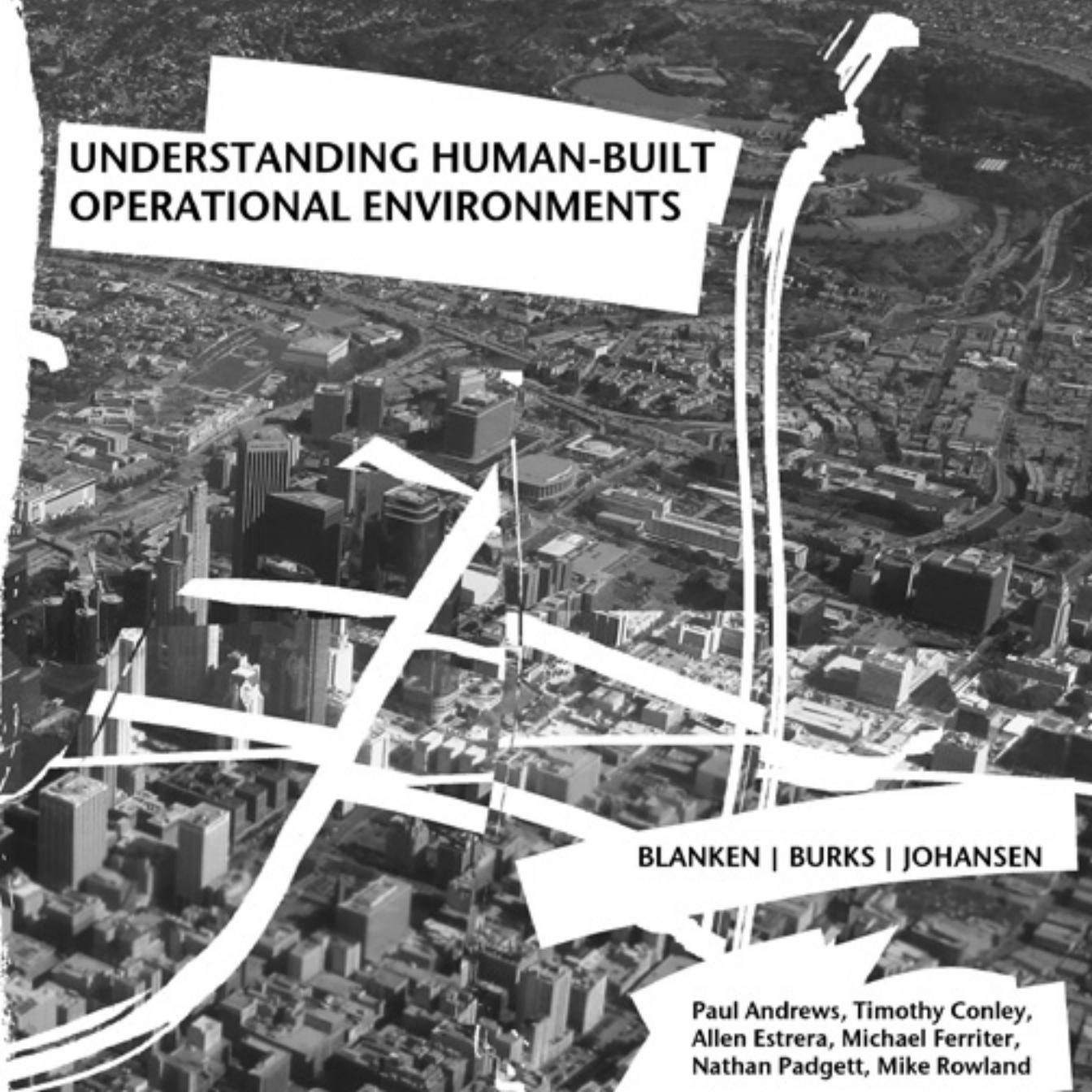
UNDERSTANDING HUMAN-BUILT OPERATIONAL ENVIRONMENTS
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INTRODUCTION

Recent literature—both doctrinal and academic—points to the emergence of the "mega-city." The term is meant to imply some qualitative break with the cumulative history of the urban experience, and to hold profound implications for future military and security functions.[1] Is this the case? What attributes of current/future cities are driving this discussion? Do these arguments actually stand up to scrutiny? If so, what would be the analytic results of such an examination?

We find the term "mega city" of limited utility. We offer in its place a typological schema designed to assist in analyzing and planning current and future urban operations. Additionally, we provide the transparent and flexible methodology behind our analysis to allow for its bespoke tailoring by planners and analysts to utilize at varied levels of detail. Further, our approach allows for endogenizing the nature of the military operation into the characterization of the operational environment. We label this newly derived conceptual space *"human built operational environments"* (HBOEs).

OPERATIONS IN CITIES

One trend that has remained constant throughout the human experience is urbanization. Man is a social creature, and once evolving techniques moved human food production beyond the caloric subsistence per-capita constraint, the path was open for groups of humans to collectively

settle in a permanent location: the city was born.[2] Sometime around 8000 BC, the first agricultural settlements emerged in south-west Asia; over the next millennium, similar efforts spontaneously emerged around the world.[3] As settlements became larger, divisions of labor became possible, governance emerged, and security became necessary.[4] As such, cities came to serve a number of functions—host populations, produce goods and services, facilitate trade, generate tax revenue, and nurture culture.

This transformation of the environment into a "human-built world…[of] systems, controls, and information" required management that came to be—and remains—"a major societal challenge".[5] Internal control mechanisms grew hand-in-hand with growth; monitoring, adjudicating, and punishing functions were necessary to police the urban population. Initially, city-polities that perfected these functions dominated the European landscape,[6] but by the 17th century nascent nation-states simultaneously were battling and wooing wealthy city-states in their quest for sovereignty.[7] In France and Germany during the 17th century, sovereigns destroyed many hundreds of fortifications around towns and cities within their own territory; even the fortifications around Paris were demolished in 1670. The purpose of these seemingly counterintuitive efforts was to subjugate the city to the state.[8] By the 20th century, cities became integral manifestations of the nation state and its power.

Man has not only built and nurtured urban environments, he has fought over and destroyed them as well.[9] Sieges represent one of the classic military operations of the ancient world. Relatively small in size by modern standards, militaries unconstrained by legal or normative standards could destroy entire cities—to include their populations—once captured. In the modern era, however, cities have been less amenable to military control. During the Cold War, doctrine argued that cities could be treated in two ways. First, they should be *cordoned and bypassed* in maneuver warfare:[10]

> A shared feeling emerged that cities should be placed off-limits to ground forces and that modern, fast moving mechanized armies should bypass cities whenever possible. Cities were considered obstacles too big and complex to conquer with conventional military arms and tactics and, when they did become battlegrounds, the suffering in cultural and human terms was too much.[11]

Battles such as Stalingrad exemplified the trap of highly capable maneuver forces being drawn into a bloody stalemate in which their strengths could not be brought to bear. This burned an indelible image on the minds of modern operational planners; with one researcher stating flatly "Stalingrad was the single most brutal battle in history."[12] The second role they played was being *held hostage* as part of some coercive or deterrent strategy.[13] In this way, cities served as some valued good that could be threatened or destroyed from the air, with none of the challenges of ground operations.[14] In sum, recent military thinking has come to the consensus that cities should be avoided, either bypassed at the operational level or threatened with destruction at the strategic level.

What has changed to bring urban operations back into the minds of planners?[15] Three things: *demography, normative constraints,* and the *nature of political control.* First, population distribution has reached a tipping point: for the first time in history the majority of the world's population lives in cities. By 2030, 60% of humanity will live in cities and 60% of those urban dwellers will be under the age of 18.[16] Why should we care? The outlaw Willie Sutton was once asked "Why do you rob banks?", and he famously answered "Because that's where the money is." The logic here is similar. The future is increasingly urban and, because that is where the people will be located, so will the conflict. Many argue that since the post-9/11 operational environment has been largely rural (Afghanistan, Syria, Iraq, Sudan, Somalia), we have failed to prepare for the fight that will come "out of the mountains".[17]

The second reason that we need to think harder about the urban environment, is that many of the past strategies of dealing with cities are no longer viable. Hitler tried to "kill" the city of Leningrad by sealing off and starving the citizenry to death.[18] The US conducted an "extermination" campaign of strategic bombing over Japanese cities in World War II; the metric of performance in which was square miles of urban centers burned to the ground.[19] Barring some extraordinary set of circumstances, these types of strategies are no longer possible.[20] Operations will most likely be characterized by constraining rules of engagement, high degrees of interaction with the local population, and conducted under high media scrutiny.[21] In other words, bypassing cities or threatening them with countervalue punishment will no longer be viable.

A final, related, problem with future urban operations is the "softening" of state sovereignty. If one assumes a world of strict Westphalian states, then cities only have strategic meaning within the state context. In such a model of conflict, actors can use cities as pawns (held as hostages in a contest of nuclear escalation, for example) to coerce the state leadership. Consequently, once a settlement was reached between state leaderships, the enforcement of such a settlement was carried out by the host state at the local level. Neither of these are necessarily true anymore. One may not be able to credibly hold cities hostage (see second point, above),[22] and the state's leadership may not be capable of controlling outcomes within its own cities even if a settlement is reached.[23] When both of these things are true, they jointly forestall the two modal strategies for dealing with cities.

