Preparing for Future Joint Urban Operations:

The Role of Simulations and the *Urban Resolve* Experiment

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Executive Summary

Operations in urban areas have long perplexed military planners, and military analyses predict extensive urban operations for the foreseeable future. Even analyses of the recent urban operations in Iraq recommend significant revision of future training efforts for the conduct of urban operations, emphasizing the need for improved modeling and simulation of urban terrain. While the historic approach has generally been to avoid cities or wage massive campaigns of attrition, it is clear that urban areas can not be avoided and that modern sensibilities chafe at widespread collateral damage.

This paper discusses recent developments in the area of joint urban operations concept development and experimentation, arguing that initiatives under way at U.S. Joint Forces Command have great potential for improving preparation for urban conflict. The paper first discusses the context for new thinking and doctrine on joint urban operations, including analysis of recent data on patterns of global urbanization and U.S. troop deployment and responses. The strategies being used for assessing urban operations concepts are presented, including preliminary detailed results from the ongoing *Urban Resolve* experiment and its application of cutting-edge modeling and simulation technologies.

Briefly, *Urban Resolve's* breakthrough first phase, completed in October, 2004, convinced senior leaders that its experimental approach and tools could be applied across a wider range of venues to assist the Defense Department with current 'real world' problems. *Urban Resolve* has thus been expanded to assess nascent urban capabilities and to immediately address current challenges, such as the unconventional use of mortars in Iraqi cities. *Urban Resolve* and its associated modeling and simulation capabilities are thus important support elements in the current approach to training and preparing U.S. forces for joint urban operations.

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Operations in urban areas have perplexed military planners since the advent of the walled city. As early as 1400 B.C., Israelite armies were conducting sieges against the residents of their future Promised Land. One thousand years later, Sun Tzu advised, "The worst policy is to attack cities. Attack cities only when there is no alternative…[T]hose skilled in war…capture his [enemy's] cities without assaulting them and overthrow his state without protracted operations."[1] Very recently, U.S. and Iraqi joint forces were engaged in street-to-street urban combat again in Fallujah, wresting control of the city from insurgents.

From this and other recent operations ranging from Mogadishu to Kabul to Baghdad, new doctrine and new capability requirements are emerging to enable more effective urban operations. These changes reflect new thinking that is complemented by experiments using state of the art modeling and simulation at U.S. Joint Forces Command's Joint Experimentation directorate. This article argues that Joint Urban Operations concept development and experimentation have great potential for improving preparation for urban conflict. First, the context for new thinking and doctrine on joint urban operations is articulated, including analysis of recent data on patterns of global urbanization and U.S. troop deployment and responses over the last half-century. The strategies being used for assessing urban operations concepts are then discussed, showing the ways in which the *Urban Resolve* experiment applies cutting-edge modeling and simulation technologies to the subject. The conclusions suggest the ways in which these activities support current and future joint force operations.

The U.S. Army's major 'Lessons Learned' document for Operation Iraqi Freedom, *On Point*, made prescient recommendations for future training efforts: "What must be done next is to build

a simulation that affords joint commanders the opportunity to plan and execute realistic training in large urban areas that replicate both the urban core and urban sprawl. This task, while daunting, is not out of reach."[2] The present article argues that such a simulation is already in hand.

We Have Seen the Future War, and It Is Urban

When it comes to operations in urban areas, military planners face distinct challenges that derive from the city's characteristics, its *urban triad.* These are a complex manmade terrain superimposed on natural terrain, a large and densely distributed population, and physical and service infrastructures. "These characteristics interact to make each urban area a complex and dynamic system of systems, with a unique physical, political, economic, social, and cultural identity." Joint Urban Operations are the joint operations planned and conducted in these environments.[3] While the ability of Operation Iraqi Freedom (OIF) Phase I coalition forces to adapt and make the way for success in their urban battles is widely praised, future joint forces will benefit from improved doctrine, training, and leadership in the area of urban operations.

It is now clear that this is a matter of extraordinary importance, as all indicators point to extensive urban operations for the foreseeable future. First, the nation's adversaries will continue to move their battles into urban areas, where they believe American asymmetric warfighting advantages may be neutralized. Second, the world's population is relocating to urban areas to a significant degree, including in those regions where U.S. forces were most active in the last two decades. Third, American urban operations will continue to include stability, reconstruction, and humanitarian operations, with important strategic consequences.[4]

Patterns of U.S. Military Deployments and Responses, 1950-2002

Part of this discussion hinges on whether U.S. forces are required to engage extensively in

urban areas compared with other areas. We can, for example, assess whether urbanization trends (the propensity for population growth in urban, versus rural, areas) are related to U.S. military activity. We should be concerned if our military is more likely to be deployed or engaged in areas where urbanization is occurring. If military deployments or engagements are not taking place in urbanizing areas, then the concerns about the impact of worldwide urbanization on the U.S. military may be misplaced.

