But as their work progressed, they made the links to human population problems more and more explicit.<sup>9</sup>

To play out his crowding experiments, Calhoun built increasingly elaborate enclosures that he liked to describe as “rat cities.” These were anthropomorphic spaces, deliberately modeled on the inner-city tower block with nesting accommodation stacked in vertical arrangements above narrow entrances and “stairwells” that trammed the rodents into regular contact. Under laboratory conditions, the mechanisms that had inhibited population size in his outdoor pens now resulted in increasingly severe behavioral pathologies, and again Calhoun was not reticent about describing these in anthropomorphic terms. Within the rat cities, dominant rats were “despots” or “king-pins,” excessively violent young rats were “juvenile delinquents”; animals became hypersexual, homosexual, or pansexual; cases of female rats attacking their young were synonymous with “child-abuse” and “battered child syndrome.” Calhoun was particularly taken with problems of withdrawal, describing a huddled, vacant mass of males as the “beautiful ones,” which he further characterized as “social misfits,” “autistics,” or “drop-outs.” As the population became overwhelmed by evermore-obstructive pathologies, what Calhoun had first described as a “rodent utopia,” had rapidly descended into “hell.” Within what he called “the behavioral sink,” mortality rates reached 96 percent and, unable to recover or function, he later showed how the populations dwindled inexorably to zero (1962; 1973).

#### FROM ANIMAL LAB TO HUMAN ZOO

While ecological studies of crowding stress had become commonplace in animal ecology by the 1950s, it was in the 1960s and 1970s that they captured the imagination of a generation concerned with the urban environment, environmental degradation, and rapid population growth, or, in Paul Ehrlich’s memorable Cold War turn, *The Population Bomb* (1968). This first wave of the environmental movement, quickened by Rachel Carson’s *Silent Spring* (1962), culminated at decade’s end with “Earth Day” in 1970, where attention fell squarely on the problems of space and numbers.

For many social commentators, these were problems evident in the modern city, and the American city in particular. In 1965, the five-day Watts riot left thirty-four people dead and more than a thousand injured. In 1966, rioting in Detroit caused forty-three deaths, and following Martin Luther King’s assassination in 1968, rioting broke out in over 120 cities including

<sup>9</sup> Calhoun’s research into behavioral pathology was by far the more dramatic and, through his 1962 paper in *Scientific American*, was packaged to attract the attention of a broad audience.



Chicago and Washington, D.C. Combined with this urban violence, conservatives also saw signs of sexual deviance in the growing drug culture, an increasingly visible homosexual community, and the “free love” movement across American campuses. The failure of numerous witnesses to react to the sexual assault and murder of Kitty Genovese in Queens in 1964 was held up as evidence of a numb withdrawal and misanthropic isolation characteristic of the urban mindset. For writers and journalists, drawing behavioral analogies between the rats in Calhoun and Christian’s crowded pens and social breakdown in the urban environment seems to have been irresistible. In Tom Wolfe’s *The Pump House Gang*, the association between physical space and behavior was critical.<sup>10</sup> Reflecting on the behavior of New Yorkers at rush hour, Wolfe writes: “It got to be easy to look at New Yorkers as animals ... running around, dodging, blinking their eyes, making a sound like a pen full of starlings or rats or something” (1968: 233).

Suspicion grew that far from being a *solution* to the problem of the crowded city, the modern apartment complexes were perhaps part of the problem. Social engineering by relocation had not delivered on the early promise of Stuyvesant Town, and a growing sense of pessimism set in. A public-housing resident interviewed by Daniel Seligman in the mid-1950s sums up the mood in especially trenchant terms: “Once upon a time we thought that if we could only get our problem families out of these dreadful slums, then papa would stop taking dope, mama would stop chasing around, and junior would stop carrying a knife. Well, we’ve got them in a nice new apartment with modern kitchens and a recreation center. And they’re the same bunch of bastards they always were” (1957: 106).

Architects and planners began to wonder if there was something that they were failing to understand regarding the human relationship with the built environment. Seeking answers, they turned to the behavioral sciences, just as socially concerned psychologists and sociologists were turning their attention to the urban environment. In the crowding studies of Christian and Calhoun both found a convenient explanation, and with it, a possible solution: designing the urban environment in accordance to humanity’s biological needs as a mammal. For Lewis Mumford, one of the great critics of modern planning initiatives, modern architecture seemed to have been designed for the social insect: “the beehive, the termitary, and the ant-hill—structures often imposing in size, skillfully wrought” (1961: 6). Yet Mumford did not see order and efficiency in these beehive cities, but violence and decay, a “focal center of organized aggression” and “mass extermination” (ibid.: 42). To comprehend that disjunction, he turned to Calhoun and Christian’s experiments with rats: “No small part of this ugly barbarization has been due to sheer physical

<sup>10</sup> Even the title of the book, with its explicit echo of the Gas House Gang, refers to a socially outcast band of surfers who gather at a sewage pump house on La Jolla beach in California.

congestion: a diagnosis now partly confirmed with scientific experiments with rats—for when they are placed in equally congested quarters, they exhibit the same symptoms of stress, alienation, hostility, sexual perversion, parental incompetence, and rabid violence that we now find in the Megalopolis” (1968: 210).

ECOLOGY AND ARCHITECTURE: IAN MCHARG

From the early twentieth century through to the 1950s, the problems of the city were to be solved by the designer-as-engineer—a technological solution to a technological problem. The style has been aptly described by Michael Conan (2000) as “sanitary modernism”: by providing individuals with standardized, clean, functional buildings, human nature would be allowed free and creative expression, in ways that worked towards, rather than against, an ordered, cohesive, and ultimately healthy society. With the laboratory and field studies of those such as Calhoun and Christian, coupled with growing skepticism over the technology’s capacity to fix the problem of the city, the focus now shifted, away from the science of engineering, and towards the science of ecology.