So given that modern militaries are going to conduct a much broader swath of activities in urban landscapes, a conceptual framework is necessary to characterize such human-built operational environments.

THE IMPORTANCE OF BUILDING CONCEPTS

What is missing from the burgeoning literature on current and near future urban locales is a meaningful construct of a rigorous conceptual framework. In current usage, the label "mega city" can be traced to a 2011 United Nations report on urbanization, and it simply refers to cities with populations larger than 10 million.[24] The report itself, however, notes that there are only currently 28 such mega cities, and only one in eight urban dwellers live in one. On the other hand, one in two urban dwellers live in cities of 500,000 or more.[25] What this means, is that the 10 million marker is an arbitrary cut-point of limited utility. Rather, a more flexible and thoughtful analytic tool is required; we produce one here.

Concept formation is crucial in the study of any phenomenon.[26] Developing a concept "involves a theoretical and empirical analysis of the object or phenomenon referred to by the word…Concepts are theories about ontology: they are theories about the fundamental constitutive elements of a phenomenon."[27] Without a shared conceptual space regarding some phenomenon—such as urban environments—confusion ensues.[28] All science requires categorization, but the hard sciences benefit from simple and uniform materials to work

with. These are gathered neatly in the periodic table of elements, in which a human-designed concept such as "copper" or "noble gasses" correspond to materials found in our environment. There is no confusion; a Chinese chemist and a Canadian chemist may have language differences and cultural differences, but both can identify copper without fail. This is not true for more abstract, multidimensional, and sometimes contested concepts. Anatol Rapoport labeled this challenge one of "recognition" and wrestled with it thusly:

> Since [behavioral] sciences have only recently arisen from the humanities, their terms are derived from common sense... at best, and from deeply rooted pre-scientific notions and prejudices at worst. Outside of science, no need may be felt to endow terms with operational meanings; one's intuitive meaning seems to suffice on the basis of the universal naïve assumption that the other's perceptions are like one's own.[29]

Without rigorously working through the conceptual framework behind a complex and

loaded term such as "mega city", however, no serious analysis is possible.[30] Rapaport warns us in no uncertain terms: "where agreement is not easy, that is, where one cannot immediately agree on an easily recognizable class of events which shall be subsumed under the term 'democracy' or 'status' or 'power,' it is futile to pass to the study of these supposed entities."[31]

OUR TREATMENT OF URBAN OPERATIONS

At the most basic level, we argue that human built operating environments are constituted by three dimensions: the *physical space,* the *social domain,* and the *nature of the mission.*

It should be reiterated that the current effort to build the conceptual space surrounding HBOEs is not to be confused with the causal arguments that will be built upon it. In other words, the construct merely serves to characterize the operational environments in which US forces may find themselves. Causal arguments—concerning what doctrine, technology, and forces might perform well in future urban operations—are not developed here, but are enabled by this work.[32]

The document proceeds as follows. In the following section we explain the morphological analysis methodology for generating and refining the concepts. We do this in order to explicate the process as clearly as possible, as this will facilitate critical analysis and extensions of our work. We then turn to the development of our morphological analysis of HBOE. First, we explain the three core dimensions of the concept: physical, human, mission. We then unpack these further, resulting in six parameters: external access, internal access, demographics, social expectations, governance, and kinetic nature.

We then conduct our initial analysis. We show that the human dimension can usefully be compressed into four main categories producing a typology consisting of four main city types: The *fragmented city*, the *functional city*, the *revolutionary city*, and the *hostile city.*

In the final analysis these city types are fused with the physical characteristics of the urban landscape as well as the nature of the military operation, specifically the use or non-use of

kinetic force. We conclude that the city types correspond to an aggregate city-mission typology consisting of, again, four main types. We name these:

- Restoring the fragmented city
- Assisting the functional city
- Fighting the hostile city
- Defending the revolutionary city

This analysis combines vastly complex problems into one simplistic conceptual construct. It is our belief that this is a necessary step on the road to more exhaustive studies. However, further studies will have to deepen and widen our understanding of urban missions. We therefore recommend that future research focus on:

- Description and characterization of the physical features of urban landscapes; climate, terrain, infrastructure.
- How cities are governed; political legitimacy in urban landscapes.
- Urban missions; concepts and technology

NOTES

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THE APPROACH: MORPHOLOGICAL ANALYSIS

Morphology—the term is derived from ancient Greek *morphe* which means *shape* or *form*—refers to a wide range of methods for modelling and studying relationships between objects and phenomena in different scientific fields, inter alia botany, linguistics, geology and mathematics. A generalized version of the method was originally proposed by the Swiss-American astrophysicist Fritz Zwicky (1898–1974), professor at the California Institute of Technology (Caltech). Zwicky, who had originally developed the method for classification of astrophysical objects, observed that the principles of morphological research could also be applied to the study of "... abstract structural interrelationships among phenomena, concepts and ideas, whatever their character might be".[1]

General Morphological Analysis is essentially a method for modelling of non-quantifiable, non-reducible, complex problem spaces. Zwicky himself used the method for analyzing and proposing solutions in such diverse fields as the development of jet and rocket propulsion systems, the legal aspects of space travel and colonization, in addition to astrophysical research.[2] In recent years General Morphological Analysis has mostly been applied to problems that involve human behavior and political choice. This particular category of problems—sometimes referred to as "wicked problems"[3]—typically cannot easily be described or delineated; they do not easily lend themselves to causal modelling or simulation, and solutions often lack a satisfactory audit trail.

As opposed to traditional reductionist causal modelling, General Morphological Analysis seeks to identify and investigate the entire set of relationships or "configurations" contained within the problem space. In this sense, the method is closely related to typological analysis. In contrast to some classification techniques in the social sciences, the morphological process, however, does not make any theoretical claims or purport to explain a given phenomenon in cause-and-effect terms.[4] The only information one can extract from the morphological process is whether a given solution is consistent or not, i.e. whether it relates to something that may exist in the real world.

The morphological process can be described as a dialectical progression through repeated sequences of analysis and synthesis. The first step in the process consists of the formulation of a focus question, i.e. a description of the problem that is the object for analysis. It is essential that this description is as exact and comprehensive as possible. In the next step the focus question is broken down into a parameter set that encompasses the entire problem. Each *parameter* must be precisely defined, and an exhaustive and mutually excluding set of possible states, or *values*, pertaining to each parameter, has to be decided.

The process so far allows for the construction of the multidimensional matrix that contains within itself the entire *morphological field* (or the *problem space*) of the given problem. In the multidimensional matrix the parameters are presented in the top row with the associated values in columns beneath each parameter as shown in table 2.1.

PARAMETER A	PARAMETER B	PARAMETER C	PARAMETER D
A1	B1	C1	D1
A2	B2	C2	D2
A3	B3	C3	D3
	B4	C4	D4
		C5	

Table 2.1—Multidimensional Matrix. Shaded cells constitute one solution.

The matrix shown in table 2.1 contains four parameters with the number of values attached to each parameter varying from three (Parameter A) to five (Parameter C). The total number of configurations, or theoretically possible *solutions*, in this matrix is $3 \times 4 \times 5 \times 4 = 240$. A "solution" can be defined as a *shape* consisting of one value on each parameter. In the example matrix, the shaded cells represent one of 240 possible solutions.

The main goal of the morphological process is the reduction of complexity. This is achieved when a potentially very large and complex problem space is reduced to a smaller and more manageable *solution space*. In contrast to the morphological field, the solution space consists of only those configurations that can be considered possible, or consistent.

Thus, in the next step of the analysis the relationship between the parameters is defined and analyzed by performing a pairwise *cross-consistency assessment*. The assessment of consistency is based on two main criteria: First, *internal* consistency, i.e. whether any given value pair can be assessed as either consistent or non-consistent on purely logical grounds and, second, *external* (or *empirical*) consistency. The latter implies an assessment as to whether any given value pair conforms to or contradicts what may be considered plausible.

The logic behind the cross-consistency assessment rests on the premise that the solution space cannot contain value pairs that are not consistent. By weeding out inconsistent value pairs only those configurations that are considered possible on both logical and empirical grounds remain. It is not unusual that this process reduces the morphological field by more than 90 percent. What the procedure does is strip away all the "noise"—in the form of inconsistent configurations—that litters the original problem space. The resulting *solution space*, thus, can be seen as a conceptual "map" that aids the discovery and identification of new relationships and configurations as well as encouraging investigation of boundary conditions. Hence, morphological analysis is as much a problem structuring tool as it is a means for analysis and modelling.

In practice, the cross-consistency assessment is carried out by systematically working through the entire matrix assessing the consistency of each and every value pair. The process is helped by the fact that the number of pairs in a matrix increases at a much lower rate than the number of

configurations when new parameters are added. Thus, a relatively small number of pairwise consistency assessments will suffice to analyze even a large morphological field.[5] However, this process, although simple in principle, can be exceedingly time-consuming if done manually, so a computerized support tool that presents results in an orderly fashion usually is required. For this study, a simple Excel based tool is employed.