Three sets of data, which to my knowledge have not yet been considered in concert, relate directly to this question. First, the United Nations tracks national populations and publishes urban growth rates by country and region. Second, a new dataset on U.S. military deployment rates was published in late 2004 by the Heritage Foundation, documenting the number of billets assigned to countries for every year from 1950 through 2003. Finally, Thomas Barnett, a Naval War College professor with close ties to the Defense Department's Office of Force Transformation recently collated U.S. military responses to situations worldwide between 1990 and 2002.[5] Although a nation-by-nation analysis of these datasets could be undertaken, here I aggregate the data by region. In this way, we can assess whether there is a first-order relationship between regional urbanization and U.S. military activity.

To test the hypothesis that U.S. deployments are related to urban growth, I compare regional urban growth rates with changes in troop deployment patterns across that time period (see Appendix Table A-1). This measure is developed by taking the mean number of troops deployed to each region in each decade; the 1990s mean is subtracted from the 1950s mean, yielding the change in average regional troop deployments over the four decades. As we would expect, the number of billets varies considerably; compare, for example, the 129,000 troops on average deployed in 1990s Northern and Western Europe with Southern Africa's 32. To make a direct comparison between regions, I convert the troop changes to percentages. In Northern and West-

ern Europe, this produces a 1950s-1990s reduction in U.S. troops of 58.2%: (309,188 - 129,192) ÷ 309,188 = .582.

Table 1 presents regions' 1950-2000 urban growth rates and percentage change in U.S. troops deployed over the same time period. Regions are rank-ordered by urban growth rate. Eastern Africa had the highest urban growth rate, at an average of 5.77% per year, followed by Western Africa (5.33%), Western Asia and Middle Africa (4.41%). The regions with the slowest urban growth were Northern and Western Europe (0.84%), Southern Europe (1.38%), North America (1.59%, excluding the U.S.), and Eastern Europe (1.75%). The world's urban growth rate was 2.68%, with a substantial difference between developed (1.4%) and less-developed regions (3.73%).

Only four regions saw increases U.S. troop levels: Eastern Europe (+1,579%), Western Africa (+779%), Western Asia (+95%), and Eastern Africa (+15%). The massive increase in U.S. troops in Eastern Europe during the '90s is clearly a function of Cold War-Post Cold War adjustments, but represents a real change of only 1,282 billets; similarly, Western Africa's increase represents only 91 billets. (The political connotations of the Eastern Europe changes are historically unique, so I drop it from this part of the analysis.) Excluding these two regions, there was typically a 40% reduction in U.S. troops between 1950 and 1999.

Table 2 (see also Appendix Table A-2) shows Barnett's classification of U.S. military responses to different types of situations between 1990 and 2002; regions are ranked by their 1950-2000 urban growth rates. The region with the most U.S**.** responses is Western Asia, with 35; 69% involved force application, while 31% were humanitarian (including peacekeeping). Southern Europe, which includes the nations of the former Yugoslavia, saw 23 U.S. responses, of which about half were humanitarian (mainly NATO peacekeeping missions). Eastern Africa witnessed 16 responses; although predominantly peacekeeping, Task Force Ranger's October 1993 experi-

ence in Mogadishu shows that humanitarian missions can devolve quickly into combat. About 57% of all military responses were humanitarian, and 43% were intended primarily as shows of force, contingency positioning, or combat operations.

There is a strong statistical relationship between urban growth and troop deployments. There is a multiple correlation between urban growth and military deployment changes of 0.62 (on a scale of 0 to 1), and urban growth rate explains 38% of the variation in troop deployment changes. Regions with urban growth rates greater than about four percent in the last half of the twentieth century were likely to see increasing U.S. troop deployments, while regions with lower rates saw troop presence reduced. Additionally, there is reasonably strong relationship between urban growth rates and U.S. military responses. Excluding Southern Europe's NATO mission, the measures have a correlation coefficient of .58, urban growth rate explains 34% of the variation in U.S. responses, and a one percent increase in urban growth produced 3.9 more U.S. military responses. The overall picture that emerges from these data is of increasing American military engagement in rapidly urbanizing areas of the world, confirming the extant assertion of military analysts that calls for improved preparation for combat and humanitarian operations in urban environments.[6]

It should be noted that Barnett has a somewhat different take on the distribution of military activity in the post-Cold War time frame. He suggests that the U.S. engages in those areas of the world that are excluded from economic globalization's bandwagon. The results in the analysis presented here do not contradict his assertion, because the less developed regions of the world experienced much faster urban growth than developed areas, so American military activity took place in the less developed regions with their high urban growth rates.

The Iraq Example

Operation Iraqi Freedom epitomizes the issues that apply to urban operations. The 1991 Gulf War taught the Iraqi military leadership that fighting the American-led coalition in the wide open spaces of the Arabian Peninsula was a hopeless undertaking. In the 2003 war, the fighting capacity of the Iraqi armed forces was centered in urban areas, but the regime and most cities fell quickly. The relatively meager combat challenges initially faced by coalition joint forces have left little room for complacency about urban warfare, however. Post-major combat operations (including humanitarian and stability operations) have produced uneven stability on the road to the final transition to Iraqi civilian control, with the most virulent insurgency elements concentrated in cities. The relative calm of Iraq's first election day on January 30, 2005 was a promising harbinger, though the insurgency continues to find support where economic reconstruction is slow.