It is a shift reflected in the approach of the architect Ian McHarg, whose “method and approach took the profession by storm” (Nadenicek and Hastings, 2000: 143). His interdisciplinary program of landscape architecture at the University of Pennsylvania inherited the mantle of America’s premier school of planning and design from Harvard, where such luminaries as Louis Kahn and Walter Gropius had steeped a generation of American students in the aesthetics and philosophy of European Modernism.

A newcomer to the field of architecture, McHarg had left the British army to enroll as a student of architecture and planning at Harvard following World War II. Here he was inspired by the Modernists’ aim of making cities humane by designing for space, light, and moments of tranquility. However, he took his lead not from the Modernist school, but rather from the courses in landscape architecture overseen by those such as Holmes Perkins, William Holford, and others from the British Garden Cities and new town movements (Walker and Simo, 1994: 269). The Garden City approach had been first developed by Ebenezer Howard to combat slums and overcrowding, and to relieve pressure of population within London, the worst of what he called the “crowded, ill-ventilated, unplanned, unwieldy, unhealthy cities—ulcers on the very face of our beautiful island” (1965: 145).<sup>11</sup>

McHarg believed the British town planners had been among the first to make urban design consistent with the needs of the environment, as opposed to mere economic concerns with convenience, growth, efficiency, and money (1962). The ecologist was to be considered heir to a truly organic architecture: “Once

<sup>11</sup> See also pp. 42, 74 and 128. For institutional context, see, for example, Reade (1987: 31–68).

upon a time, architects used to say ‘Form follows function.’ This was a kind of manifesto, illustrated by inorganic systems such as utensils, planes, and rockets. But if one notes that this was being proclaimed at a time when Darwinism had existed for almost a century ... it seems, in retrospect, almost infantilism.... If one examined organic systems, I think one would be persuaded to adapt the statement and say ‘Form expresses process,’ or better still, ‘Process is expressive’” (ibid.: 102).

The process was one of adaptation, resulting in a vast web of interactions between species and their habitats. Humanity, in contrast, functioned solely as a depletive or entropic element in the system, our cities “gouging, hacking and destroying” (ibid.). This language would become a recurring motif: anarchy, cancer, disease—humanity was nature gone awry; the cities were an unplanned, unchecked, ultimately destructive phenomenon. In a sentiment he would repeat when addressing the crowds at Earth Day in 1970, McHarg compared the uncontrolled spread of humankind to a cancer, wondering if we ought to view “the cities of man as gray, black, and brown blemishes upon the green earth with dynamic tentacles extending from them,” and asking: “Are these the evidence of man, the planetary disease?” (1964: 4).

Perhaps McHarg’s most significant contribution was his development of an analytic method to diagnose and deal with this threat. Known as the “layer-cake method,” the process involves measuring multiple features of potential building sites and then compiling these onto a simultaneous display, layering plans of rock, soil, water, wildlife, human needs, even beauty, over one another to create a *deep profile* of the local ecology and its interrelations. By so doing, it was possible to establish where best to build and where to preserve, thereby limiting ecological damage.

McHarg’s environmental concerns resonated with his generation, and from 1962 (the same year that Carson published *Silent Spring* and Calhoun his article in *Scientific American*), McHarg began to teach a studio course with an ecologist, hired a forester as a fulltime faculty member, and, with a fellow Penn architect and planner, founded a firm, Wallace and McHarg, through which his philosophy could be implemented. As his onetime student Anne Whiston Spirn recalls, it was from this point that his environmentalism became fully integrated into his teaching and professional work and he emerged as a leader who played an increasingly important role in shaping national environmental policy (2000: 103).

McHarg’s university courses and public lectures frequently overlapped as he sought to realize two interdependent aims: first, to generate a generation of planners and designers who were ecologically minded, second, to establish a demand for their wares. Regarding the former, McHarg had leading figures in science and policy address his students, and eight of the fifteen lectures in his 1963 course were delivered by Nobel Laureates (ibid.: 103). They left McHarg’s students with little doubt as to their role as saviors of the American

city, Loren Eiseley urging, “We have not escaped nature.... So I would like to say that you as City Planners, as Architects should remember that your task is not just that of crowding as many human beings into as small a space as possible, your task is also that of trying to create in the cities of man and the buildings of man at least some natural touch, some human memory of what the world was like when John Locke said, ‘In the beginning the whole world was like America.’”<sup>12</sup>

Many of these speakers were interviewed on McHarg’s own television show, *The House We Live In*, which first aired on CBS in 1960. Here, ecologists, social scientists, psychologists, psychiatrists, and physiologists, as well as planners and architects, considered urban problems and policy solutions. The viewer was introduced, through Hans Selye, to the problem of stress; through Fairfield Osborne to an understanding of population growth and limited resources; through Lewis Mumford to the multitude of failures in urban planning. A central theme was the problem of the crowd, the normally cautious Christian declaring: “My own, purely personal, reaction is one of horror.”<sup>13</sup> Yet it was a personal reaction underwritten by scientific evidence. “Just to drive on the East and Southwest coast expressways is a traumatic experience,” Christian said, “one which is certainly associated with city and urbanity, the inability to get out and away from this creeping menace of burial under a housing development is a real restriction of individuality and of freedom. I think that possibilities for outlets for emotions are being seriously curtailed and, further, that this is the mechanism which is going to limit population growth in human beings. I feel reasonably certain, although this again is prognostation, that the same thing will happen to human populations as happened with the experimental animals.”<sup>14</sup> During the interviews, McHarg prompted his guests to address the impact of population density on human health, and it was typical for him to append their answers with, “It seems to be true for Dr. Christian’s animals.”<sup>15</sup> When guests were reticent in extrapolating from crowded rodents to man, McHarg would make the connections for them. As he often stated when introducing his speakers, they were coming at the problems of health in the city, “through ... experiments with mice.”<sup>16</sup>

This is what Calhoun had intended. While he had expressed sympathy with Mumford’s critique of Stuyvesant Town in 1948, he also noted how

<sup>12</sup> Loren Eiseley, “Man and Environment,” 109.II.E.2.21, Ian McHarg Archives, University of Pennsylvania.

