

First Bites

Mapping Urban Environments

First Bites are, as the name suggests, my first attempts to take my random notes and bring them into some sort of order. I am doing them primarily for myself so as to make it easier to refer to content and see how potential sections and chapters of the PhD might shape up, but I thought that others might find them useful, and I'd welcome any comments.

These ARE NOT draft chapters, they are WORKING NOTES and as such are likely to be full of errors and omissions and half-baked ideas, so I strongly suggest you check sources should you want to quote anything! Note that the references are for the eventual chapter, not just this First Bite.

If you find this one useful and would like me to do more then please let me know. The better ones may well form the basis of formal research papers, and all will feed into the eventual PhD thesis.

More information on the PhD at <http://taunoyen.com/wiki/doku.php?id=phd> and you can contact me at david.burden21@bathspa.ac.uk.

Mapping Urban Environments

Whilst other First Bites in this topic are taking a non-military view of urban development, this section will introduce a number of models used by the military in order to characterise urban (and other) environments. The intent is to have a framework of tools available so that they can be used in the following chapters when analysing urban conflicts. Also these models can help to identify what features need to be modelled or at least considered in an urban wargame, as well as to help players (or commanders) plan an urban operation. By presenting information in the wargame in a manner similar to which military players are used to then the games should be more accessible, and hopefully more valid, to them.

Whilst the majority of these models are drawn from US Doctrine they are widely used in the UK and by NATO partners

All will be revisited in a later chapter when I consider the broader issues of the Intelligence Preparation of the Operating Environment (IPOE) and specifically the Intelligence Preparation of the Battlefield (IPB).

Theories of Urban Structure

There have been a number of theories around how urban areas develop an emergent structure (Johnson, 1971). Principal among them are:

- Burgess' **Concentric** model consisting (in one version) of:
 - Zone I - An inner "central business district", surrounded by
 - Zone II - A Zone in Transition, where older residential spaces are being replaced by commercial or light industrial buildings (a.k.a gentrification), surrounded by
 - Zone III - A zone of working-class housing, surrounded by
 - Zone IV - Middle-class residential housing, surrounded by
 - Zone V - A commuter zone out to ~1 hour commute.
- Hoyt's **Sector** theory, that early patterns of use in a tight core perpetuate out as a series of

- radial sectors as the city grows.
- Harris & Ullman's **Multiple Nuclei** theory where growth develops from multiple points based on:
 - Facilities (natural or man-made);
 - Symbiosis and collaboration;
 - Mutual exclusion (e.g. heavy industry not close to or up-wind of high-class residential);
 - Land/rent costs (cheaper housing or more land intensive commercial activities in cheaper areas).
- Lowry's analysis of the inter-play of basic (e.g. manufacturing) and non-basic (e.g. service) employment populations.

All of these have their issues (Johnson, 1971), but each has some element of insight. A particular challenge in the context of the PhD is the extent to which they apply to non-western urban settlements.

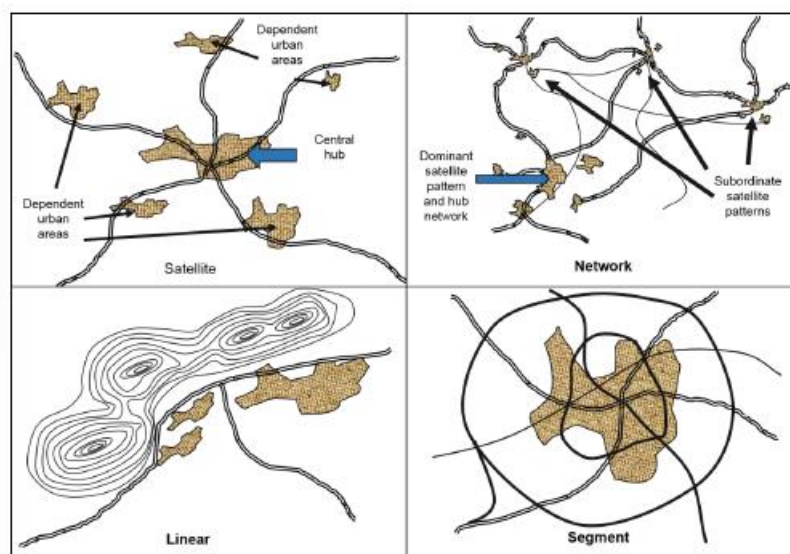
Urban Patterns

Johnson (1972) usefully identifies that settlements have three morphological components which change at different rates:

- The street plan, which changes very slowly due to the investment in it and boundaries of ownership;
- The buildings;
- The functions, including how buildings are used and the services and trades that people are involved in and how they are distributed across the city

Johnson remarks that "these three strands are woven into the design of the urban pattern".

ATP3-06 identifies four major patterns of urban settlement (satellite, network, linear and segment) as shown in Figure 1.











Source: ATP 3-06 Urban Operations (US Army, 2017:1-7 Fig 1-3)

Figure 1: Major Urban Patterns

ATP3-06 (US Army 2017) identifies 3 basic street patterns (radial, grid and irregular) whilst ATP 3-

06.11 (US Army, 2011) identifies 8 different types as shown in Table 1. It is important to note Johnson's comments above about the persistence of the street plan element of a city morphology.

Shape	Street Pattern	Effect
	Rectangular or Chessboard	Grid-like streets with parallel streets intersected by perpendicular streets.
	Rayed	Streets fanning out at various angles from a given focal point and through less than 360 degrees.
	Radial	Primary thoroughfares radiating out from a central point, which may extend outward 360 degrees around the central point or within an arc from a point along a natural barrier, such as a coastline.
	Radial-Ring	Loops or rings surrounded by successively larger ones that are usually found in conjunction with larger radial patterns. Radial rings incorporate the elements of both radial and ring or concentric designs.
	Contour Forming	Primary streets running parallel to contour lines, with intersecting roads connecting them. Pronounced terrain relief influences construction of roadway along lines of elevation.
	Irregular	Irregular street patterns specifically engineered without geometric patterns for aesthetic or functional reasons.
	Combined Pattern	Any combination of the above.
	Linear Pattern	A primary thoroughfare running down the center with buildings on either side.

Source: ATTP 3-06.11 Combined Arms Operations in Urban Terrain (US Army, 2011:A-12 Table A-2)

Table 1: Typical Internal Street Patterns

So What?

As will be discussed in Chapter 4 the typology of a settlement can have a significant impact on military planning and operations. As with the human terrain models being aware of military typology classifications can help in analysing historic battles and potential locations for future battles. Any urban wargame could be reasonably expected to represent the impact of the typology on the players actions and options.

Although it is anticipated that most wargaming will be based on real settlements, there is still a case for using fictitious locations (e.g. as in the DATE environment - <https://odin.tradoc.army.mil/DATEWORLD>). In these cases understanding how settlements evolve and their typologies can help to ensure that any fictitious location has the ring of truth to it.

Urban Terrain Zones (1000)

In considering an urban environment it is useful to have a framework to geospatially segment the urban space into different types of terrain – as these will impact military operations in a variety of ways including: the likely presence of civilians, the limits to the movement of large vehicles, the ability of structures to resist HE fire, and the likelihood of the presence of chemicals which may cause large secondary explosion or the release of irritant or poisonous gases. The impact of terrain on military operations is considered in more detail in Chapter 4.

In order to facilitate such a geospatial assessment, militaries have developed frameworks based around Urban Terrain Zones and similar categories.