On Point, while generally positive about joint urban operations in Iraq, notes two "significant deficiencies" in U.S. training on the subject. First, the primary training facilities for U.S. forces are modeled as small towns or villages, rather than major metropolitan areas. Second, legacy computer simulations were insufficiently realistic to adequately prepare joint force commanders or warfighters for urban operations.[7] In summary, while our military is the best funded and equipped in the world, doctrine and training lagged, until recently, when it came to preparation for urban operations. In the last ten years, the challenge of doctrine and concept development was framed by two distinct, yet related questions.

Critical Question 1: How Will We Fight?

> *How can we fight in urban terrain against an intelligent, determined, well-equipped adversary and win quickly without unacceptable casualties to ourselves or our allies, unacceptable civilian casualties, or unacceptable destruction of in-*

frastructure?[8]

The question itself reframes the debate on urban operations. Historically, the primary issue was simply how to fight in urban terrain; collateral damage was of secondary concern. Beginning in 1998 a Joint Urban Working Group addressed the new question, and made several recommendations for developing an effective new joint doctrine for urban operations.[9]

The core of the resulting Joint Urban Operations (JUO) concept is to apply new and innovative thinking regarding joint capabilities and urban operations, and new technologies to bring the open environment advantages our military currently enjoys into to urban environments. Two elements comprise the new thinking: joint (versus service-centric) operational capabilities and a new conceptual framework for urban terrain. The JUO concept leverages emerging technologies to conduct effective urban warfare while explicitly addressing concerns about friendly casualties and collateral damage. Rather than relegating planning for action in cities to secondary status, urban operations are viewed as important opportunities for accelerating the attainment of strategic goals.

The Strategy: New Thinking and Doctrine

The center of gravity for new, innovative thinking on JUO is U.S. Joint Forces Command's (JFCOM) Joint Experimentation directorate (J9), headquartered in Suffolk, Virginia. In 2003 JFCOM was designated as the Defense Department's Executive Agent for improving capabilities in joint urban operations, and partners with the Institute for Defense Analyses (IDA) and its Joint Advanced Warfighting Program (JAWP) for doing so.

The modern framework for conducting JUO is articulated in all of the major documents prompted by the deliberations of the Joint Urban Working Group. In general, the self-conscious end state of JUO is transferring control to a nonmilitary authority after strategic and operational

objectives have been achieved. The doctrine is summarized by the acronym USECT.[10] Joint Force Commanders must

- **Understand**: Evaluate the urban battlespace first, including the urban triad and the threat, to determine the implications for military operations.
- **Shape**: Establish favorable conditions for engagement by influencing the strategic setting and controlling the physical environment.
- **Engage**: Apply diplomatic, informational, military, and economic capabilities to achieve operational objectives, from full-scale combat to humanitarian assistance.
- **Consolidate**: Protect what has been gained and retain the initiative to disorganize the adversary in depth, to maintain operational advantage.
- **Transition**. Return control to civilian authorities; the transfer could be to another military force or international organization.

JUO conceptual innovations have led to several new operational and tactical approaches. In general, they reflect transition *from* operations that use massed confrontation, attrition, contiguous and sequential tactics, *to* operations that are information-based, using discriminate precision force projection, measured effects, and overmatching power. The new urban warfare concepts "offer the prospect of significantly reducing both friendly and civilian casualties, as well as collateral damage, however, they also require greatly improved capabilities for achieving understanding *before* engaging." [11]

The JUO Joint Integrating Concept currently being developed at JFCOM outlines in more detail the conditions and capabilities needed for planning and conducting successful joint urban operations. Because the urban environment is too complex for single-agency or single-service solutions, "generating desired effects and avoiding unintended effects [requires] careful integration of joint forces and interagency supporting capabilities at each point of action and at every

level of decision."[12] A significant portion of the directorate's JUO energy is dedicated to this task.

Critical Question 2: How Do We Determine How We Fight?

How can we determine which concepts, matériel, tactics, techniques, and procedures are most effective for fighting in urban terrain?

The approach for addressing this question was articulated in the *National Security Strategy of the United States,* "Innovation within the armed forces will rest on experimentation with new approaches to warfare, strengthening joint operations, exploiting U.S. intelligence advantages, and taking full advantage of science and technology." This echoed congressional language supporting the creation of "an energetic and innovative organization" within the Defense Department for future-oriented experimentation.[13] Most recently, the 2004 Unified Command Plan assigned to JFCOM responsibility for leading and coordinating joint concept development and experimentation.