The consistency matrix positions parameter values against each other in a pair-wise manner (see tables 4.4, 4.7 in Chapter 4). For each pair a judgement is made as to whether the values can coexist according to the criteria of internal and external consistency. This judgement does not consider direction or causality, hence causal modelling is alien to morphological analysis.

The outcome of the morphological process is a linked parameter space, or a morphological inference model. The model is an abstract description of the entire solution space, i.e. all possible solutions—or forms—related to the given problem. The final phase of the morphological process consists of a thorough examination of each solution in order to determine its relevance for further processing or use. A vital part of this examination is to provide explanation—or "meaning"—to relevant solutions by "verbalizing" the morphological structure in terms of textual descriptions, images or other means for communication and cognizance. In Chapter 4 a conceptual construct is developed based on the outcome of the morphological analysis that designates the HBOE problem in terms of a set of descriptive categories.

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APPLICATION: AN ANALYSIS OF HUMAN BUILT OPERATIONAL ENVIRONMENTS

We now turn to the application of the morphological analysis methodology to the problem of military operations in urban environs. The purpose of this application is two-fold. First, there is the substantive contribution. As such, we provide a novel synthesis of the urban operations challenge, taking on the daunting task of simplifying the infinitely complex problem into a tractable construct. To do so, we had to consult the wide and growing literatures on "mega cities" and urban doctrinal debates and attempt to create a baseline distillation from which more refined analyses can be built. Second, there is the methodological contribution. By (a) making a case for the necessity of conceptual clarity and (b) providing a transparent and flexible tool that is well-suited to building such conceptual clarity, we enable the urban operations research community to build their own tailored analyses upon which to ground their efforts.

In the following section, we will first introduce the three overarching dimensions that define the HBOE: *physical*, *human*, and *mission*. Next, we extend these core dimensions into some subcomponents. We create two sub-dimensions of the physical space into *internal access* and *external access* and provide a brief operationalization of each. We then take the social dimension—by far the most complex aspect of urban environments—and break it into three relevant sub-dimensions: *demographics*, *social expectations*, and *governance*. Finally, we maintain the unidimensionality of the mission type and discuss its operationalization through the degree to which operations are *kinetic*.

After we have introduced our proposed dimensions and sub-dimensions of the HBOE, we proceed to apply the morphological analysis methodology. In doing so we seek to accomplish two goals. The first is to provide and defend an initial—if very coarse—conceptualization of HBOEs. The second is to explicate the morphological methodology clearly enough that others may easily extend and refine the process to fit their needs. We now turn to the three core bins of human built operational environments.

DEVELOPING THE THREE CORE DIMENSIONS: PHYSICAL, HUMAN, MISSION

The human built operational environment can be divided into three core dimensions: *physical*, *human*, *mission*. These correspond to (a) the material attributes of the urban environment, the (b) human terrain laid on top of the physical landscape, and (c) the nature of foreign military forces' interaction with the city.

One should ask themselves what these three "dimensions" constitute and how should a reader judge the choice we have made? There are three likely questions regarding our choices here, and we will respond to each in turn. First, do they represent the only correct way to carve up the phenomenon in question? No, they are a modeling choice, and like all modeling choices, they are not a true interpretation of the world, but a (hopefully) useful one. A critic of our work may posit an alternative way to compose the dimensions of urban operational environments; we encourage such efforts and have given them the tools here to do so. Second, are there objective criteria, however, to judge such typological efforts (ours or any alternative)? Yes. The dimensions should be *exhaustive* and *exclusive*. In other words, any aspect of an HBOE should fit into one, but only one, of these three dimensions. There should be no aspects of the phenomenon that fall between the gaps, or could be placed into more than one of the dimensions simultaneously. Finally, are they too simple? The answer is no, for two reasons. On the one hand, HBOEs are infinitely complex. To make any tractable characterization of them will require sacrificing the vast majority of the details of the phenomenon. The key is to make such gross simplification useful to some purpose. On the other hand, the analysis provided here can be extended to provide more detail in any direction desired by a

critic. Such transparency and flexibility should empower the community currently emerging around future urban operations to build an entire pool of analytic models that are scaled (and further scalable) to a variety of purposes. We now turn to the three core dimensions.

- *Physical:* This dimension of the HBOE includes all of the physical attributes of the landscape. These include natural and constructed aspects of the environment: roads, rivers, buildings, airports, and all subterranean elements.
- *Human:* This dimension is comprised of the human occupants of an urban environment and the social, economic, political, and cultural fabric which they and their behavior constitute.
- *Mission:* This is the nature of the proposed activity undertaken by the foreign actor. This aspect does not help us characterize cities but is, in fact, necessary to characterize urban operational environments. Its inclusion allows planners not just to consider the types of cities that exist around the world, but would also allow them to walk through the types of operations that may occur in those cities. By working through the likelihood—or even logical possibility—of various missions occurring in various urban locales, the analytic tools provided here provides the flexibility to not just ponder emerging trends of urbanization, but to lay mission-types on top of them.

These three dimensions, we argue, constitute the entirety of human built operational environments. As a next step, we refine these three core dimensions to an additional level of granularity. The resulting six parameters provide the raw material for our morphological analysis. In this refinement process we provide the logic of each sub-dimension, explain the qualitative values that each parameter can take on in our analysis, and provide some guidance for future efforts to establish reliable measures of these concepts.

REFINING THE THREE DIMENSIONS

Each of the three bins has the flexibility to be broken into sub-bins, of finer and finer granularity. The degree of refinement is driven by the needs of the analyst, weighted against the

reduced parsimony driven by each layer of complexity added to the construct. We now proceed to decompose the physical dimension of the HBOE into two sub-components: internal access and external access. The human dimension is decomposed into three sub-components: demographics, social expectations, and governance. The mission aspect remains unidimensional and is operationalized by the degree to which operations are kinetic in nature. This next level of granularity, therefore, is comprised of six aspects of the HBOE (see Figure 1). These, then, will comprise the six "parameters" of our morphological analysis. We explicate the values which each of these six parameters can take below.

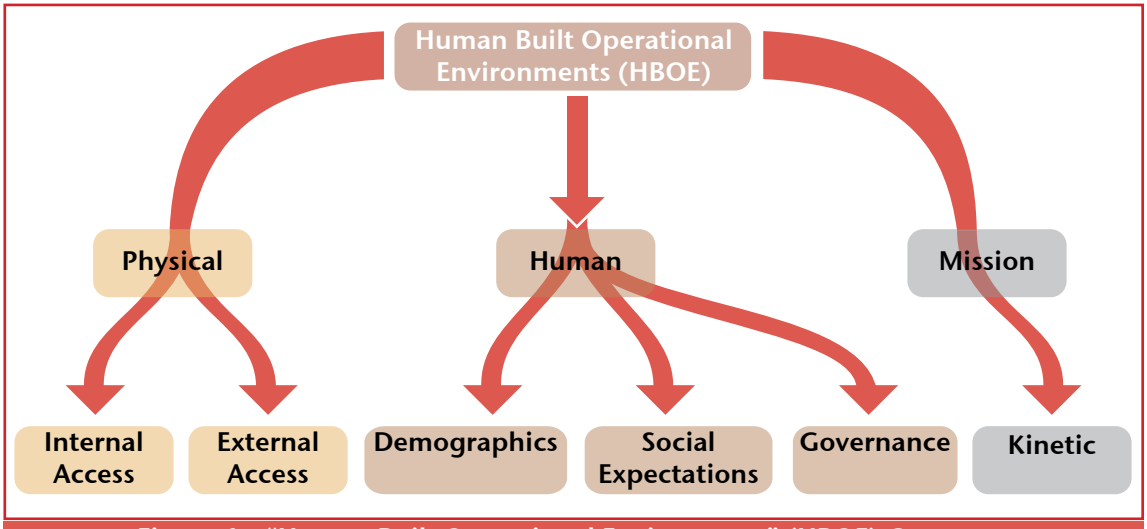

Figure 1—"Human Built Operational Environment" (HBOE) Construct

Refining the Physical Dimension

The physical nature of modern urban environments is becoming exceeding complex.[1] Any attempt to reduce it to a small number of aspects must be driven by the need to highlight only the most essential attributes relevant to the purpose of the analysis. In our estimation, the most essential aspect of urban environments is the ease with which people, material,

and information can move into and within it.[2] A study on megacities conducted by the US Army Strategic Studies Group states that "[f]low is the movement of people, resources or things into or out of a megacity".[3] The study further stated "flow", together with context, scale, density and connectedness, is a crucial characteristic of a megacity that must be studied for greater strategic appreciation of HBOEs.[4] Therefore, we propose two sub-components of the urban landscape that constitute the most relevant to potential military operations: internal access and external access.