<sup>13</sup> *The House We Live In*: series # 2, program #4, John Christian, February 1961, 109.II.B.2.25, McHarg Archives, University of Pennsylvania.

<sup>14</sup> *Ibid.*

<sup>15</sup> *The House We Live In*: series #2, program #9, Leonard Duhl, April 1961, copy #1, 109.II.B.2.7, McHarg Archives, University of Pennsylvania.

<sup>16</sup> *Ibid.* See also, *The House We Live In*: series #2, program #7, talk with William L. C. Wheaton, Director of Institute for Urban Studies, March 1961, 109.II.8.2.8, McHarg Archives, University of Pennsylvania.

Mumford lacked the empirical data he needed.<sup>17</sup> This Calhoun would provide through his rat and mouse cities. So successful was Calhoun that he was invited to speak every year for McHarg's course on landscape architecture. The designers, builders, and planners of the future needed to be, in essence, ecologists, and it was the ecology of Calhoun and Christian—the idea that density is dangerous—that they were exposed to. McHarg even had his students carry out their own “Calhounian”-inspired study of Philadelphia, layering statistical measures of crime, sexual deviance, poverty, and general “social disease,” onto one another, and then correlating this to population density (McHarg 1969). Just as natural processes were unitary, with any change in one part affecting the entire system, so too with the study of social and biological stresses on the human body and society. The result was a layer-cake method for human ecology, a “single accounting system” to deal with urban social pathology.<sup>18</sup>

In Calhoun's presentations, the hexagon assumed a dual role. It delineated the distance between territories of rats in the wild, based on the amount of space required for rodent populations to live peaceably in extended networks of ten to twelve adults. As Calhoun argued, nature wasted no space. From here he extrapolated to human spaces and territories, what Calhoun called “culture areas.” The emphasis was again on the economy of numbers-per-square-unit-area, but crucially, unlike the cities of Gillette, Müller, and Lamb, the hexagon was used not as a means of *containment*, of compacting large numbers of people in one space and keeping them in. Rather, the emphasis was on keeping them *apart*. In the ecological model, the hexagon offered safe distance.

Yet he also used the hexagon in a very different way: to model Modernist architecture and assess its effects. Calhoun describes how a discussion with an entomologist led him to recognize his rodent universes as cells.<sup>19</sup> We can see this influence in his designs for a vivarium, which is a universe of hexagonal interconnected cells designed to create chaos, to show that the beehive world would lead to the social, mental, and physiological breakdown of individuals and society (see Figure 4).

McHarg's work was important in entwining psychology, ethology, and architecture. During the early 1970s, the environmental movement was widening its sphere of concern, partly out of an awareness that urban problems were ultimately environmental problems (pollution, land use, habitat destruction),

<sup>17</sup> For Calhoun, “human values” were more important than mere “engineering efficiency”; letter to J. P. Scott, 15 Dec. 1948, Calhoun Papers, box 11a, University of Wyoming. [At time of composition, Calhoun's archive is split over two sites—the National Library of Medicine, and Wyoming. Future plans are to consolidate the archive at the former.]

<sup>18</sup> “Metropolitan Open Space from Natural Processes,” ch. 2, p. 29, 109.II.C.61, McHarg Archives, University of Pennsylvania.

<sup>19</sup> Calhoun, Report, 1 Dec. 1964, Calhoun Papers, box 22, National Library of Medicine.

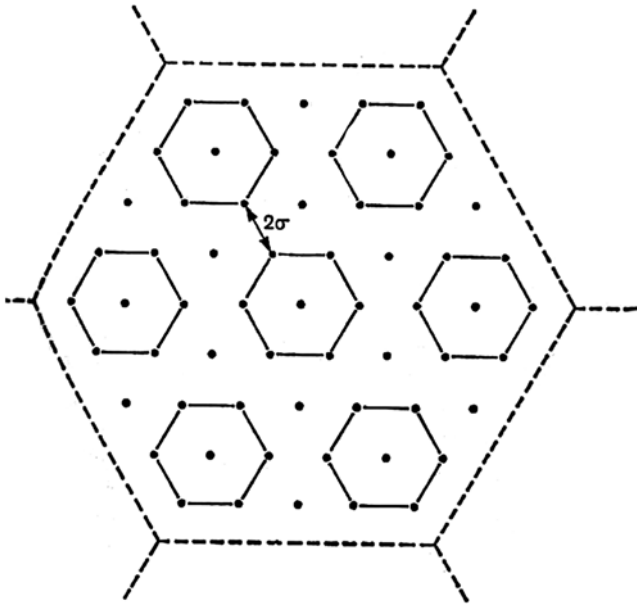


FIGURE 3 Calhoun's "idealized format of a 'culture area'" where "each dot represents the location of a village site." Calhoun Archive, National Library of Medicine, Bethesda, Maryland.

and partly in response to critics who charged that the environmentalist movement was an elitist, middle-class luxury, which prioritized the aesthetic experience of nature and marginalized the experience of the urban poor. As the demographer Philip Hauser put it, reviewing a book by the Ehrlichs in 1971: "There is danger that the ecologists' crusade ... can be used to obscure more immediate and pressing man-made problems of at least equally high priority. Certainly in the coming generation it will be at least as important to eliminate slums and ghettos as to preserve the Great Lakes; and to eliminate rats in sub-standard housing as to preserve the bald eagle" (1971: 445).