The command's strategy is to develop capabilities and concepts that will increase the effectiveness of joint force commanders in the field, through vigorous debate, collaboration, refinement, prototyping, and experimentation. Its Joint Concept Development path generates promising concepts through discovery and concept refinement experimentation. By collaborating with Services, combatant commands, multinational partners, and civilian agencies the pathway assesses concepts' potential for conversion to prototypes and informs future force investments. Concepts with promise for improving near-term warfighting capabilities are refined in the Joint Prototype Pathway to get them into the hands of joint warfighters as quickly as possible.

Four main experimentation methods are used in concept development: war games, experiments in virtual environments, constructive simulations, and live simulations. The stage of con-

cept maturation determines the mix of experimentation methodologies applied. Once new concepts emerge, "born jointly" from exploration, then refinement and assessment occur in a nonlinear and complementary experimentation process. Virtual environment experiments and constructive simulations grow in importance.

Human-In-The-Loop (HITL) experiments are crucial at this point. Blue concept developers play against Red Teams in real time; the mission of the Red team is to challenge, react, and adapt to the Blue team playing according to the parameters of the new concept. Red team does not respond according to pre-programmed algorithms, but simulates the response of an aggressive and adaptive enemy. In essence, Red tries to see if they can push the new concept to failure. This permits exploration of the interaction between new concepts and new technologies; assesses real and prototype command-and-control; and controls for human factors, such as cognitive reasoning and training.

The *Urban Resolve* Experiment

The JUO office is currently in the midst of a major multi-year experiment, *Urban Resolve*, involving HITL concept refinement exploring JUO enabling concepts. (Earlier experiments and war games include the *Joint Urban Warrior* series, co-sponsored with the Marine Corps.) As initially conceived, the experiment consisted of three major phases, focused on three key JUO capabilities: achieving a high-level of situational *understanding* via networked sensors; *shaping* (isolating and controlling) the urban battlespace through precision effects; and effectively *engaging* by maneuvering joint forces. The experiment was initially truly future-oriented, attempting to identify capabilities for execution in the 2015-2020 timeframe.

Urban Resolve's overall scenario involves a 2015 invasion of an island nation by a fundamentalist opponent (Red). Red forces are forced by a U.S.-led Combined Joint Task Force into a

major urban center, where Red is preparing for a final defense. Phase 1 included four HITL trials, occurring between June and October, 2004 (although concept and simulation development began in early FY04). Participants in the HITL phases were distributed, located at J9 Facilities (Suffolk, VA), Ft. Belvoir (Northern VA), Wright-Patterson Air Force Base (Dayton, OH), the Space and Naval Warfare Systems Command Support Center (San Diego, CA), and the Maui High Performance Computing Center, (Kihei, HI).

Phase 1 assessed a Joint Force Commander's ability to acquire situational understanding when he has access to a persistent and pervasive intelligence, surveillance, and reconnaissance (ISR) network suited to the urban environment. The ISR assets tested included human intelligence, current unmanned high- and medium-altitude sensors, and future low-altitude sensors (Organic Air Vehicles under development at the Defense Advanced Research Projects Agency [DARPA]). The players were challenged to use sensors to detect and track targets that frequently move in and out of sight; to pick those targets out of dense background clutter; to find very well concealed targets; to distinguish military targets from civilian look-alikes; and to disguise sensors and deploy them in stealthy ways.

Phase 2, tentatively scheduled for July through September 2006, will focus on shaping the battlespace via precision weaponry. Specifically, it will assess the Blue commander's ability to isolate and control the urban environment using standoff precision strike weapons systems. Phase 3 is tentatively scheduled for 2007, and will focus on forces engaging Red through joint maneuvers, adding full ground and special operations forces.

During Phase 1, senior leaders realized that its experimental approach and tools could be applied across a wider range of venues to assist the Defense Department with other vexing challenges. Under their explicit guidance, *Urban Resolve* was expanded to generate a baseline assessment of our overall urban warfighting capabilities and supporting programs, and to

immediately address challenges being faced in current urban operations. The two new "real world" applications of Urban Resolve will be (1) quickly adapting its modeling and simulation capability (discussed below) into a mission planning and rehearsal tool for deploying joint forces, and (2) assisting with developing more effective responses to non-traditional mortar attacks now occurring in Iraq. This more comprehensive character expands *Urban Resolve's* charter to investigate a wider range of near and far term urban issues to better support the joint warfighter.

Simulating the Urban Triad: Joint Semi-Automatic Forces

A central component of *Urban Resolve* is its use of the breakthrough simulation toolkit known as JSAF (Joint Semi-Automatic Forces), a collection of simulation components that is an outgrowth of DARPA Synthetic Theater of War initiatives.