External Access: High / Low. External access refers to the capacity to enter an urban center, or to resupply an existing operation within an HBOE (see Figure 2). We conceive of a continuum of external access that ranges from high to low capacity to move people, material, and information into and out of the urban locale. This spectrum, in turn, can be bifurcated into a qualitative dichotomy for the purpose of our morphological analysis. We now look at three types of ingress into an urban center: land, air, and maritime.

In most environments, physical geography of the natural terrain plays a role in the determination of land-based surface options and the presence or absence of subterranean external access.[5] Both surface and subterranean external access can potentially be achieved by road, rail or foot in varying degrees. Gauging the external access of a HBOE by road raises certain pertinent questions that can be addressed through open source analysis. For example, modern HBOE might have a robust system of highways with multiple points of

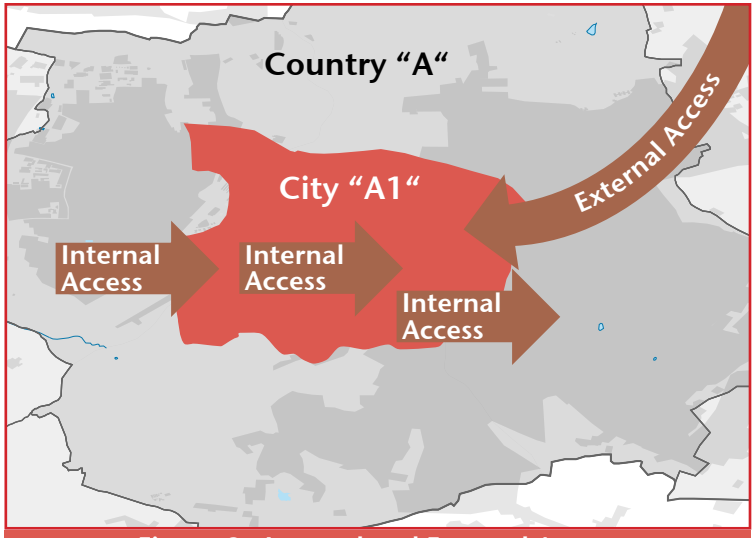

Figure 2—Internal and External Access

entry and access into almost all parts of the environment. Conversely, underdeveloped HBOE might only have paved road access to certain areas leaving some areas isolated or accessible only by other means. Similarly, external access by rail could be determined and assessed based on the scope and scale of rail options leading into an urban center, both on the surface and subterranean levels. External access by foot, ostensibly possible into any HBOE, could be objectively measured by terrain complexity and structure density.

As compared to a land-based approach, the speed and reach of air power allows for unrivalled responsiveness to a crises or other operation in a dense HBOE.[6] External access into a HBOE by air can generally be accomplished by manned or unmanned fixed-wing or rotary-winged assets. Assets landing or operating in or near a given HBOE require an understanding of the usable landing surfaces and obstacles. Usable landing surfaces for fixed-wing aircraft can range from dirt strips to complex modern aerodromes while a usable landing surface for rotary-winged aircraft could be something as innocuous as an open field or rooftop. Open source analysis can reveal the air infrastructure resident within any given HBOE. For example, a large modern HBOE might have multiple large commercial or military aerodromes and dozens of smaller private runways. That said, external access by air is not always straightforward, whether due to disrepair or the lack of load-bearing capacity needed to accommodate heavy aircraft.[7] Conversely, a less developed HBOE might not have any paved surfaces at all. In some outlying examples, the physical geography of the surrounding natural terrain could preclude the air-land employment of fixed-wing assets all together. Examining obstacles in and around a HBOE is the other key element of determining air-based external access. Obstacles could be anything presenting an impediment to air operations—tall buildings, communications towers, physical geography, or even local air traffic patterns.

The applicability of maritime external access is first determined by proximity to a body of water. Thus, the physical geography of a HBOE is the determinant factor in the assessment of a maritime external access. If a HBOE is littoral or situated next to a major river contiguous to the ocean, it can be considered susceptible to maritime external access. Maritime external access can be achieved through the employment of surface or subsurface vessels regardless of the presence of a natural or man-made harbor. Small vessels can reach the shore of

almost any body of water, and larger vessels can anchor or float off the coast and deploy smaller landing craft to embarkation points. Furthermore, the presence of a deep water harbor or modern port greatly increases the utility of larger vessels and could be considered a category worthy of delineation. Depending on the mission, a large scale maritime operation is more feasible given these conditions.

Once again, for the purpose of the morphological analysis we simply dichotomize external access into high/low values. More refined operationalization of this attribute would be necessary for finer grained analyses. For example, what proxies would be used to measure and empirically code cities as to being high or low? Is there substitutability among the three modes of ingress (land, air, maritime)? Does it vary by mission?

Internal Access: High / Low. Once a city is entered, the question of internal access becomes paramount. It subsumes the possible rate of movement of individuals, materiel, and information through an urbanized terrain (see Figure 2).[8] Such movement will allow military forces to conduct missions effectively in this type of environment. We conceive of a continuum of internal access characterized by degree of ease in moving people, material, and information throughout the urban environment. This spectrum, then, can be bifurcated into a qualitative dichotomy for the purpose of our morphological analysis. The significance of understanding the level of congestion in planning for city access and maneuver is underscored by Kevin Felix, when he asserts that "[c]ongestion in all domains will significantly impede traditional forms of movement and maneuver that may not even involve armed enemy threats."[9]

Cities around the world differ in their physical infrastructure, which distinguish the flow of people and resources in each city. There has been, however, significant work to generally classify urban area in terms on internal access, one of which is congestion.[10] Klaus Desmet elaborates that "[h]ow fast the benefits of efficiency and amenities erode with population size because of increasing congestion costs depends on the quality of governance, responsible for the provision of road infrastructure, sewage systems, clean water, and security."[11] To operationalize internal access, one can focus on simple proxy indicators that could predict congestion, such as *road space allocation*.[12] Urban road networks are analogous to the

arteries and veins of mammal, as Peter Carol states, "[s]treets are explicitly defined as physiological arteries of the circulatory system. The urban street functions to allow the circulation of the cities' lifeblood."[13] Likewise, some authors also argue that the basic way of evaluating the effective functioning of megacities is through their transportation systems:

> The dense development and relative lack of land devoted to roads make it more difficult to build and operate efficient forms of transportation and increase the cost of acquiring land for expanding the road network. Developing-country cities frequently have much less space allocated to roads. In Chinese cities, for example, the amount of land devoted to road space is often less than 10 percent, while even in 1910, when New York City was at its most dense in terms of population per hectare, roads comprised fully 15 percent of the urban land area in Manhattan.[14]

For the purpose of our morphological analysis, we simply dichotomize the internal access range to "high/low." What constitutes the difference between a "high internal access city" and a "low internal access city"? For the morphological analysis here, that question is immaterial. For future research, however, there are a number of options for coding cities along

the internal access spectrum. First, quantitative measures (such as road space allocation) could be chosen individually, or combined into an index. Second, some operationally relevant qualitative measure could be chosen to establish the cut-point: could a brigade-sized element be resupplied across the city with existing resources and SOPs?

Refining the Human Dimension

The complexity of the physical domain in urban environments is dwarfed by that of the human populations that inhabit them. We choose three sub-dimensions to characterize the human terrain of HBOEs: *demographics*, *social expectations*, and *governance*.

Demographics: Large / Small. Demographics of a city are defined here by the size and density of the population. For the purpose of the morphological analysis we simply dichotomize cities as large or small. Given that these measures are readily quantifiable, then the question then becomes how to choose qualitative cut-points that are relevant for military operations. After discussing some methods and sources for measuring urban populations, we return to this question below.

A recent report by the Army stipulates that it is indeed "the density of the population, not its mere presence, [that] makes the urban environment unique."[15] A simple and approachable source for analyzing the density of urban spaces is Forsyth's *Measuring Density: Working Definitions for Residential Density and Building Intensity*, as it provides a comprehensive set of definitions suitable for a quick study of urban density terminology.[16] Depending on the scale of planning, any number of the definitions contained in that text may be applicable. However, for a macro look at a HBOE, and to support comprehension of future models, one should be familiar with the following terms:

- **Floor Area Ratio (FAR)**[17]—"Built floor area on all floors divided by the parcel area." This can refer to any structure but is most applicable to analyzing a multi-story building when referencing density functions.
- **Dwelling Unit Density (DUD)**[18]—"Dwelling Units divided by the entire developed area of the city or town." Alternatively, one can use DU and compare it to

any plot of land, neighborhood, city, or metropolitan area to determine a DU per Area metric. This is also true for Population Density.

- **Population Density (PD)**[19] —The number of people per unit of area. This definition is applicable at all levels and equally correct as long as the measure is labeled with an appropriate scale.

These three metrics are important because they provide insight in to the overall shape of the residential and commercial spaces (via FAR). Analysts can combine the three metrics to perceive the average building height and overall human footprint in an area (whether vertical or horizontal). However, these are introductory terms and more sophisticated metrics are available should the situation require an enhanced picture of a particular dwelling, block, or city.