The US Army Field Manual FM 3-06 “Combined Arms Operations In Urban Terrain” 2002 identifies the following categories of urban terrain (See FM 34-130 for more information):

- City Core
- Core Periphery
- CP - Dense Random Construction
- CP-Close Orderly Block Construction
- Dispersed Residential Area
- High-Rise Area
- Industrial-Transportation Area
- Permanent or Fixed Fortifications
- Shantytowns

Interestingly, the 2006 edition of FM3-06 (ATP 3-06 Urban Operations) replaces these categories with 7 “urban functional zones” (US Army FM3-06:2-09, 2006), and these zones are shown graphically in Figure 2:

- **Core** – usually compact, high-rise, “downtown” retail and entertainment, civic government and the Central Business District (CBD);
- **Core Periphery** – usually older areas which have so far escaped “gentrification”;
- **Commercial Ribbon Area** – relatively uniform shops and business along major arteries, often bigger and a storey or two higher than the buildings behind them;
- **Industrial Area** – relatively dispersed, may be on the periphery if newer, or more sectoral (see below) if older. May follow major transportation routes in/out.
- **Residential Area** – from dense urban to less dense suburban of varying heights and construction. May include shanty-towns;
- **Outlying High-Rise Area** – newer, high-rise business and accommodation blocks;
- **Military Area** – as well as more modern camp/barracks may include historical fortifications and citadels.

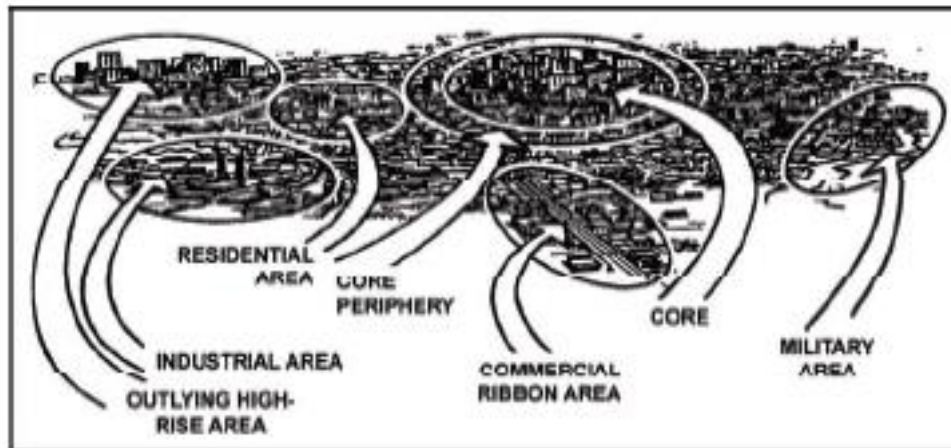


Figure 2: Urban Functional Zones (from US Army FM3-06 Fig 2-6, 2006)

ATTP 3-06.11 Combined Arms Operations in Urban Terrain (US Army, 2011) has the same zones but also adds in Residential Sprawl and Outlying Industrial Areas, and separates Residential into High-rise and Low-rise.

ATP 3-06 Urban Operations (US Army, 2017) uses the 2006 list and definitions but has re-titled them as Urban Functional Areas and its diagram (1-10 Fig 1-5) is even less clear than the 2006 version!

An earlier Cold War era US Army Human Engineering Laboratory, Technical Memorandum 18-87 (Ellefsen, 1987) presents a more detailed model, with 3 levels, 3 categories (Attached, Open Detached and Close Detached) and 20 types, ranging from A1 (commercial offices) to Do31 (weekend houses – a speciality of the German countryside, akin to English allotments).

Hegazy (2004), collapses Ellefsen’s 20 categories to only 4 for ISTAR modelling purposes:

- high-rise, closely spaced;
- high-rise, widely spaced;
- low-rise, closely spaced; and
- low-rise, widely spaced.

Between the extremes of Hegazy and Ellefsen any UTZ type model needs to balance enough categories and information to make useful distinctions between different terrain/land-use/functional area types, and not having so many categories that they are hard to remember and take too much time to identify and discriminate between.

I will revisit UTZs in Chapter 4 as I develop an urban conflict model and provide a framework to guide my own urban wargame design.