> JSAF is a simulation system that generates entity level platforms such as infantrymen, tanks, ships, airplanes, munitions, buildings, and sensors, which interact at the individual level in a robust synthetic natural environment. …The synthetic environment is a representation of real world terrain, oceans, and weather conditions that affect the behaviors and capabilities of the synthetic forces…Command and control behaviors and architectures are realistically simulated, as are sensors, logistics, weapons effects, and entities' reaction to various combat stimuli.[14]

The importance of JSAF to the experiment can be understood in terms of the urban triad. The simulation portrayed a complex three-dimensional urban terrain of more than 1.8 million discrete buildings. Of those, about 65,000 had the capacity for greater interaction with Red and Blue forces, such as the ability to enter, fight inside, and view the street from inside a building. The environment was mapped based on two sections of a real city; the buildings, parking lots, and other urban clutter simulated actual physical characteristics, such as being built of wood or concrete. The presence of so many buildings simulated line-of-sight limitations as Blue team mem-

bers moved through the city.

JSAF also simulated the large, densely distributed urban population. More than 110,000 discrete person-entities were routinely simulated; about 35,000 were active and displaying culturally-appropriate behaviors. (Tests confirmed that one million entities could be generated in the simulation; a significantly higher number seems very likely.) Civilian vehicles and pedestrians were fully integrated into the simulation, controlled by a "Green" team, and Red and Blue teams both had to take civilian presence into account in their play. For example, a roadblock set up by the Red team would adversely affect traffic flow and Red's own movement. The simulated infrastructure reflected the model city. City streets and highways were affected by culturally-specific traffic flows; traffic and civilian presence increased around mosques at the appropriate times for daily prayers.

All the entities and players were affected by the urban triad, including being constrained to act in real time. A human intelligence agent, for instance, might be tasked for information acquisition. If "he" received the task during normal sleeping hours, the mission could not be performed until enough time had elapsed for getting up, getting dressed, traveling to the assigned site, observing the desired activity, and establishing communication with the Blue team players.

The Technology

The technical scale of the experiment was unprecedented. The architecture that allowed the distributed simulation to be effective had three elements: JSAF, Scalable Parallel Processors, and the Defense Research Engineering Network.[15] As we have seen, JSAF demonstrated the capacity to integrate very large numbers of entities into the experiment.

The experiment's architecture joined JSAF with Scalable Parallel Processor (SPP) clusters to enable these performance levels. An SPP cluster is a group of interconnected processors that

work together as a supercomputer. It breaks apart large computational tasks, parcels them out to the processors in the cluster, and reassembles them quickly. These clusters allow greatly increased computational speed without the use of expensive individual high-powered computers. In short, the JSAF-SPP combination vastly improves the training capability of HITL experiments, because the urban terrain, entity behaviors, sensors, weapons platforms and effects, and the civilian population and clutter of a city are more realistically simulated.

Two supercomputer clusters were used in *Urban Resolve*, located in Kehei (Maui), Hawaii and Wright-Patterson AFB. The SPP clusters were linked to the rest of the federation via the Defense Research Engineering Network. This very large and efficient DOD network provided the bandwidth necessary to transmit information from one site to another (up to 140 Mb/s), with no significant data transfer delay. This meant that players distributed across the country could interact in real time, on a 24/7 basis.

Results and Achievements

While comprehensive findings of *Urban Resolve* Phase I are being analyzed as this paper is being written, it is clear that its players successfully used JSAF to assess the impact on situational awareness of a pervasive ISR network. Three levels of understanding were assessed: "Where is Red?", "What is Red doing?", and "What is Red going to do in the future?" Between 60% and 70% of Red forces were successfully detected. Even after sensor operators eliminated high- and medium-altitude sensors in later trials, Blue analysts adapted their techniques, tactics, and procedures to accomplish the mission. Red's current activities were correctly identified between 55% and 70% of the time, and 60%-70% of Red's future actions were correctly anticipated. A total of 80%-90% of Red entities were tracked by the sensor network.

Several significant technical achievements are associated with *Urban Resolve* Phase 1. First,

J9 built, for this experiment, the largest, most complex, most reliable Virtual Urban Environment in the world to date. On the hardware front, the distributed simulation architecture controlled remotely over 300 computer nodes on the SPP and on the network; collected and analyzed massive amounts of data – about 100 gigabytes per week; and successfully conducted a large-scale distributed experiment over the DREN. Nearly 1.7 terabytes of data were collected over the experiment's four trials.

The experiment applied, for the first time, SPP supercomputers for interactive, real-time forces modeling. JFCOM was able to use the SPP hardware on a continuous basis, in which the players and simulation operators controlled entities on the supercomputers. This required new levels of cooperation between the JFCOM simulation team, the DREN program office, and the High Performance Computer Center management teams.

Joint Urban Operations and the Future Joint Warfighter

While urban conflict has always been part of military operations, the transformation in U.S. foreign policy under the Truman Doctrine also opened the door for expanded military engagement in non-combat activities. Operation Iraqi Freedom is a prominent recent example. As noted in early postwar analysis, "urban warfare in Iraq …. highlights the need to see urban warfare in peacemaking and nation-building terms and the need to develop suitable tactics, training, and equipment."[16] This finding is reinforced by analysis of the relationship between urban growth rates, changes in U.S. troop deployment, and military responses. The logical conclusion is that expanded Joint Urban Operations concept and doctrine development, experimentation, modeling and simulation will benefit practitioners of warfare's operational arts.