Population size is an easier concept to define and manage. Here, artificial breaks between sizes of cities may not truly differentiate any difficulty in military operations (e.g. a city of 4 million is likely to be as complicated as one with 6 million). However, in order to standardize definitions, planners could adopt the UN model for population sizes (Table 3.1).[20]

CLASS	POPULATION
Rural	N/A
Urban 1	Fewer than 500,000
Urban 2	500,000 to 1 million
Urban 3	1 million to 5 million
Urban 4	5 million to 10 million
Urban 5	10 million or more

Table 3.1: UN Urbanization Measures

Given the relative ease of operationalizing the sub-dimensions of population size and density, the question then becomes how to index the two, and then choose operationally relevant cut-points. On the other hand, one might utilize "unit per cordonment" as qualitative signifier. For example, any city that too large to be cordoned off by an infantry division (or

three brigade combat teams, for example) would be considered "large". Once again, such coding issues do not hamper our concept building exercise, but are saved for future research.

Social Expectations: Met / Not Met. Cities teeming with millions of individuals develop deep, varied, and complex webs of social fabric.[21] This includes myriad cultural, social, economic, and religious dynamics that define the lives of the urban inhabitants.[22] Rather than attempt to characterize the multitude of urban socio-cultural environments around the globe we, rather, attempt to distill this factor down to its most basic relevant aspect for operations: is the current state of affairs of the city fundamentally meeting the expectations—whatever those may be—of its inhabitants? Or is it not?

This characterization is useful for two reasons. First, it is simple, relevant, and universally applicable, as it is agnostic to level of poverty, equity of wealth distribution, cultural variation, et cetera. Second, it is founded in the logic of the well-developed "Davies J-curve" theory.[23] In its classic formulation, the theory predicts revolutionary unrest when ongoing social development meets a sudden reversal; in other words, when progress takes a downturn and looks like an inverted letter "J". This argument, also associated with the "relative deprivation" research agenda is based on the basic notion that "people's reactions to objective circumstances depend on their subjective comparisons."[24] In other words, people are not upset when they are disadvantaged in absolute terms, but when their circumstances do not match their (subjective) expectations.

We treat this complicated concept as a simple dichotomy; an urban population's expectations are either met or not met. For measurement and coding purposes, further analysis will need to be done.

GOVERNANCE: AUTHORITATIVE PARTNER / EXPEDIENT PARTNER / NO PARTNER

As a part of the typology for any large city, the system of public administration must be considered. Urban governance is an extremely vital part of creating a functioning large-scale

urban environment, providing everything from transportation infrastructure and public utilities to security for the populace to land-use and economic regulations. However, due to the inherent nature of urban areas, which are generally dense and have a high growth rate, adequate urban governance is difficult for many states to provide, and many of the solutions that states use to combat the growing issues found in HBOEs only serve to create new problems or amplify existing ones.[25] In fact, as military objectives shift from ones that are geographically based, such as seizing or securing a piece of terrain, to objectives that are population-centric, such as conducting counter-insurgency operations or providing disaster relief and humanitarian assistance, more and more of the conduct of local governance is of concern to military planners.[26] Current US military units formations would be easily consumed by the sheer scale, density and complexity of megacities—consider the fact that the local police for the city of Shanghai is roughly the same size as the entire United States Marine Corps.[27] John Spencer writes, "Most military doctrine, and the strategic theory it is built upon, encourages land forces to bypass, lay siege to, or—if required—isolate and slowly clear cities from the outside in. The great armies of the world have historically fought *for* cities rather than *in* cities, a distinction with a significant difference."[28] Without the ability to isolate a megacity or clear it block by block, foreign forces will have to leverage local systems to shape outcomes within a large and dense urban population.

In order to address this concern, two questions should be asked about a potential operating environment and the potential partners in the area. Does this actor have a level of legitimacy and authority in the operating environment in question? To what degree is this actor politically viable as a partner for United States military?

We can imagine two types of actors that partner with foreign forces. Most often, the partner is the host sovereign state; that is, those who are internationally recognized as the legitimate government inside a country and that have a monopoly on the use of violence within its borders. This international recognition is one form of legitimacy: an external legitimacy. However, while states may have external legitimacy, they may not have any natural level of support from a part or parts of the population. In some areas, especially when governmental control has been ceded or contested, a non-state actor may "offer alternatives to weak

and inefficient government as the legitimate representative of minority grievances,"[29] which provides this non-state actor with some natural level of support amongst the populace, or, an internal legitimacy. This may lead states to choose to cede control over parts of the city and not integrate them into the established governance system, "because integrating them offers few benefits and may pose high costs to host regimes."[30] In these instances, even though the state may want to assert control over an area, a non-state armed group has pushed back against state control, usurped the monopoly of violence and coercion in an area, and become the de-facto governing authority. These groups may be economically motivated criminal networks and gangs, or minority ethnic or social groups who do not feel that the state adequately meets their needs. These groups may also be politically motivated counter-state groups seeking to expand into government controlled territory in order to usurp political power and ultimately replace the state.

This discussion, then produces three types of governance partnering outcomes. First, a *formal* partner would have both internal and external legitimacy. They exercise a high degree of control over the urban population, and that authority is seen as valid.[31] Second, an *expedient partner* is one who possesses authority and legitimacy within parts or whole of the urban landscape. They do not, however, possess external legitimacy, and may create political costs for any partnering force. These may include militias, gangs, ethnic groups, or other non-state consociations. They may be considered a "second best" option for partnering. Third, we may consider situations in which there is *no partner*, in other words, a politically palatable, capable entity by, with, and through whom US forces may work.[32] Again, we trichotomize this parameter conceptually, but future research would be required to work through coding and measurement issues.

Refining the Mission Dimension

Finally, we propose that the nature of the military operation helps define the urban operational environment.[33] This paper proposes the following categories for all possible military operations. It is an ordinal ranking based on the degree of kinetic combat involved in the mission: Non Kinetic Operations, Low Kinetic Conflict and High Kinetic Conflict.[34]

These nest with Joint Publication 3-0 definitions of the Department of Defense's Range of Military Operations "three primary categories: military engagement, security cooperation, and deterrence; crisis response and limited contingency operations; and large-scale combat operations."[35] By grouping mission sets into these three broad categories, this enables morphological studies and comparisons to assist in characterizing HBOE challenges (Figure 3.3).

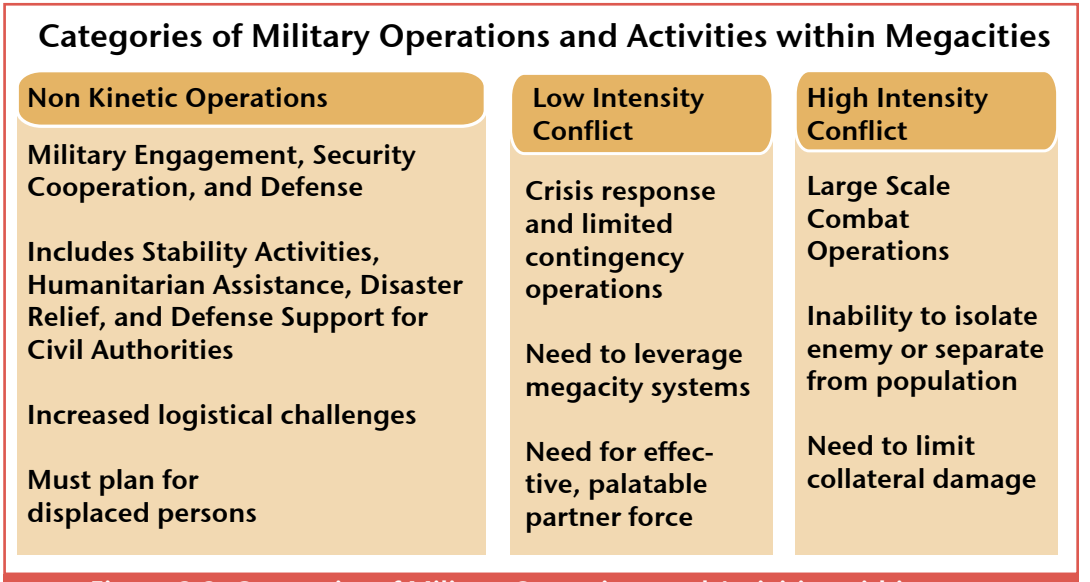

Figure 3.3: Categories of Military Operations and Activities within HBOE

Operations: High Kinetic / Low Kinetic / Non Kinetic. We now explicate this trichotomized range of kinetic activity more fully:

- **Non Kinetic Operations: Military Engagement, Security Cooperation, and Deterrence:** Non-kinetic operations are military operations that are planned to assist a civilian population or deter enemy action without the purpose of fighting the enemy in a kinetic manner. The following Joint Publication (JP) 3-0 missions

normally fall under non kinetic operations: stability activities, defense support for civilian authorities, foreign humanitarian assistance, foreign internal defense, recovery operations, non-combatant evacuations, military engagement, and security cooperation.[36] Of note, non-kinetic operations can escalate into violent confrontation. Additionally, foreign internal defense, recovery operations, and noncombatant evacuation operations may be conducted in areas with a high enemy threat and could then be advanced to the low intensity conflict category.