But the environmental movement would prove crucial in acting as a trading ground for exchanges between psychologists, ethologists, and architects. As environmental concerns restated the population problem as an ecological problem—linking the growth and management of human populations to the plight of endangered species and ecosystems—it became increasingly normal to speak of human and non-human populations in the same terms, of "defensible space," of "the built environment," of "territory" and "instinct." By the time E. O. Wilson's *Sociobiology* arrived to much fanfare in 1975, ethology—the study of animal behavior—was widely considered an appropriate register with which to discuss human interactions.

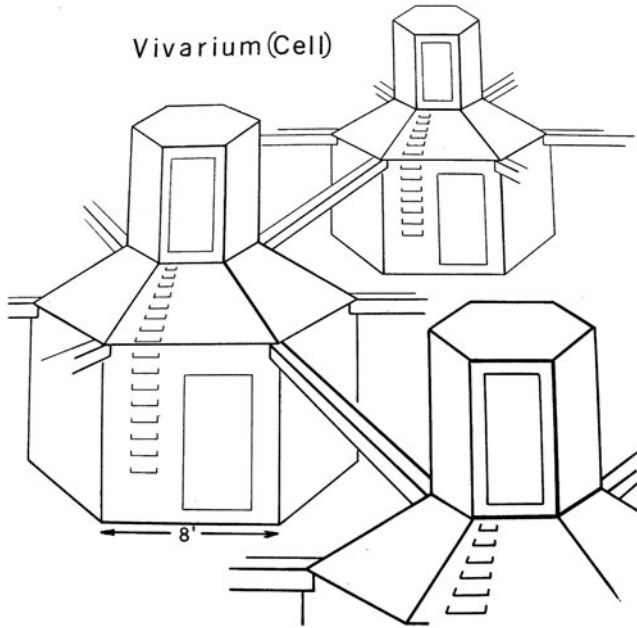


FIGURE 4 Calhoun's plan for a vivarium from *Mammalian Behavioral Evolution*, 10 February 1967. Calhoun Archive, National Library of Medicine, Bethesda.

#### ECOLOGY AND "ARCOLOGY": PAOLO SOLERI

Elsewhere, the new concern with ecological thinking resulted in renewed attempts to realize the beehive city, now under the banner of environmental protection. Although the rationale was original, the designs will be familiar: vast, geometric, compact, super-dense cities (compare Dantzig and Saaty's 1973 *Compact City* with Gillette's "Metropolis"). One of many such plans was unveiled by the architect Paolo Soleri in 1969. Described as a "Hexahedron," it was an enclosed environment composed of two offset, inverted, pyramids, three thousand feet high, designed to house one hundred thousand people. The hexahedron was part of a broader project he called "Arcology," a portmanteau of architecture and ecology. In some respects, Soleri's philosophy shared much with McHarg's: both saw their approaches as protecting the environment from the reckless, sprawling growth of cities and suburbs, and, more fundamentally, both foregrounded the interconnectedness and co-dependency of humanity and nature. But Soleri's prescription was very different. Rather than attempting to harmonize with the landscape, the city was to be viewed as an alternative to, and largely independent of, the natural ecosystem. It would insulate nature from the "cancer" of the city by segregating human habitation into

confined zones of high-density occupation, much like Gillette's Metropolis. For Soleri, density was not the problem, but the solution.

Soleri saw his work as combining elements of European rationalism and American organicism, but it was Le Corbusier who "spoke to him" (Lima 2003: 20). By containing human populations in vast mega-structures surrounded by open space, Soleri believed he could maximize the potential of both city and countryside: nature, protected from unchecked sprawl, would flourish, while the new cities would act as vast urban laboratories to nurture a higher intellectual and spiritual community. For Soleri, the crowd was essential to this cultural evolution, and the city was essentially "a crowding phenomenon" (2003: 25): "The value, indeed the imperative of crowding, is documented by 3.5 eons of life. Organisms are by definition crowded, self-contained, miniaturized realities. Organisms, societies, and cultures that turn away from such an imperative would be strange, paradoxical, and ineffective exception.... Sprawl is a pathological event. It suffers from gigantism with all the derivative handicaps and shortcomings: environmental disruption, waste, pollution, energy and time depletion, expensive logistics, segregation, and urban decay" (1983: 24). Although he proposed them as a serious alternative, as William Thompson (1990: 37) observed, they looked like the sketches for a sci-fi movie or comic book (and were the inspiration for several). It is an impression only reinforced by closer inspection; the designs have the appearance of complexity, but what appears to be detail is merely suggestive rendering. These are not plans but sketches.

Soleri implies that this imprecision is to some extent deliberate—details can be supplied later. Yet it seemed he had thought no more about how these cities would function than he had about how their citizenry would function within them. Ultimately, this reflected his failure to consider the needs of the human as a social, biological, and psychological being: he has designed a beehive and demanded that humanity adapt. For his many critics, that Soleri's cities were reminiscent of beehives, anthills, and termitaria suggested more politically noxious connotations, and some even accused him of fascism (Thompson 1990: 48).

Despite his ideas being predicated upon such a pliable conception of human nature, Soleri believed that the fundamental difference between the beehive and the city was that the inhabitants of cities could think for themselves: "This will be the fundamental distinction between the city and the anthill, the beehive, the termite colony, and so on: not just brains by the score but also minds by the score. The romantic and rugged individualists will speak out immediately about the mindlessness of the human beehive. They might want to glance at nightmarish suburbia with its six billion individuals; but it is their privilege not to reason about mankind and the staggering logistics it is faced with" (Soleri 1969: 12).