So What?

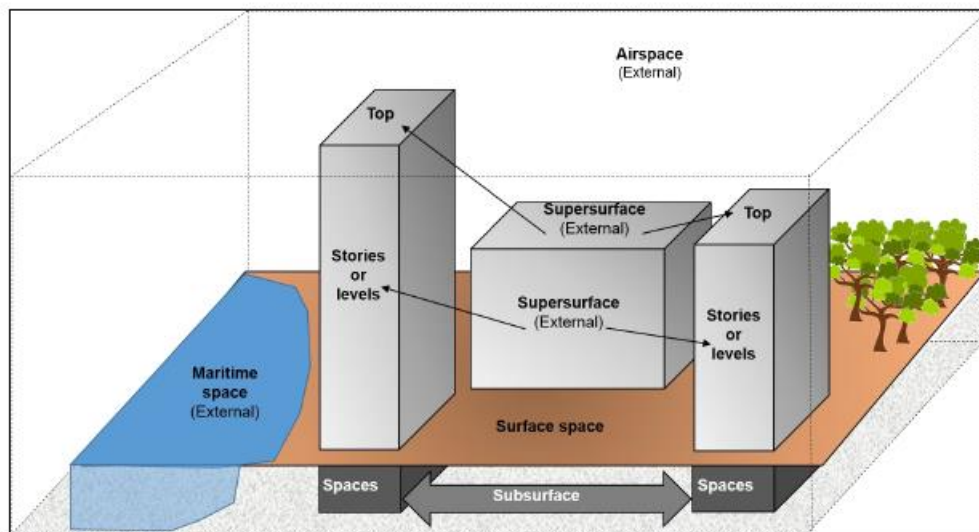
When it comes to looking at historic Urban Battles using a UTZ model to analyse the urban terrain being fought over may help with gaining a better understanding of the battle.

When developing a wargame, or reviewing an existing wargame, using a UTZ model may help to better represent the terrain being fought over, and different zone types should have manifestly different impact on the conduct of military operations.

The 3D City

ATP 3-06 Urban Operations (US Army, 2017:1-5) uses Figure 3 to illustrate the different environments within the 3D nature of an urban environment. These are:

- **Subsurface** – underground tunnels (e.g. for sewerage or transport) and spaces (e.g. cellars and car parks)
- **Surface** – street level, the public realm;
- **Supersurface** – the internal floors and external roofs;
- **Airspace** – the space above the buildings, but which might be obscured to and from by buildings. “Near airspace” is sometimes used to refer to the space immediately above/beside a building where UAVs might operate.
- **Maritime space** – as previously discussed many/most cities are either littoral or riverine and so may have significant amounts of maritime space. ATP3-06 states that in 2013 “75% of large cities were on a coastline.”



Source: ATP 3-06 Urban Operations (US Army, 2017:1-5 Fig 1-2)

Figure 3: The Multi-Dimensional Urban Battlefield

As will be seen in later chapters much of the focus of urban doctrine and training is learning how to use the subterranean, the supersurface, and with the advent of UAVs, the close airspace.

So What?

An urban wargame needs to at least consider the aspects of the 3D city other than just the surface space (or the internal supersurface for CQB type games). In particular it needs to consider the subsurface, the external supersurface and the near airspace.

Whilst the majority of the models above have been concerned with the physical nature and terrain of the urban, the next set of models looks more at the human terrain.

ASCOPE

ASCOPE is a common framework used in the military to understand civil considerations. These could be at a village, town, city district, region or whole country level. Whilst it includes “people” as one of its elements it is primarily concerned with the “things” in as space. ASCOPE is defined in Intelligence Preparation of the Battlefield (ATP2-01.3 C1:4-25,2019)

ASCOPE covers:

- **Areas** - e.g. political, ethnic, commercial, land-use and cultural divisions;
- **Structures** - including residential, commercial, governmental, infrastructure and heritage (including potential protected sites);
- **Capabilities** - particularly those required to save (e.g. medical), sustain (e.g. infrastructure and food distribution) or enhance (e.g. schools, media recreational) life;
- **Organization** – e.g. political, trade unions, religious, cultural, criminal media, NGOs, councils, non-military governmental;
- **People** – who and how to engage, and socio-cultural factors, language, religion;
- **Events** - annual, seasonal, religious, holidays, political, natural phenomena, disasters.