- **Low Kinetic Conflict: Crisis Response and Limited Contingency Operations:** Low intensity conflict fills the spectrum between non-kinetic operations and high intensity conflict. The largest proportion of US military contingency operations fall into this category. Crisis response and limited contingency operations acknowledges an enemy threat and designs operations to counter the enemy's influence and freedom to operate. Low intensity conflict generally includes counterinsurgency, peace operations, including peacekeeping, peace enforcement and peace-making, chemical biological radiological nuclear (CBRN) response, countering weapons of mass destruction, counter drug operations, mass atrocity, and combating terrorism.
- **High Kinetic Conflict: High Intensity and Large Scale Combat Operations:** High intensity conflict includes all large scale combat operations and some counterterrorism operations. While the simplest to define, high intensity conflict with current collateral damage restrictions is perhaps the field needing the greatest advances in technology, doctrine, and capabilities.

NOTES

1 See Geo Risks Research Department. 2004. *Megacities-Megarisks: Trends and Challenges for Insurance and Risk Management* (Munich: Munchener Ruckversicherungs-Gesellschaft).

2 See Ethan H. Decker, Scott Elliott, Felisa A. Smith, Donald R. Blake, and F. Sherwood Rowland. 2000. "Energy and Material Flow through the Urban Ecosystem," *Annual Review of Energy and the Environment,*" 25: 685–740.

3 Harris, Marc, Robert Dixon, Nicholas Melin, Daniel Hendrix, Richard Russo, Michael Bailey. 2014. MegaCities and the United States Army: Preparing for a Complex and Uncertain Future (Chief of Staff of the Army, Strategic Studies Group)

4 Ibid. See also, Kevin Felix and Frederick Wong, "Megacities: Pros and Cons, The Case for Megacities," *Parameters*, Spring 2015.

5 For a detailed analysis of a single city, see Salman Qureshi. 2010. "The Fast Growing megacity Karachi as a Frontier Environmental Challenges: Urbanization and Contemporary Urbanism Issues," *Journal of Geography and Regional Planning* 3(11): 306-321.

6 Farrell, Mark, *Air Operations in the Urban Environment: An Analysis of the Challenges and Opportunities for Contemporary Air Power.* Unpublished paper from Joint Services Command and Staff College, United Kingdom.

7 Morrison, Dawn and Colin Wood, 2016. "Megacities and Dense Urban Environments: Obstacle or Opportunity?," *Small Wars Journal*, 23 February 2016.

8 "Transportation Options for Megacities in the Developing World." National Research Council. 1996. Meeting the Challenges of Megacities in the Developing World: A Collection of Working Papers (Washington, DC: The National Academies Press)

9 Kevin Felix, "Megacities: Pros and Cons".

10 For some promising analytic tools for these purposes, see Jacques-Francois Thisse. 2014. "The New Science of Cities by Michael Batty: The Opinion of an Economist," *Journal of Economic Literature* 52(3): 805-819.

11 Klaus Desmet. 2016. "Analyzing Urban Systems: Have Mega-Cities Become Too Large?" World Bank Policy Research Working Paper No. 6872.

12 Md Aftabuzzaman, 2007. "Measuring Traffic Congestion—A Critical Review," 30th Australasian Transport Research Forum.

13 Peter Carol, 2006. *Between Heaven and Modernity: Reconstructing Suzhou, 1895–1937* (Stanford: Stanford University Press).

14 "Transportation Options for Megacities" p.74

15 U.S. Army, 2016. "Urban Operations in Megacities: White Paper," *Army Capabilities Integration Center*, p. 4. See also Russell W. Glenn. 2004. *Managing Complexity During Military Urban Operations: Visualizing the Elephant* (Santa Monica, CA: RAND).

16 Forsyth, Ann, 2003. *Measuring Density: Working Definitions for Residential Density and Building Intensity*, (Minneapolis: Design Center for American Urban Landscape), pp 5–7.

17 Forsyth, *Measuring Density*, 6.

18 Forsyth uses the term "city density", *Measuring Density*, 6.

19 U.S. Census Bureau, 2017. "U.S. and World Population Clock," https://www.census.gov/popclock.

20 United Nations, 2016. "The World's Cities in 2016: Data Booklet," (New York, NY: United Nations), http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf, 3.

21 See Geo Risks Research Department. 2004. Megacities–Megarisks.

22 See Joel Kotkin. 2014. *The Problem with Megacities* (Orange, CA: Chapman University Center for Demographics and Policy), p. 15.

23 Davies, James C. 1962. "Toward a Theory of Revolution," *American Sociological Review* 27(1): 5-19.

24 Walker, Iain, Heather J. Smth. 2001. "Fifty Years of Relative Deprivation Research," in I. Walker and H.J. Smith, eds., *Relative Deprivation: Specification, Development, and Integration*. (New York: Cambridge University Press), p. 1.

25 Nuissl, Henning, Carolin Höhnke, Michael Lukas, Gustavo Durán, and Claudia Rodriguez Seeger, 2012. "Megacity governance: Concepts and challenges," in *Risk habitat megacity*, ed. Dirk Heinrichs, Kerstin Krellenberg, Bernd Hansjurgens, and Francisco Martinez (Berlin: Springer), p. 88. See also David Shunk, 2014. "Mega Cities, Ungoverned Areas, and the Challenge of Army Urban Combat Operations in 2030–2040," *Small Wars Journal*, 23 January 2014.

26 Andre Sorensen and Junichiro Okata, 2011. "Introduction", in A. Sorensen and J. Okimoto, eds., *Megacities: urban form, governance, and sustainability* (Berlin: Springer), p. 3.

27 Grau, Lester W., and Jacob W. Kipp. 2007. "Urban Warfare: Monumental Headaches and Future War," in J. Antal and B.T. Gericke, (eds.) *Forests of Steel: Modern City Combat from the War in Vietnam to the Battle for Iraq* (Fort Worth, TX: EFW), p. 26.

28 John Spencer. 2017. "It's Time to Create a Megacities Combat Unit." www.realcleardefense.com. 31 January 2017.

29 Sukanya Podder, 2013. "Non-State Armed Groups and Stability: Reconsidering Legitimacy and Inclusion," *Contemporary Security Policy* 34(1): 19.

30 Jennifer Keister, 2014. "The Illusion of Chaos: Why Ungoverned Spaces Aren't Ungoverned, and Why that Matters," *CATO Institute Policy Analysis*, no. 766 (December): 2.

31 Jackman, Robert W. 1993. *Power without Force: The Political Capacity of Nation-States* (Ann Arbor: University of Michigan Press).

32 Finally, we have eliminated the case of partners with external legitimacy, but no authority within the city. We deem such a situation logically irrelevant, due to the potential partner's inability to significantly affect outcomes in the urban operation. Future researchers may reintroduce such a category, as they see fit.

33 For an historical overview of urban military operations see J. Antal and B. Gericke, eds., 2003. *City Fights: Selected Histories of Urban Combat from World War II to Vietnam* (New York: Ballantine) and J. Antal and B.T. Gericke, eds., 2007. *Forests of Steel: Modern City Combat from the War in Vietnam to the Battle for Iraq* (Ft. Worth, TX: EFW) and G. Gentile, D.E. Johnson, L. Saum-Manning, R.S. Cohen, S. Williams, C. Lee, M. Shurkin, B. Allen, S. Soliman, and J.L. Doty III. 2017. *Reimagining the Character of Urban Operations for the US Army* (Santa Monica: RAND).

34 We choose to range the values of the parameter along a single dimension: the degree to which kinetic force is used. Other approaches have been attempted; Williams and Selle, for example, provide six nominal categories of missions. We choose our route for the sake of parsimony. See Williams and Selle, *Military Contingencies*, pp. 21-32.

35 Joint Publication 3-0.

36 Joint Publication 3-0. V-3.

MORPHOLOGICAL ANALYSIS OF HBOE

Now that the three core dimensions and their subcomponents are defined, it is time to construct the multidimensional matrix that contains the entire morphological space of our research problem: megacities as operational spaces.

CORE DIMENSIONS	PHYSICAL		HUMAN			MISSION
PARAMETERS	Internal Access	External Access	Demo-graphy	Social Expecta-tions	Governance	Mission
VALUES	High Int Access	High Ext Access	Large	Met	Formal Partner	Non Kinetic
	Low Int Access	Low Ext Access	Small	Not Met	Expedient Partner	Low Kinetic
					No Partner	High Kinetic

Table 4.1—Morphological field of megacities as operational spaces

Table 4.1 presents the core dimensions in the top row, and then the subcomponents associated with each core dimension in the second row. The subcomponents constitute the

parameters that go into the morphological analysis. Each *parameter* is defined by a set of *values*—or conditions—that are listed in columns under each parameter.