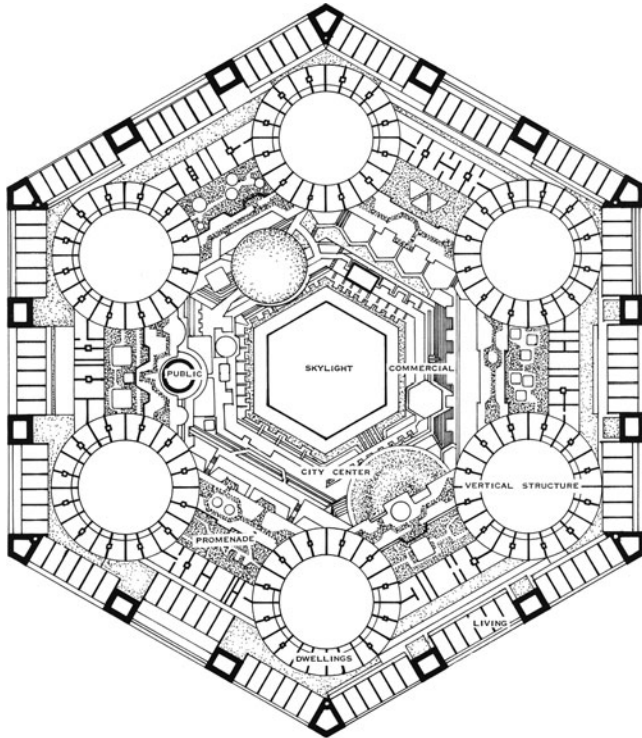


FIGURE 5 Soleri's "Arcvillage 2" inc. detail (Soleri 1969: 74). Reproduced with permission from Cosanti Foundation.

So the city would not so much form the human, as the human would form the city; or rather, man would reach a new level of social and spiritual awakening *through* the city. Yet while Soleri may have celebrated the individual, he was, paradoxically, becoming "the spokesman for the collectivization of mankind," his arcologies "cultural containers rather than cultural vehicles" (Thompson 1990: 44, 58). For Thompson, the designs were not merely hopelessly naïve, they were potentially dangerous: "If one moves Western, secular, aggressive, civilized man into an arcology, the settlement will be no more successful than a public housing development of a British New Town. The arcology, rather than solving the problem of urban civilization, could very well become the ultimate instrument of human collectivization" (*ibid.*: 57).

For other designers of mega-structures, too, including Japanese architect Kenzo Tange, making dense urban living a success meant sacrificing personal preferences for the good of the community (Kulterman 1970). In Japan, Soleri

and Tange's "mega cities" were seemingly taken more seriously.<sup>20</sup> As Walter Gropius had remarked, while Japan was so often emulated and imitated for its simple, frugal, and beautiful use of space, balance between form and function was achieved, in part, through "voluntary subordination to a common principle" (1960: 2).

But even if the Japanese really were more inclined to accede to authority, the level of "subordination" the planned cities demanded in order to function was considerable, and for many, here was the problem with trying to achieve a utopia through design. Lewis Mumford saw totalitarianism implicit in the very concept, and asserted that autocracy and city planning were entwined from the very start: "Plato makes his republic immune to change: once formed, the pattern of order remains static, as in the insect societies to which it bears a close resemblance" (1965: 275). Building big embodied both the utopian vision of curing the city through design, and its inevitable failure, the high-rise becoming, in the words of the anthropologist Edward Hall, "a new source of anomie in ghetto life" (1969: 182).<sup>21</sup> This was the danger of the artist-architect's vision imposed onto the populous. The beehive world not only demanded that the people play subservient drones to an all powerful "queen," but the metaphor also allowed and even encouraged the population to be considered as an undifferentiated aggregate.<sup>22</sup> The ramifications of the "city-as-hive" are underscored by philosopher Susanne Langer, who reminds her readers of significant *disanalogies* between cities and hives: "Its citizens are the whole and only individuals. They are not a "living mass," like a swarm of semi-individuated bees. The model of the hive has brought with it the concept of human masses, to be cared for in times of peace, deployed in times of war, educated for use or sacrificed for the higher good of their state. In the specious analogy of animal and human society, the hive and the city, lies, I think, the basic philosophical fallacy of all totalitarian theory, even the

<sup>20</sup> Soleri often expressed his admiration for Japanese architecture, and in reciprocity, in 1996 the Japanese Ministry of Construction supported a competition for a "Hyper Building." Soleri was one of three selected for the project, but the economic crisis forced its halt (Lima 2003: 353).

<sup>21</sup> Through his studies of "proxemics," Hall had done more than most to explicate the mechanics of personal space. Similarly inspired by the work of Calhoun and Christian, Hall argued that man had evolved a biological capacity to deal with a limited number of social contacts. Privacy and social distance were required, qualities all too often lacking in the crowded urban environment (1966).

<sup>22</sup> As Claire Preston has it, "*Bees* are always communal, plural, public, unindividuated, corporate, *en masse*... One bee is no bee" (2006: 15). Little wonder, then, that as relations between the communist nations and the capitalist West cooled, the bee analogies came to seem increasingly suspect. Seen through the hostilities of the Cold War, the bee is no longer an industrious Fordian production line worker, but something much closer to the passive, obedient Soviet. Indeed, Corbusier had himself lent his support to the architectural projects of Soviet-era communism, where it was supposed that a people suitably accustomed to living in equal conditions in vast concrete blocks might come to think of one another as equals.

most sincere and idealistic—even the thoroughly noble political thought of Plato” (1962: 122).

McHarg agreed. When asked for his opinion of Soleri, he was characteristically brusque: “I love Solari [*sic*],” he told an audience at the American Institute of Planners in 1971. “I think he designs beautiful buildings—for termites who’ve had pre-frontal lobotomies” (Porter 1971). The beehive world, McHarg was saying, was no place for humans, and those designers and planners who had supposed men might live in the manner of social insects—pacified, docile, orderly—were mistaken. Instead, under these crowded conditions, they would react like Calhoun and Christian’s rodents.