PMESII-PT

A useful framework widely used in the military for understanding human terrain is PMESII-PT (ATP2-01-3 C1:1-2,2019). PMESI-PT covers considerations for the following categories:

- **Political** – organisations, movements, personalities etc;
- **Military** – capabilities, organisations, bases;
- **Economic** – structure, financial stability, industries, banks, institutions;
- **Social** – cultural groups, religious groups, social centres, sports;
- **Information** – media, social media, internet, communications infrastructure;
- **Infrastructure** – power, water, transport, sewerage, irrigation;
- **Physical Environment** – landscape, terrain, rivers, climate, settlements;
- **Time** - diurnal, weekly, seasonal and annual factors, e.g. harvest, festivals, election cycles;

A crosswalk of PMESII versus ASCOPE (e.g. as in ATP2-01-3 C1:4-26,2021) can be useful in order to understand the relationships as shown in at Figure 4.

	P Political	M Military	E Economic	S Social	I Information	I Infrastructure
A Areas	Areas - Political (District Boundary, Party affiliation areas)	Areas - Military (Coalition / LN bases, historic ambush/IED sites)	Areas - Economic (bazaars, shops, markets)	Areas - Social (parks and other meeting areas)	Areas - Information (Radio/TV/newspapers /where people gather for word-of-mouth)	Areas - Infrastructure (Irrigation networks, water tables, medical coverage)
S Structures	Structures - Political (town halls, government offices)	Structures - Military / Police (police HQ, Military HHQ locations)	Structures - Economic (banks, markets, storage facilities)	Structures - Social (Churches, restaurants, bars, etc.)	Structures - Information (Cell / Radio / TV towers, print shops)	Structures - Infrastructure (roads, bridges, power lines, walls, dams)
C Capabilities	Capabilities - Political (Dispute resolution, Insurgent capabilities)	Capabilities - Military (security posture, strengths and weaknesses)	Capabilities - Economic (access to banks, ability to withstand natural disasters)	Capabilities - Social (Strength of local & national ties)	Capabilities - Info (Literacy rate, availability of media / phone service)	Capabilities - Infrastructure (Ability to build / maintain roads, walls, dams)
O Organizations	Organizations - Political (Political parties and other power brokers, UN,)	Organizations - Military (What units of military, police, insurgent are present)	Organizations - Economic (Banks, large land holders, big businesses)	Organizations - Social (tribes, clans, families, youth groups, NGOs / IGOs)	Organizations - Info (NEWS groups, influential people who pass word)	Organizations - Infrastructure (Government ministries, construction companies)
P People	People - Political (Governors, councils, elders)	People - Military (Leaders from coalition, LN and insurgent forces)	People - Economic (Bankers, landholders, merchants)	People - Social (Religious leaders, influential families)	People - Info (Media owners, mullahs, heads of powerful families)	People - Infrastructure Builders, contractors, development councils)
E Events	Events - Political (elections, council meetings)	Events - Military (lethal/nonlethal events, loss of leadership, operations, anniversaries)	Events - Economic (drought, harvest, business open/close)	Events - Social (holidays, weddings, religious days)	Events - Info (IO campaigns, project openings, CIVCAS events)	Events - Infrastructure (road / bridge construction, well digging, scheduled maintenance)

Figure 4: PMESII vs ASCOPE Crosswalk (from USMC, 2017)

Several commentators have found the ASCOPE/PMESII-PT models wanting, particular when it comes to analysing modern complex cities and megacities (e.g. Orsini, 2018). Lomedico & Bartels (2015) see ASCOPE in particular as being too static in its analysis and introduce F (for flows) at the start of the acronym. Ducote (2010) challenges PMESII-PT in a similar way exploring a more non-linear systems think based analysis.