In light of these considerations, we can identify several specific advantages that seem likely to accrue to joint warfighters from JUO concept development and experimentation. First, they

will benefit from commanders' improved understanding of the urban battlespace, obtained through training in constructive simulations and advanced planning capabilities currently being fielded in the combatant commands.[17] Improved ISR has also been shown to vastly improve situational understanding and promise to revolutionize intelligence preparation of the urban battlespace.[18] These technologies will help future warfighters cope with elements unique to the urban triad.

Second, joint forces will be better prepared for the actual battle. By planning, training, and rehearsing for operations via advanced virtual simulations, commanders will gain better understanding of the impact of civilian population dynamics, urban structures and infrastructure. This will equip them to more effectively shape the battlespace to their own advantage. Smarter engagement with the adversary will result from the improved understanding and shaping process.

Moreover, improved preparations will occur in the near term as *Urban Resolve's* capabilities are applied to planning for and coping with current challenges in Iraq. Although joint experimentation has generally focused on the operational level of war, JSAF and SPP now allow JFCOM to selectively investigate key joint warfighting issues from strategic through operational to tactical, creating the opportunity to better recognize and understand key linkages and relationships in the conduct of joint operations. The initial effort to apply these modeling and simulation capabilities will be focused on improving our ability to deal with the extensive use of mortars and rockets to attack our forces in theater, with a strong possibility of then addressing the challenge posed by improvised explosive devices on the ground in Iraq.

Third, the JUO conceptual framework explicitly includes stability and reconstruction operations (Consolidation) and begins with the end-state in mind (Transition), facilitating more effective planning. Early understanding of the cultural and geographic dimensions of an urban environment, along with precision engagement, eases the movement to stability operations. These

increase commanders' awareness of the longer term implications of tactical decisions. By employing maneuver rather than attrition in urban engagement, noncombatant and combatant casualties may be minimized, attenuating post-combat resentment of coalition forces engaged in humanitarian and reconstructive operations. And by employing precision munitions with an awareness of nonmilitary and culturally sensitive urban sites, the joint force may avoid unnecessary collateral damage that undermines domestic and international support.

Despite Sun Tzu's advice, military commanders continue to find that cities are central elements in the logistical and operational landscapes. Future Joint Force Commanders and warfighters will benefit from the training opportunities afforded by new simulation and modeling initiatives, such as those demonstrated in *Urban Resolve*. Its breakthrough simulation of the urban triad improves prospects for gaining and maintaining information and decision superiority in the urban battlespace. Military planners and forces also have greater prospects for success in urban operations short of combat. Should combat be required, planning tools allow commanders to anticipate the consequences of tactical decisions, and improve opportunities for smoother and swifter transitions to civilian control.

Appendix Table A-1. United States Troop Deployments to World Regions, 1950-2003 (Decade Averages)

Region/Country	Decade Averages 1950s	1960s	1970s	1980s	1990s	2000-03	1950s-1990s Change
Africa							
Eastern Africa	788	1,620	555	119	908	223	120
Middle Africa	0	59	37	55	43	24	-16
Northern Africa	15,384	7,031	1,009	1,238	1,592	493	-13,792
Southern Africa	35	18	21	19	32	39	-4
Western Africa	12	81	77	102	103	102	91
Americas							
North America (non-US)	22,983	14,777	3,116	2,370	934	278	-22,049
Central America	10,972	10,638	9,998	10,892	8,399	491	-2,573
Caribbean	7,334	4,945	3,505	2,523	4,543	751	-2,792
South America	920	765	427	292	387	526	-534
Asia							
Eastern Asia	318,109	147,040	102,434	91,134	81,298	79,584	-236,811
South Central Asia	568	2,000	850	102	93	6,581	-475
Southeast Asia	15,471	236,398	99,806	15,381	2,787	615	-12,684
Western Asia	6,623	10,729	6,683	6,037	12,939	56,325	6,316
Europe							
Northern and Western Europe	309,188	300,095	248,466	287,130	129,192	86,211	-179,996
Southern Europe	21,042	25,657	25,041	28,426	23,457	23,377	2,415
Eastern Europe	81	72	89	121	1,363	271	1,282
Oceania	4,839	2,359	1,794	1,111	778	538	-4,062

Cell entries are the average number of U.S. military billets assigned to countries in each region in each decade, and aggregated. The original data are reported annually by country; regions are as defined by the United Nations. Antarctica, Continental U.S. and U.S. territories outside the continental United States are excluded.
Source: Tim Kane, "Global U.S. Troop Deployment, 1950-2003," Heritage Foundation Center for Data Analysis Report #04-11 (www.heritage.org/Research/NationalSecurity/cda04-11.cfm accessed 18 January 2005).

Appendix Table A-2. U.S. Military Responses to Situations, 1990-2002, by Region.