#### RAT VERSUS BEE

In his cultural history of the rat, Jonathan Burt calls it “the totem animal of modernity”: a “hero of science” and the most abject and hated of all creatures (2006: 112). What was hated, at least in part, was the overlap: the rat as “man in miniature,” a role that warranted and was reinforced by the rat’s use as an experimental animal. The rat parallels the behavior of humans in a manner that would make it seem, as Burt has it, “the twin of the human.” With the rat seen to rival man as the quintessential urban animal, it was unsurprising that so many were taken with Calhoun and Christian’s results.

In using the experimental “rat cities” to challenge the beehive worlds, McHarg was joined by an emerging generation of social and behavioral scientists similarly inclined to make associations between density and pathology. As the sociologists Galle, Gove, and MacPherson declared: “We . . . take the animal studies as a serious model for human populations” (1972: 23). In transferring their focus from animals to humans, many turned to statistical data collected through censuses and surveys in such cities as Chicago, Hong Kong, and New York. Like McHarg, they began to correlate measures of urban density with socio-pathologies chosen to match those exhibited by crowded rats: aggression was to be measured by crime and delinquency, withdrawal by admissions to mental hospitals, sexual deviance by assault and the breakdown in maternal behavior by welfare measures (Freedman 1975; Schmitt 1966; Winsborough 1965). Others sought to observe the various behavioral pathologies identified in the animal studies among humans at various levels of density, in laboratories, prisons, dormitories, apartment buildings, and schools. Calhoun and Christian’s rodents were proving a useful means of constraining the spread of the beehive cities as envisaged by Soleri and Tange, environments that seemed built for “extremely high insect colony densities” (Schiffenbauer et al. 1977: 9). Those who regarded “density as a prerequisite for the optimal organization of society and the enhancement of human life” were misguided (Stokols et al. 1973: 87). Their designs for a beehive world, cities as “concrete honeycombs” (Ardrey 1970: 238) would, when populated by humans, yield a rat city. As the ethologist Robert Ardrey explained,

“If man is infinitely malleable, as so many would have us believe, then urban concentration should offer no dismay. We can adapt to anything, even to the crawling masses of insect life. It is a proposition that few would accept. The territorial principle has been evolution’s most effective implement in the distribution of animal space ... we must somehow preserve NO TRESPASSING signs” (1970: 227–28).

It helped that all this evidence of the pathological consequences of high population density fitted neatly into existing beliefs about the evils of the crowd, which had, of course, long been spoken of as a social malaise. Indeed, in 1931, when Wright describes the urban scene he so despised, it is in language that closely prefigures Calhoun’s descriptions of the behavioral sink: “And the herd-instinct that moves in the crowd and curses it is only the more developed by the mechanistic conditions in which the crowd swarms and lives. Millions are already sunk so low as to know no other preferment, to desire none. The common denominator—so profitable when congested—being further educated to congest, *taught* to be lost when not exited by the pressure and warmth of the crowd, turns argus-eyed toward what—more whirl?” (1931: 107).

Like Calhoun’s rats, people are drawn to one another, irrespective of the harm it does them, becoming more debased with every encounter. As Wright sees it, by providing an environment where the masses can “swarm,” the modern city both enables and ennobles the very processes that ultimately lead to the degeneration of its citizenry. The city at once corrupted its citizens, and provided an environment in which that corruption was permissible. As fiction writer Bruce Malzberg put it, the city gave people “the opportunity to do without penalty exactly all of those things that we must do in order to bear it” (1973: 38). What manifested as behavioral pathologies were really coping mechanisms, (mal)adaptive responses to living at social densities far in excess of anything evolutionary history had prepared us for. The city was a danger for the same reasons that it was attractive. Both the rat and the human thrived in the city, and both ultimately suffered because of it. In the rodent experiments, the provision of “ideal” conditions led to overpopulation and the behavioral sink. Hence Calhoun’s conclusion that “utopia was death” (Pines 1971). And those who opposed them contended that a similar fate awaited residents of the human apiaries. In their attempts to make man into a social insect, beehive worlds were not only unattractive politically and aesthetically, they were doomed to failure. Amid architectonic order would be socio-cultural chaos.

Of course, those who supported the beehive paradigm were not so easily dissuaded, complaining that the rodent experiments had fitted in with existing preconceptions just a little *too* neatly. For Soleri, those who assumed that high density led to violence and social breakdown were very much mistaken: “An environ 10 times more eventful (a city for instance) should reasonably carry

10 times more violence. *The astonishing fact is that this is not so.* The fact is that, on average, the urban effect is *benevolent*. Quite a feat" (1983: 77). While such optimism might be expected from Soleri, social and behavioral scientists who had been expecting to identify and replicate Calhoun and Christian's pathologies in the laboratory and field would be disappointed. Their results were inconsistent, and some even showed negative correlations between density and pathology. What behavioral pathologies they *did* locate rarely matched the dramatic intensity of those witnessed in the rodents' crowded pens. This lack of evidence encouraged many to question the validity of arguing from analogy, and the reliance on evidence from rodent experiments was increasingly a source of criticism. For the urban sociologists Claude Fischer and Mark Baldassare, "Urban critics too often make the leap from rat cages to cities" (1975: 532). As a consequence, the experiments of ecologists had conspired to generate what Douglas Porteous dismissed as "a modern folk-myth concerning the evils of crowding" (1977: 176).

