

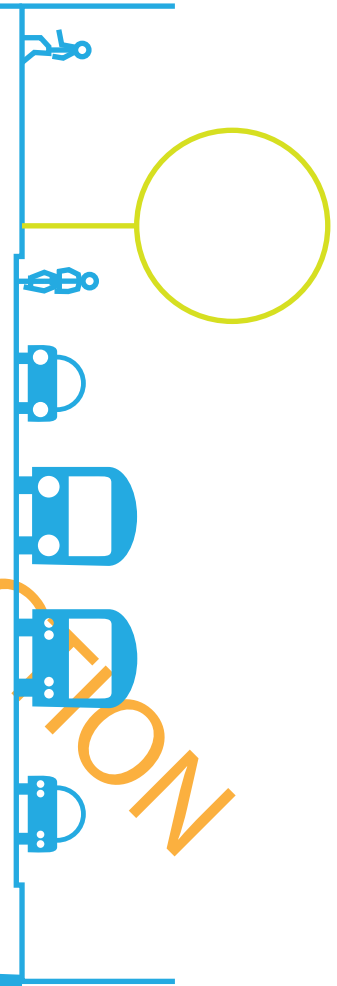
Transit-Oriented Development 2 (TOD2)

an Urban Design (UD) handbook for Public Transport (PuT) mobility hubs and sustainable mobility



Copenhagen 2025

UNDER VO? TOD2
CONSTRUCTION



Transit-Oriented
Development 2
(TOD2) – an
Urban Design (UD)
handbook for
Public Transport
(PuT), mobility hubs
and sustainable
mobility

*Starting with Sweden
(v0.2. but under
continuous reiteration)*

Table of Contents

Introduction	5
Theoretical framework	7
Sustainable mobility and Urban Design (UD).....	8
Infographics and utopias	12
Morphologically informed design	14
Public Transport (PuT) schools and transit manuals	19
Mobilities paradigm and public mobility as transit culture	22
TOD2 HANDBOOK	23
Public transport (PuT) hacks	25
Lines shaping cities	26
Pinning stops.....	31
Designing networks	32
Urban design (UD) tips.....	37
The dream house and cool apartment.....	38
The half-mile TOD1 pearl.....	42
The viewshed amoeba of TOD2.....	48
The TOD2 corridor mix.....	52
New trends (mobility hubs, sharing and automation)	54
Reference handbooks	57
Acknowledgements	57

Introduction

Year 2023 marked the thirtieth anniversary of Transit-Oriented Development (TOD) as Urban Design (UD) policy. Peter Calthorpe coined the term TOD addressing urban sprawl and the future sustainable development in American cities. *Transit*, a shortening from *mass transit* is an American catchall for policy to prioritize Public Transport (PuT). TOD refers to buildings near transit or larger developments of up to a mile radius around rail stations that are high-density and mixed-use, with walk-accessible shopping and commercial core, pedestrian amenities and physical form that encourage walking and support PuT.

The TOD2 handbook juxtaposes diagrammatic knowledge of UD with PuT infographics and heuristics. Peter Calthorpe draws a transit-friendly community along a commercial strip with walking distances (or walksheds) defining service areas for PuT and urban growth boundaries for TOD. Each TOD with its radial walkshed looks like a pearl on a string. ***TOD2 diagrammatizes PuT and UD elements, highlighting public spaces and urban experience at human scale, the “whole journey” travel experience in PuT corridors and networks, public mobility and the sustainable mobility paradigm.*** The sustainable mobility paradigm emphasizes accessibility and promoting access with multiple mobility choices by envisioning cities and futurist scenarios and in a broader perspective on social and cultures of movement. **The TOD2 handbook is written for laymen.** It defines key terms and presents PuT hacks and UD tips to develop TOD visions seeking to inspire retrofit of

car-dependent suburbs recognizing the strong suburbanization momentum and dominance of automobility. ***TOD2 mixes old PuT and new shared mobility and forwards mobility hubs (mobhubs) as potential TOD embryos.*** Mobility hubs are stations for shared vehicles and there are new developments with Shared Autonomous Vehicles (SAVs). With mobhubs as public spaces and stations for shared vehicles, SAVs, podcars and robotaxis, the TOD pearls can change in size and access. In practice it is often difficult to implement TOD, because many suburbs have high social status and there is strong resistance for redevelopment. A mobility hub on a street can potentially transform neighborhood into a future TOD.