	Combat	Show of Force	Contingency Positioning or Reconnaissance	Evacuation or Security	Peacekeeping	Total
Africa						
Eastern Africa		1	1	7	7	16
Middle Africa				5	2	7
Northern Africa	1			1		2
Southern Africa					2	2
Western Africa				9	2	11
Americas						
North America (non-US)						0
Central America		1				1
Caribbean		2	2	3	3	10
South America			6			6
Asia						
Eastern Asia		2	1	1		4
South Central Asia	5					5
Southeast Asia			1	3	4	8
Western Asia	7	15	2	9	2	35
Europe						
North and Western Europe					1	1
Southern Europe	3	5	2	5	8	23
Eastern Europe						0
Oceania						0
Totals:	16	26	15	43	31	131

Sources: Military response data are from Thomas P.M. Barnett, "The Pentagon's New Map," *Esquire*, March 2003 (www.thomaspmbarnett.com/published/pentagonsnewmap.htm 28 Jan 2004. Regions are as defined by the United Nations.

Table 1. World Regions, Urban Growth Rates (Ranked) and Changes in U.S. Troop Deployment, 1950-2000

	Rank	1950-2000 Urban Growth Rate[a]	Rank	% Change in US Troop Deployment (1950s-1990s)[b]
Eastern Africa	1	5.77	4	15.2
Western Africa	2	5.33	2	779.5
Western Asia	3	4.41	3	95.4
Middle Africa	3	4.41	8	-27.4
Southeast Asia	5	4.02	13	-82.0
Northern Africa	6	3.74	16	-89.7
Central America	7	3.67	7	-23.4
South America	8	3.44	10	-58.0
South Central Asia	9	3.34	14	-83.7
Eastern Asia	10	3.25	12	-74.4
Southern Africa	11	3.00	6	-10.7
Caribbean	12	2.75	9	-38.1
Oceania	13	2.14	15	-83.9
Eastern Europe	14	1.75	1	1,579.1
North America (non-US)	15	1.59	17	-95.9
Southern Europe	16	1.38	5	11.5
North and Western Europe	17	0.84	11	-58.2
World		2.68	Mean:	103.2
			Median:	-38.1
			Mean (without Eastern Europe and Western Africa):	-40.2
			Median (without Eastern Europe and Western Africa):	-58.0

[a] Average annual rate at which a region's urban population increased between 1950 and 2000. Source: U.N. Department of Economic and Social Affairs, *World Urbanization Prospects: 2001 Revision*, www.un.org/esa/population/publications/wup2001/WUP2001report.htm accessed 22 September 2004.

[b] The difference in the average number of U.S. military billets assigned to countries in each region in each decade (see Appendix Table 1). Original data are reported annually by country; here they are aggregated by U.N. region (see Appendix Table A). Excluded are Antarctica, Continental U.S. and U.S. territories outside the continental United States. Source: Tim Kane, "Global U.S. Troop Deployment, 1950-2003," Heritage Foundation Center for Data Analysis Report #04-11 (http://www.heritage.org/Research/NationalSecurity/cda04-11.cfm accessed 20 January 2005).

Table 2. World Regions and U.S. Military Responses to Situations, 1990-2002.

Region[a] (Ranked by 1950-2000 Urban Growth Rate)		U.S. Military Responses Involving Force[b]		U.S. Military Humanitarian Responses		Total U.S. Military Responses
1.	Eastern Africa	2	(12.5%)	14	(87.5%)	16
2.	Western Africa	0	(0.0)	11	(100.0)	11
3.	Middle Africa	0	(0.0)	7	(100.0)	7
4.	Western Asia	24	(68.6)	11	(31.4)	35
5.	Southeast Asia	1	(12.5)	7	(87.5)	8
	Subset Mean:	5.4		10.0		15.4
6.	Northern Africa	1	(50.0)	1	(50.0)	2
7.	Central America	1	(100.0)	0	(0.0)	1
8.	South America	6	(100.0)	0	(0.0)	6
9.	South Central Asia	5	(100.0)	0	(0.0)	5
10.	Eastern Asia	3	(75.0)	1	(25.0)	4
11.	Southern Africa	0	(0.0)	2	(100.0)	2
12.	Caribbean	4	(40.0)	6	(60.0)	10
13.	Oceania	0	(0.0)	0	(0.0)	0
14.	Eastern Europe	0	(0.0)	0	(0.0)	0
15.	North America (non-US)	0	(0.0)	0	(0.0)	0
16.	Southern Europe	10	(43.5)	13	(56.5)	23
17.	North and Western Europe	0	(0.0)	1	(100.0)	1
	Subset Mean	2.5		2.0		4.5
	Totals:	57	(43.5)	74	(56.5)	131

[a] Regions are as defined by the United Nations. Urban Growth Rate is the average annual rate at which a region's urban population increased between 1950 and 2000. Source: U.N. Department of Economic and Social Affairs, *World Urbanization Prospects: 2001 Revision.*

[b] See Appendix Table 2. U.S. Military responses to situations data are from Thomas P.M. Barnett, "The Pentagon's New Map," *Esquire*, March 2003. Responses Involving Force include combat, shows of force, and contingency positioning or reconnaissance; Humanitarian Responses include evacuations or security and peacekeeping or relief.