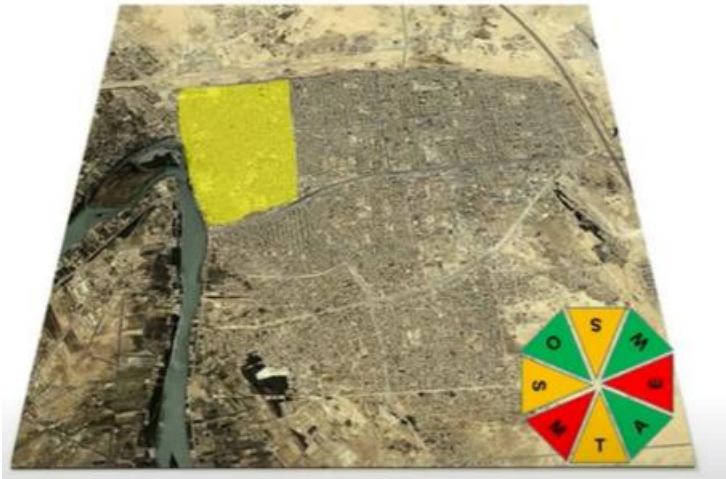
SWEAT-MSO

SWEAT-MSO is defined by FM 3-34.170 Engineer Reconnaissance (US ARMY, 2008:6-14). As the publication title suggests it takes more of an engineers view of an environment, and is aimed at “gathering technical information on the status of the large-scale public systems, services, and facilities of a country or region that are necessary for economic activity.”

SWEAT-MSO stands for:

- Sewerage;
- Water;
- Electricity;
- Academics (i.e. schools, colleges);
- Trash;
- Medical;
- Security;
- Other Considerations (e.g. transport, communication, food and governmental infrastructure)

Figure 5 presents a graphic SWEAT-MSO dashboard showing the status of the different areas of a city.



Source: Markel, 2022.

Figure 5: Example SWEAT-MSO Dashboard

As can be seen there is some similarity between elements of the SWEAT-MSO and particularly the ASCOPE frameworks and the PMESII-PT model

United Nations Models

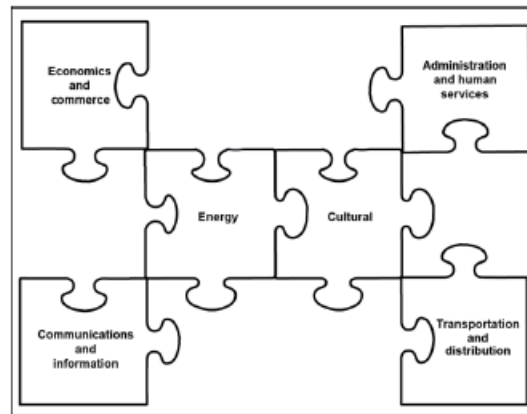
The UN offers at least two models, one focussed on generic urban planning (their City Action Plan Assessment Tool) and one for responding to displaced persons in urban areas, which cover similar ground to ASCOPE and SWEAT-PSO. If City Action Plans have been developed in accordance with UN guidelines then they could provide a fast-track to any ASCOPE/SWEAT-PSO analysis, and likewise during Humanitarian operations if some synchronicity could be achieved between military and civilian planning then there should be mutual benefits. These two UN models are detailed in