This morphological field consists of 2 × 2 × 2 × 2 × 3 × 3 = 144 different combinations of values. In theory this means that 144 unique *solutions*, or typological categories, are found within the problem space. Most likely, a sizeable part of this space consists of solutions that are logically or empirically inconsistent. It is the object of further analysis to weed out inconsistent solutions thus retaining only those solutions that are assessed to be consistent.

However, initial analysis indicates that even after eliminating logically or empirically inconsistent solutions, the resulting solution space still encompasses a very large number of configurations. A typology thus might end up either having too much diversity within each category, or having too many typological categories. Therefore, in order to simplify the analysis and enhancing clarity, a two-step approach to analysis was adopted.

In the first step, each of the core dimensions (PHYSICAL, HUMAN, MISSION) was analyzed separately. Hence, it was possible to create more meaningful, abstract concepts that could be taken into the second aggregate phase of the analysis. Then, in the next step, these concepts were fused into a second morphological field.

CORE DIMENSIONS ANALYSIS

In the following section we present the initial Core Dimension Analysis. In later sections we employ the resulting concepts to build an aggregate morphological field that encompasses all core dimensions in an integrated matrix.

THE PHYSICAL DIMENSION

The Physical dimension consists of two parameters—*internal access* and *external access*—each of which is characterized by two values—*high* and *low*.

Table 4.2 presents the morphological field of the physical dimension. Assessment of the interrelationships between the parameters indicates that the field cannot be significantly compressed. Hence, there are four possible outcomes:

1. High Internal Access–High External Access
2. Low Internal Access–High External Access
3. High Internal Access–Low External Access
4. Low Internal Access–Low External Access

Internal Access	External Access
High Int Access	High Ext Access
Low Int Access	Low Ext Access

Table 4.2—The physical dimension

THE HUMAN DIMENSION

The Human dimension consists of three parameters–Demography, Social Expectations, and Governance (see Table 4.3).

DEMOGRAPHY	SOCIAL EXPECTATIONS	GOVERNANCE
Large	Met	Formal Partner
Small	Not Met	Expedient Partner
		No Partner

Table 4.3—The human dimension

For the demography parameter two values are defined: large and small. The social expectations parameter also has two values: met and not met. For the governance parameter three values are defined: formal partner, expedient partner, and no partner. The morphological field of the Human dimension thus consists of $2 \times 2 \times 3 = 12$ different configurations. In the next stage a cross consistency assessment is carried out in order to establish a consistent solution space.

The cross consistency assessment measures each value against every other value in the matrix in order to establish the consistency of value pairs and, consequently, of entire solutions. The consistency matrix is presented in Table 4.4 (next page).

Two value pairs were identified as inconsistent:

- **Social expectations/met–Governance/expedient partner**

  Urban societies that meet the social expectations of its inhabitants will, in the majority of cases, comprise a legitimate and authoritative governing body and be characterized by social stability. Furthermore, the presence of a government upholding a monopoly of violence over the entire city leaves no room for parallel security structures or rival actors claiming internal legitimacy. Hence, expedient partnership—i.e. a partner that has only internal legitimacy—is deemed inconsistent with socially stable human landscapes. For future research, however, it would be interesting to explore situations where informal governance meets the social expectations of the citizenry, as it may approximate it. In describing the gang-ruled *favelas* of Rio de Janeiro, an expert from the US Army's Training and Doctrine Command (TRADOC) opined "there may be order, but I wouldn't call it law and order."[1]

	Large	Small	Met	Not Met	Formal Partner	Expedient Partner	No Partner
Large							
Small							
Met							
Not Met							
Formal Partner							
Expedient Partner			×				
No Partner				×			

Table 4.4—Consistency matrix of human dimension. An "×" indicates an inconsistent value pair.

- **Social expectations/not met–Governance/no partner**

  A downturn of social expectations, especially if it is sudden, erodes support of government and provides fertile ground for non-state groups challenging the monopoly of violence. In a disintegrating city either of two partnerships is possible: (i) Formal partnership with actor(s) claiming internal and external legitimacy, or (ii) expedient partnership with actors claiming internal legitimacy. In these cases, the "no partner" option is deemed inapplicable to an intervening force.

The solution space of the human dimension then consists of eight unique solutions (see Table 4.5). In the next step we will seek to compress this space further.

DEMOGRAPHY	SOCIAL EXPECTATIONS	GOVERNANCE	CONCEPTS
Large	Not Met	Expedient Partner	Fragmented City
Small	Not Met	Expedient Partner	
Large	Met	Formal Partner	Functional City
Small	Met	Formal Partner	
Large	Not Met	Formal Partner	Revolutionary City
Small	Not Met	Formal Partner	
Large	Met	No Partner	Hostile City
Small	Met	No Partner	

Table 4.5—Solution space for human dimension

In synthesizing the solution space there are four main configurations that go together to form qualitatively separate categories. We will name these *Fragmented City*, *Functional City*, *Revolutionary City* and *Hostile City* respectively.

Fragmented City. A fragmented city is characteristic of human landscapes where social expectations are not met, thus eroding support of central authorities. Disintegrating central government gives rise to a potentially wide range of parallel power structures—militias, criminal gangs, and other non-state groups—that compete for power and territorial control internally, and with the government. In the absence of functioning central power structures, expedient partnership remains as the principal partnering option available to an intervening force.

Functional City. Where social expectations are largely met as a result of a rational and legitimate government, a functional city may ensue. Legitimate central government leaves no room for parallel power structures, thus formal partnership is the only alternative on offer.

Revolutionary City. Social deprivation may cause an insurgent populace to challenge a central government for power in a revolutionary city. Where that government maintains external legitimacy as the city's lawful authorities, formal partnership is the main partnering alternative to an intervening force.

Hostile City. In a city where social expectations are met the city's governing authorities most likely enjoy basic trust and support on the part of the population. An intervening force entering a city firmly under the control of a coherent government without a partner will confront a hostile city.

All city types conform to both large and small demographies.

MISSION

The core dimension mission only consists of one parameter. Hence, the three values that were defined in on page 30 remain as the entire set of outcomes:

1. Non Kinetic
2. Low Kinetic
3. High Kinetic

OPERATIONAL ENVIRONMENT ANALYSIS

We now turn to the aggregate analysis of cities as operational environments. For this analysis we fuse the analytic output of the three core dimensions into one morphological field (see Table 4.6).

The problem space consists of 4 × 4 × 3 = 48 possible configurations. In order to determine a solution space, consisting only of solutions that are logically and empirically consistent, a cross consistency assessment is carried out. The outcome of the cross consistency assessment is presented in Table 4.7.

Altogether 16 value pairs are found to be inconsistent. We will briefly present the main argument for the assessment of consistency.

PHYSICAL	HUMAN	MISSION
High Int High Ext	Functional City	Non Kinetic
High Int Low Ext	Fragmented City	Low Kinetic
Low Int High Ext	Revolutionary City	High Kinetic
Low Int Low Ext	Hostile City	

Table 4.6—Aggregate Analysis Morphological field

	High Int High Ext	High Int Low Ext	Low Int High Ext	Low Int Low Ext	Functional City	Fragmented City	Revolutionary City	Hostile City	Non-Kinetic	Low Kinetic	High Kinetic
High Int High Ext											
High Int Low Ext											
Low Int High Ext											
Low Int Low Ext											
Functional City			×	×							
Fragmented City	×	×									
Revolutionary City	×	×									
Hostile City			×	×							
Non-Kinetic						×	×	×			
Low Kinetic					×			×			
High Kinetic					×	×	×				

Table 4.7—Cross Consistency Matrix of Aggregate Analysis. An "×" indicates an inconsistent value pair.

- **Physical/High Internal Access—Human/Fragmented City; Revolutionary City**
  There are no firm criteria for what constitutes "high" or "low" in terms of physical access. However, the degree of disorganization and infrastructure decay that might be associated with fragmented or revolutionary cityscapes is assessed to be inconsistent with high internal access.

- **Physical/Low Internal Access—Human/Functional City; Hostile City**
  We assess low internal access to be inconsistent with functional city and hostile city respectively. In the case of a functional city this follows directly from the conceptualization of that city type; high internal access is an aspect of a city being functional. As for a hostile city, the fact of it being administered by a well-functioning government strongly indicates that its infra-structure requirements are being met, hence, internal access will be "high" rather than "low".

The mission-sets *non kinetic*, *low kinetic*, and *high kinetic* combine in various ways with the city typology defined under the human dimension.

- **Mission/non-kinetic—Human/Fragmented City; Revolutionary City; Hostile City**
  Non-kinetic missions comprise cooperative military activities in a low threat environment. Therefore, given the potential for having to confront violent opposition, non kinetic is assessed to be inconsistent with a fragmented city, a revolutionary city, and a hostile city.

- **Mission/Low Kinetic—Human/Functional City; Hostile City**
  Low kinetic missions presuppose the presence of an enemy threat within the theatre of operations. Operations are therefore designed to counter that threat and to protect own forces and allies. Hence, low kinetic is deemed to be of little relevance in functional cities: assuming that a local monopoly of violence is being firmly maintained by a legitimate formal partner, any use of weapons on the part of an intervening force is incompatible with the fundamental tenets of that form of partnership. In the case of a hostile city,

"low kinetic" can be seen as wholly inadequate as a doctrine considering the potential for organized, large scale armed opposition.