The rodent experiments seemed to serve what was ultimately a conservative, anti-urban philosophy that saw the masses as an inherent evil; uncultured "rats" to be controlled and restricted from above through centralized planning. A new criticism emerged: in spite of the supposed differences between the rat and bee models, were they not, ultimately, after the same thing? For one critic, whether for or against density, all were guilty of the same crime of autocratic "over-planning": "In this century, we have seen notions aired from the garden city to proposals for a single-structure with a fully conditioned atmosphere, designed to accommodate the life-cycle of a whole community; from back-to-the-land to instant cities (beehive cells to beehive city); from a 300 mile-long linear settlement to horticultural skyscrapers rising from parks. These have been on-off experiments with no sociological basis and have perversely demanded that man fit the plan" (Walker 1966: 388).

Corbusier and Soleri had been criticized for their totalitarian visions of a beehive world, but now, McHarg and other environmental designers faced similar charges. In the case of McHarg, his dogmatism and insistence on branding those that did not follow his approach as "anti-scientific" bred a growing discontent among planners and architects.<sup>23</sup> In attempts to bring nature into the city, as McHarg demanded, many had even turned to the hexagonal form of the beehive.

The late twentieth century saw the emergence of a new critical perspective on planning to correct the failing city. Particularly influential was the work of

<sup>23</sup> A profile from 1965 contains a scathing assessment: "'The man's a fraud,' said a[n unnamed] former colleague. 'He can't design and he's got no feeling for aesthetics. What he does have is a genius for self-promotion.'" In "Nature Boy," *Greater Philadelphia Magazine*, Oct. 1965: 57, 80-87, quote p. 85. McHarg may not have disagreed: always deprecating about his design capacities, he called himself a "pseudo, crypto, quasi-artist" (Dubois 1974).

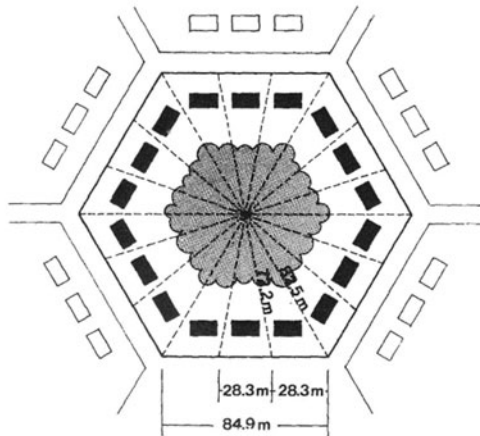
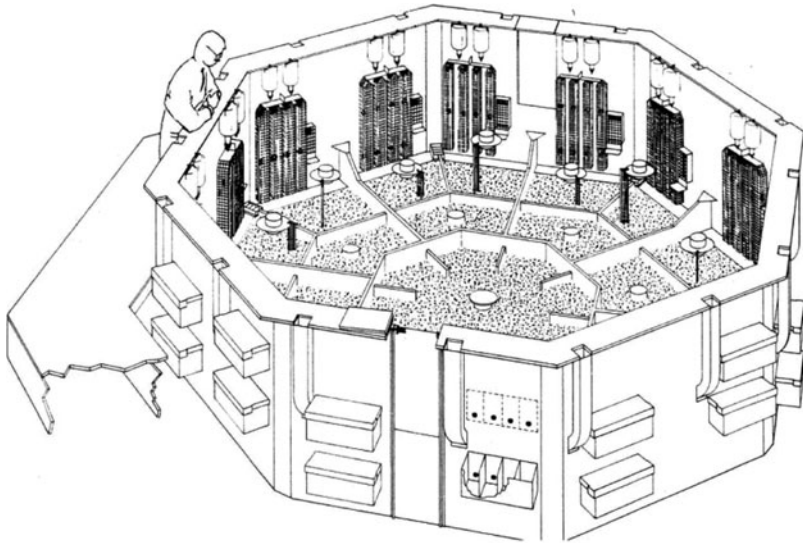


FIGURE 6 Design drawing for Calhoun's rodent "Universe 133." Calhoun Archive, National Library of Medicine, Bethesda; McHarg-inspired plan to maximise bird species diversity whilst allowing "the efficient assembly of large residential developments" (Goldstein, Gross, and DeGraaf 1980–1981: 123). Reproduced with permission from Elsevier Limited.

Jane Jacobs. A noted critic of urban planning, Jacobs sought to defend the city, its vitality, and its capacity to accommodate and meet diverse needs. She maintained, "In our cities, at least, this supposed correlation between high densities and trouble, or high densities and slums, is simply incorrect, as anyone who

troubles to look at real cities can see" (1961: 202).<sup>24</sup> She noticed planners often assumed that overcrowded slums were "teeming" with people, whereas, "The overcrowded slums of American real life are, more and more typically, dull areas with a low density of dwellings" (ibid.: 204). She was particularly critical of "decentrist" city planners such as Patrick Geddes and Ebenezer Howard, whom she regarded as not only incompetent but rather, in their common hatred of the urban environment, unfit for their nominal task. Regarding the city as inherently undesirable, their "plans" for the cities were plans for the city's eradication. On Howard's attitude to London, she writes: "He hated the city and thought it an outright evil and an affront to nature that so many people should get themselves into an agglomeration. His prescription for saving the people was doing the city in" (ibid.: 17).

For Jacobs and others, density was a solution to the problems of the city, not to be contained and isolated within Corbusier or Soleri's vast concrete structures, but instead brought onto the street. Through open, diverse, busy, sometimes chaotic street life at the heart of every urban community, populations would police themselves. Crime and social breakdown did not take place in communities bustling with life, but in areas of quiet, calm, and enforced isolation (see Newman 1972). Indeed, as William Whyte, considered one of the forefathers of the new urban movement, declared when criticizing the "lot of nonsense" written about cities: "What about undercrowding? The researchers would be a lot more objective if they paid as much attention to the possible effects on people of relative isolation as lack of propinquity. Maybe some of those rats they study get lonely too" (1968: 337).