City Action Plan Assessment Tool	Guidance For Responding To Displacement In Urban Areas
<ul style="list-style-type: none"> - Land ownership/ cadastral data - Morphological or physical data - Natural features and topographical data - Risk data (disaster-prone areas and risk assessments) - Demographic data - Utilities and services data <ul style="list-style-type: none"> - Water supply & management - Power supply & management - Solid waste management - Drainage - Sewage - ICT (Information, Communication, Technology) - Emergency response systems - Public Facilities datasets <ul style="list-style-type: none"> - Educational facilities - Health facilities - Administrative (governmental) facilities - Cultural (institutional) facilities - Recreational (Sports/parks) facilities - Safety facilities - Religious facilities (optional) - Housing datasets - Economy data 	<ul style="list-style-type: none"> - Geography <ul style="list-style-type: none"> - Topography - Climate - Watersheds and Basins - Protected/ecologically sensitive areas - Hazards - Administration <ul style="list-style-type: none"> - Regional and national alignment - Admin boundaries to ward/neighbourhood level - Land use and zoning, incl. development plans - Utilities and Services - Historical and Cultural Context <ul style="list-style-type: none"> - Growth patterns - Built and cultural heritage - Neighbourhood typologies - Social and recreational facilities - Socio-Economic Context <ul style="list-style-type: none"> - Demography (housing, people per household, conditions, employment, education) - Displacement (registration, distribution) - Connectivity <ul style="list-style-type: none"> - International, national and regional: goods, people, services - Public transportation (lines, stops, pedestrian realm) - Built Environment <ul style="list-style-type: none"> - Density - Open and public space networks
Source: UN-HABITAT (2022c)	Source: UN-HABITAT (2020)

Table 2: UN Models for Urban Analysis

Urban Infrastructure Categories

In addition to these ATP 3-06 Urban Operations (US Army, 2017:1-19) divides urban infrastructure into 6 broad categories: economics & commerce, communications and information, energy, cultural, administration & human services (including medical and utilities) and transportation and distribution. These are shown in Figure 6.

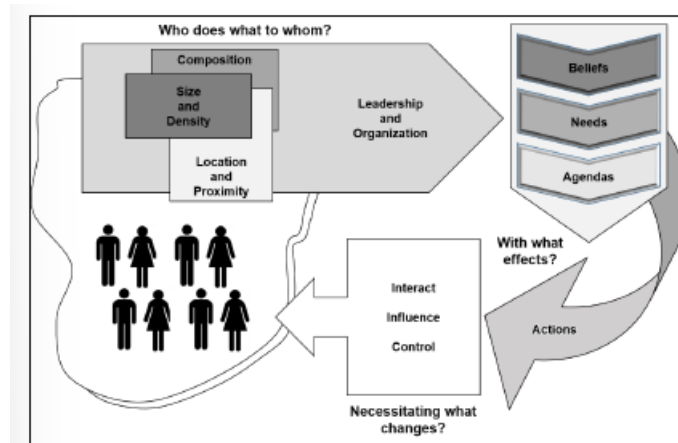


Source: ATP 3-06 Urban Operations (US Army, 2017:1-19 Fig 1-7)

Figure 6: Urban Infrastructure Categories

Urban Society Model

ATP 3-06 Urban Operations (US Army, 2017:1-14) provides a useful simple schematic to begin to think about the operation of the urban society in terms of flow and which can help to put the more mechanical analysis of PMESII-PT and ASCOPE into context. The diagram is reproduced in Figure 7.



Source: ATP 3-06 Urban Operations (US Army, 2017:1-14 Fig 1-6)

Figure 7: Simplified Analysis of Urban Society

So What?

ASCOPE, PMESII-PT and SWEAT-MSO (and similar frameworks) can help to identify what features need to be modelled or at least considered in an urban wargame, and when analysing an urban battle, as well as to help players (or commanders) plan an urban operation.

By presenting information for a wargame using ASCOPE etc it will hopefully help to validate in the minds of military players as they can relate to the information being presented.

By using ASCOPE etc within a wargame we can help to communicate these models to non-military (and unaware military) players.

UN models already have information covering similar aspects of the urban to the military formats, and knowing that these sources may exist, and developing a cross-walk to the military formats, could speed both the development of wargame material and real-world IPOE.

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