- **Mission/High Kinetic—Human/Functional City; Fragmented City; Revolutionary City**

  High intensity conflict comprises all kinds of large scale military operations. It can be presumed that such operations are relevant only in settings where there is an enemy actor with a capability to put a significant military force in the field. Hence, high kinetic missions are relevant in the case of a hostile city, assuming that extensive use of force may be required in order to defeat a well-organized enemy force. As for cityscapes of the functional, fragmented, or revolutionary kind high kinetic force is deemed inconsistent on the grounds of it being irrelevant, disproportional or potentially counterproductive.

The outcome of the cross consistency assessment is a solution space consisting of 8 consistent solutions (see Table 4.8).

PHYSICAL	HUMAN	MISSION	CONCEPTS
Low Int High Ext	Fragmented City	Low Kinetic	Restoring the Fragmented City
Low Int Low Ext	Fragmented City	Low Kinetic	
High Int High Ext	Functional City	Non-Kinetic	Assisting the Functional City
High Int Low Ext	Functional City	Non-Kinetic	
High Int High Ext	Hostile City	High Kinetic	Fighting the Hostile City
High Int Low Ext	Hostile City	High Kinetic	
Low Int High Ext	Revolutionary City	Low Kinetic	Defending the Revolutionary City
Low Int Low Ext	Revolutionary City	Low Kinetic	

Table 4.8—Solution space of aggregate analysis

Further analysis of the solution space matrix indicates that it may be compressed into four main categories. We will name these: *Restoring the Fragmented City*, *Assisting the Functional City*, *Fighting the Hostile City*, and *Defending the Revolutionary City*.

Restoring the Fragmented City. Inadequate internal communication infrastructure, the collapse of monopoly of violence, and social and political fragmentation, combine to form a highly complex cityscape. Military intervention may conceivably have the restoration of order as its fundamental rationale, possibly supporting an expedient partner in reestablishing a monopoly of violence. Operating within an urban landscape among a population of non-combatants leaves little tolerance for collateral damage. The active use of force will be restricted, hence the mission will be low kinetic.

Assisting the Functional City. External influences—political, military or natural—may require a military force to assist an otherwise functional city. The purpose of assistance may include upholding external security, ensuring safety for its population, keeping up a basic level of

public services, or advising a government. It is a precondition for establishing a mission that internal security functions are sustained by the city's own authorities; hence the intervening force has to conform to a non-kinetic mission set.

Fighting the Hostile City. A city may constitute an opposing power, requiring the forced intrusion of a military force into the city. In a hostile city, no partner—formal or expedient—is forthcoming; hence the intervening force must be prepared to fight the enemy through large scale use of force within the city itself. The ultimate goal of operations is to defeat organized enemy resistance and pacify the city populace.

Defending the Revolutionary City. In a revolutionary city military intervention will have as its ultimate goal to defend and protect the city government from armed threats emanating from within the city itself. Rival actors base out of ungoverned segments of the city where they draw on support from an alienated populace. Although a split city, the authorities maintain external legitimacy; hence, the city's authorities may seek formal partnership with an outside force in order to subdue rival actors through the use of low kinetic force.

This aggregate city-mission typology can be considered exhaustive in that it represents any plausible combination of the physical, human and mission related aspects of military operations in urban landscapes. Breaking such a vast and complex problem down into just four categories, of course, involves gross abstractions from all the detail and particularities that any practical mission will have to confront. However, at this point it is our opinion that the level of insight into the subject in the scientific and military communities is such that a generic definition of main concepts is a prerequisite for any more comprehensive studies to succeed.

NOTES

1 Quoted in Sydney Freeberg. 2014. "Army Grapples with Cyber Age Battles in Megacities," *Breaking Defense*. http://breakingdefense.com/2014/05/army-grapples-with-cyber-age-battles-in-megacities/. Accessed 1 May 2017.

CONCLUSIONS AND RECOMMENDATIONS

Current trends clearly indicate that future military operations will be characterized by decentralized networked forces, on both sides, operating in complex urban environments. The planning, thinking, decisions, and actions necessary to succeed in these complex urban environments will demand a new way of thinking about operations that clearly diverges from the current approach developed over the last forty years. Most defense thinking, organizations and structures are still focused to conduct massed kinetic operations against an opposing force. As the world continues to move toward urbanization, this way of thinking will not work.

The US is at a crossroads much like Athens prior to the second Persian invasion. Themistocles, in the 480s B.C., had the foresight and vision to recognize that future conflict with Persia would not succeed if Athens remained focused on land warfare and the infantry tactics they understood. Themistocles argued that Athens should invest the riches from a newly discovered streak of silver into the building of 200 Trireme, against the counter-argument that Athens should stay focused on land warfare. Luckily for Athens and all of Greece, the assembly accepted Themistocles' vision, as it put them on the road to defeat the Persians during the second Persian invasion of Greece in 480 B.C. Today, the US military has an opportunity to recognize that future operations will involve complex urban environments.

For far too long, the US has all but ignored the urban environment because of its inherent complexity not only in terms of operations but in simply trying to understand the environment. However, the world is moving toward more urbanization not less and these human built operational environments will become more important both politically and strategically.

The current discussion on operating in a mega city is definitely a step in the correct direction but far too limiting. Unfortunately, too much focus appears to be on a term versus attempting to get to the root of what planners need to understand when conducting operations in these environments. In addition, there remains a strong bias towards conventional operations. First, the term "mega city" is limiting the discussion to a specific class (arbitrarily defined) of urban environment and does not adequately address the full spectrum of urban environments. There are only a handful of arbitrarily defined mega cities but there are now over 460 cities with a population over one million. The point is that no urban environment should be ignored in the discussions. Second, the slant towards conventional kinetic operations is not in touch with current and future trends. There is no doubt that our adversaries will continue to gravitate toward urban areas, if for no other reasons than that is where the people are and the demonstrated difficulty of US operations in these areas. However, as the world becomes more urbanized, the US can expect to operate in fully populated contested, congested, and peer/near-peer complex dense urban environments.

Future planners will face a complex operating urban environment scaled in size from small to large and conducting military operations ranging from non-kinetic to high intensity conflict. The fact is our current doctrine does a poor job of providing a useful framework for either the planning or discussion of operating in this complex environment. This work attempts to correct this problem by providing a rigorous conceptual framework to build future discussions and research as the Department of Defense continues to struggle with this operating environment. This analysis effort provides a common conceptual foundation for further and deeper discussion and analysis across the Department of Defense.

RECOMMENDATIONS

This analytic effort proposes a new typological schema labeled human built operational environments (HBOEs) to break the limited utility of arbitrarily defined terms such as "mega city". Accepting this new schema will allow planners and analysts greater flexibility and understanding in developing military operations in these environments.

Discussion and research needs to continue and the Department of Defense community should move away from attempting to define urbanization discussions based simply on population or city size. This approach is too limiting and places less emphasis on understanding the true nature of the future operating environment. We believe that the term human built operating environment will help steer discussion in the correct direction. The conceptual framework presented in this effort will enable discussion, debate and analysis concerning doctrine development, technology focus, and force structures for operations in future human built environments.

At its basic level, this effort argues that human built operating environments are constituted by three dimensions: the *physical space*, the *social domain*, and the *nature of the mission*. This represents a necessary first step on the road to more exhaustive studies. Such studies will further our understanding of urban missions and, as a starting point, should focus on:

- Description and characterization of the physical features of human built landscapes; climate, terrain, infrastructure.
- Understanding of how cities are governed; political legitimacy in urban landscapes.

- Development of doctrinal human built environment missions; concepts and technology

This effort has established a common foundation set of four city types that are fused with the physical characteristics of the urban landscape as well as the nature of the military operation, specifically the use or non-use of kinetic force. These city types by design are not linked to a specific size of the city/population. They correspond to an aggregate city-mission typology consisting of four main types:

- Restoring the fragmented city
- Assisting the functional city
- Fighting the hostile city
- Defending the revolutionary city

These designation now establishes a common foundation to support more exhaustive studies. This breaks the discussion from the size of the city or conventional war biases to developing a clear understanding of what are the planning and operating requirements for future

success. Further, these conceptual urban mission types can be linked logically to the following future research efforts:

- Develop an understanding of the complex interactions among all the elements: government, populace, social/religious groups, criminal elements, and infrastructure.
- Identify, Define, and Understand Critical Infrastructure Interdependencies.
- Identify current doctrinal and technological gaps and vulnerabilities.
- Identify potential C4ISR and direct action capability gaps.

The last 17 years have not prepared the US military for operations in urban environments, especially those where the population will remain. The Department of Defense recognizes that there are still many questions concerning both organizational and doctrinal development and science and technology investments that will prepare for and eliminate vulnerabilities of operating in future human build operational environments. We recognize that this analysis effort does not answer all of these questions but it does provide the first common conceptual foundation for further and deeper discussion and analysis.

IMAGE CREDITS

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