Endnotes

[1] Sun Tzu, *The Art of War*, trans. Samuel B. Griffith (New York, Oxford University Press, 1971), 78-79.

[2] *On Point: The United States Army in Operation Iraqi Freedom* (Leavenworth, KS: Center for Army Lessons Learned, 2004), 390.

[3] Joint Chiefs of Staff, *Doctrine for Joint Urban Operations* (JP 3-06, September 2002), chapter I.

[4] National Defense Panel, *Transforming Defense—National Security in the 21st Century*, (Arlington, VA, 1997); Christopher J. Bowie, et al., "Trends in Future Warfare," *Joint Force Quarterly* (35, 2004), 129-133; Robert F. Hahn and Bonnie Jezior, "Urban Warfare and the Urban Warfighter of 2025," *Parameters* (Summer 1999), 74-86. *Doctrine for Joint Urban Operations*; Dept. of the Army, *Urban Operations*, Field Manual 3-06, June 2003; North Atlantic Treaty Organization, *Urban Operations In The Year 2020*, (NATO RTO Technical Report #71) April 2003.

[5] U.N. Department of Economic and Social Affairs, *World Urbanization Prospects: 2001 Revision*, (www.un.org/esa/population/publications/wup2001/WUP2001report.htm accessed 22 September 2004). Tim Kane, "Global U.S. Troop Deployment, 1950-2003," Heritage Foundation Center for Data Analysis Report #04-11 www.heritage.org/Research/NationalSecurity/cda04-11.cfm accessed 20 January 2005). Thomas P.M. Barnett, "The Pentagon's New Map," *Esquire*, March 2003 (www.thomaspmbarnett.com/published/pentagonsnewmap.htm accessed 28 January 2005).

[6] The equations on which these calculations are:

Change in Troop Deployment = - 9.6206 + (10.7 * Urban Growth Rate2) - (47.9 * Urban Growth Rate)

U.S. Military Responses = -6.2 + (3.9 * Urban Growth Rate)

[7] *On Point*, 390.

[8] The two critical questions are drawn from USJFCOM/J9 Brief (Unclassified), "Urban Resolve Experiment Update," 21 September 2004.

[9] The working group included: Offices of the Secretaries of Defense and State, the Commanders-in-Chief, the Services, Joint Staff, and representatives of DoD agencies. Later, the Joint Advanced Warfighting

Program (JAWP) at the Institute for Defense Analysis (IDA) became engaged. See LtCol Duane Schattle, "Joint MOUT Mission Area Analysis and Mission Need Assessment," In *The City's Many Faces*, Ed. Russell W. Glenn (RAND, 2000) and Department of Defense, *FY-04 Department of Defense Master Plan for Joint Urban Operations*, 1 October 2003, Chapter 1.

[10] This discussion synthesizes and, at times, closely paraphrases the description of the framework in the core JUO documents. USECT phases are interdependent, continuous, and simultaneous.

[11] *DoD JUO Master Plan*, 17. "Taking the 'Revolution in Military Affairs' Downtown," *IDA Research Summaries* 9 (Spring/Summer 2002); BG Robert E. Schmidle and LtCol Frank G. Hoffman, "Commanding the Contested Zones," *Proceedings* 130 (Sept 2004).

[12] "Joint Urban Operations Integrating Concept," Draft Working Paper (version .95), 4 June 2004, 18

[13] George W. Bush, *National Security Strategy of the United States of America*, September 2002, 30. See also 10 U.S.C. § 485 (1998) and related notes.

[14] "Joint Semi-Automated Force (JSAF) Information Paper" (20 May 2003) www.mstp.quantico.usmc.mil/modssm2/InfoPapers/INFOPAPER%20JSAF_files/INFOPAPER_JSAF.htm, accessed 12 October 2004; Andy Ceranowicz and Mark Torpey, "Adapting to Urban Warfare," Paper presented at the Interservice/Industry Training, Simulation, and Education Conference (December 2004), Orlando, FL. The STOW simulation (renamed JSAF) transitioned to JFCOM in 2000, and is now owned and managed by J9; software is provided free of charge to DOD organizations and projects.

[15] Andy Ceranowicz, Rae W. Dehncke, and Tony Cerri, "Moving Toward a Distributed Continuous Experimentation Environment," Paper presented at the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) December, 2003.

[16] *The Iraq War*, 368.

[17] Such as the Standing Joint Force Headquarters (Core Element) and its enabling concepts. See Peter W. Wielhouwer, "Toward Information Superiority: The Contribution of Operational Net Assessment," *Air & Space Power Journal* (forthcoming).

[18] Jamison J. Medby and Russell W. Glenn, *Street Smart: Intelligence Preparation of the Battlefield for Urban Operations* (RAND, 2002).