#### CONCLUSION

Amid the technological optimism of the late nineteenth and early twentieth centuries, the future of the city was often imagined in terms of a beehive, as an ordered and regular form that reflected, and contributed to, the efficient functioning of the modern urban, industrialized economy. For those seduced by the prospect, the beehive was an exemplar of the total integration of infrastructure and social structure—the one did not impede the other, but facilitated it. The rat, in contrast, provided a model in which the limits of adaptation were clearly circumscribed by nature. It was a mammal whose social structure functioned around the family rather than the collective. Through experimental science, the rat was being professionalized into the culture even as its

<sup>24</sup> She does caution, "It will not do to jump to the conclusion that all areas of high dwelling density in cities do well" (Jacobs 1961: 204). Her use of that slightly clumsy phrase "high dwelling density" is preparatory for a distinction she makes between the number of people in a room and the number of dwellings in an area. It is the former, not the latter, that is problematic. While so often placed in opposition to the findings of Calhoun, this conclusion did in fact chime with his findings, for it is unwanted social contact that leads to sink behaviors, not density per se. The complexity of Calhoun's work was rarely appreciated (Ramsden and Adams 2009).

eradication from the cities became a goal. And so while the rat may have been despised, it had its uses, both as a tool for science and as a rhetorical device for locating the failings of the modern city. As both its scientific and rhetorical uses became combined through the crowding experiments of ecologists, these failings were increasingly associated with the very attempts to impose order and unity on the chaos of the city, with the misguided and dangerous attempt to construct a beehive world. Thus, over the course of the century, the function of the two animal models, rat and bee, shifted diametrically.

In providing a rigid and orderly solution to the physical chaos of the early-twentieth-century city, the beehive model promised a solution to the concomitant moral chaos that cities generated and tolerated. But it was a solution extrapolated from the office building, and modeled on the obedient worker. The beehive world preserved density at the expense of identity. Yet it is clear that for many of those who propounded the beehive designs, some loss in human autonomy was no loss at all. That a hive-like environment might yield a more compliant population of obedient drones and workers was, from the autocrat's perspective, a point in its favor. Thus Forster's complaint that the machine-like efficiency of the hive world was in conflict with human nature was unlikely to deter the autocratic planners, for in a sense, human nature was the very problem that the beehive world sought to address.

So an appeal to human nature alone was insufficient to articulate resistance to the human apiary. It took the introduction of the rat experiments to establish that the beehive world could not, as its designers insisted, maintain *both* high population densities *and* civic order. Attention now shifted, away from designing a "machine for living" toward a closer examination of the mechanics of the mammalian body. Super-dense conditions would not make humans as efficient as bees, but rather, as debased as rats. Seen through the induced psychopathologies of the rodent crowding experiments, the moral degeneracy of the city could now be understood in naturalistic terms. The violence, hypersexuality, and withdrawal that Calhoun's rats displayed in the laboratory were duplicated in the unraveling social fabric at the urban core.

It might seem ironic that in order to convincingly argue that the beehive world was unsuitable for human habitation one needed to appeal to the nature of another animal. But what the rat model really provides here is evidence of the restricted elasticity of existing social arrangements, limits on the mutability of not just human but *mammalian* nature. It was easy to characterize human nature as infinitely pliable, but in the twinned physiological and behavioral pathologies generated by Christian and Calhoun, the use of the rat enabled the case to be framed as a biological impossibility. Somewhat perversely, as the dispute played out, it was only by acknowledging a wider biological kinship with mammals that a specifically *human* nature could be defended.

Reference to animal models, real or metaphorical, is a powerful means of promoting solutions to the problem of the city. They have contributed to, and



allowed us to trace significant shifts in planning and design. Late in his life, psychiatrist Bruno Bettelheim reflected that in his youth people seemed fascinated by “studies of the complex animal societies formed by ants, bees, or termites. [...] In short, what we learned from these animals was how an appropriate social organization can assure the outstanding success of even the densest kind of crowded mass living.” This was in contrast to the postwar era, where attention was focused on “animals of the same species that fight viciously for territory when their living space becomes restricted,” most notably “the study of overcrowding in rats.” For Bettelheim, this “leaves one with the uneasy feeling that this or that animal is selected for study when the behavior of its particular species seems to support preconceived notions about human beings while those animals whose behaviour contradicts the same notions are paid no attention” (1979: 202–3).

While Bettelheim’s reflections complement our analysis, we would argue that he is only partially correct. Not only did animal models actively *contribute* to such notions, but their influence cannot be appreciated in isolation from the *spaces* they inhabit. The significance of zoomorphic and anthropomorphic design has been obscured, perhaps, by the simultaneous power of the animal model to deny credibility to alternative solutions (as is exploited by Bettelheim). For those supportive of a beehive world, critics of high-density living liked to denigrate the urban resident as an uncultured “rat”; for those concerned that man would behave in the manner of crowded rodents if placed among concrete honeycombs, the vision of an architect treating the masses as mere “social insects” was a popular and powerful critique.

Such criticisms continue. For a more recent architectural movement, “new urbanism,” this problematic history of attempting to confront, control, or exorcise the problem of the crowd has allowed them to emphasize a break with the past, in spite of the continuities. While Leon Krier (1984) charged the modernist planner with tyrannically imposing his own vision of order, Langdon (1994) and Duany and Plater-Zyberk (1994) celebrated density as means of community building as it increases face-to-face interaction. While, once again, improved design is seen to result in improved behavior, the key, it is now declared, is to recognize and to cherish the density, diversity, and dynamism of the “traditional” urban neighborhood as a uniquely human endeavor (Calthorpe 1993). In this new architectural rhetoric, earlier attempts to impose a “master plan” had failed, since they had forgotten that cities were composed of neither rats nor bees, but of people.

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