TOD2 highlights a set of objectives:

1. Emphasize human scale and travel experience in a “whole PuT journey” perspective with focus on urban morphology, public spaces and commercialization for improving walking, waiting and onboard transit experience
2. Enriching the “string of pearls” TOD1 approach with highlighting design of PuT at various scale (“pearls”, corridors, networks) combining UD manuals and transit handbooks
3. Highlighting carbon neutrality and transport energy efficiency with morphological indicators and digitalization
4. Advocating for mobility hubs with new shared mobilities (robotaxis, podcars, etc.) as intermediary step for retrofitting suburbs
5. Developing green TOD visions with integrating ecological design and urban agriculture
6. Promoting public mobility as post-car culture of mobile communities (including passengers, drivers, conductors, transit vehicles, etc.).

Figure 1: THE MOTOR CITY PROBLEM (↓)



THE TOD2 (UTOPIAN) SOLUTION



Figure 2: THE FRAGMENTATION EFFECT OF THE SPAGHETTI EXPRESSWAYS IN SAO PAULO AND SHANGHAI (↑)

The biggest problem of implementing TODs is the hierarchical road infrastructure and sprawling suburbs that were designed for individual movement and the private automobile. Even the largest cities such as Sao Paulo or Shanghai are

fragmented by major roads and spaghetti expressways. There is a need for creative (even utopian) visions and TOD scenarios to turn things around. This TOD2 handbook compiles knowledge from architecture and urban planning and design and traffic engineering and transit planning, focusing on infographics and diagrammatic knowledge, PuT handbooks, UD manuals and TOD guidelines as well as on sustainable mobility indicators and decarbonization policy. As a “string of pearls” approach, TOD entangled in studies on land use and travel emphasizing a set of D-variables crafted by Robert Cervero. Various TOD methods, notably the Luca Bertolini’s “place-node model” were developed in the 1990s to assess the integration of station areas as nodes in neighborhood as places. **TOD2 seeks to further develop the TOD metrics and link them to environmental carbon neutrality and transport energy efficiency goals.** It advocates for establishing sustainability indicators and performance metrics, and for using digitalization to inform sustainable mobility. Curbing carbon emissions is environmental goal of many cities and municipalities, but there are no standards or (morpho)metrics on how to tackle this challenge.

Making big plans matter! TOD2 must start with bold UD visions for evolving a new *post-car* “public mobility” culture competitive to the private automobile in comfort, flexibility, reliability, easiness of use, etc. The cities in the 19th century developed around public transport, but the historic “public mobility” pattern cannot be re-established in the future, because the “system of automobility” produces and necessitates individual mobility based upon instantaneous time, fragmentation and

coerced flexibility. The *post-car public mobility* system must substantially involve individualized movement, *flexibility and comfortability* that automobility presupposes. The significance of mixing TOD with the sustainable mobility and mobilities paradigms is in the need for a *post-car* development policy that seeks to PuT as a mobility culture that seeks seamlessness with multiple mobility choices. To address that, the TOD2 framework explores furthermore digitalization and emerging transport technologies of automation and sharing such as Sharing Autonomous Vehicles (SAVs), robotaxis and podcars as complementary to PuT, as well as the emergence of the new metaverse as a new online mobility culture.

Different cities are at different motorization and suburbanization stages. TOD has been successful for new suburban developments and infills, but it often fails in retrofitting suburbs that typically have high status and low development tendencies. These neighborhoods are often problematic in terms of excessive driving. **A new infrastructure of innovative mobility hubs (mobhubs) is integrated as leitmotif in TOD2.** Mobility hubs are public spaces and new infrastructure for shared mobility aiming to boost accessibility by offering shared mobility systems such as robotaxis, carsharing and bikesharing at transit stations and in neighborhoods. An intermediate step for the transformation of car-oriented suburbs to TODs can be the introduction of new mobility hubs served by SAVs or robotaxis that work as multifunctional public spaces (e.g. carpools at peak transport times and markets and/or leisure during the day) linking to major regional transit nodes.

Theoretical framework

A picture is worth a thousand words.

“Make no little plans. They have no magic to stir men's blood and probably will not themselves be realized. Make big plans, aim high in hope and work, remembering that a noble, logical diagram once recorded will never die, but long after we are gone will be a living thing, asserting itself with ever growing insistency. Remember that our sons and grandsons are going to do things that would stagger us.” (Daniel Burnham)

“They were at the wrong place at the wrong time naturally they became heroes” (George Lucas)

“Transformation (of cities) given the outlines of a tradition” (Severio Muratori on mixing historicism and futurism)

“Progress toward more effective transit is hindered by the fact that there are no easy solutions to transport problems.” (Canadian Transit Manual)

Sustainable mobility and Urban Design (UD)

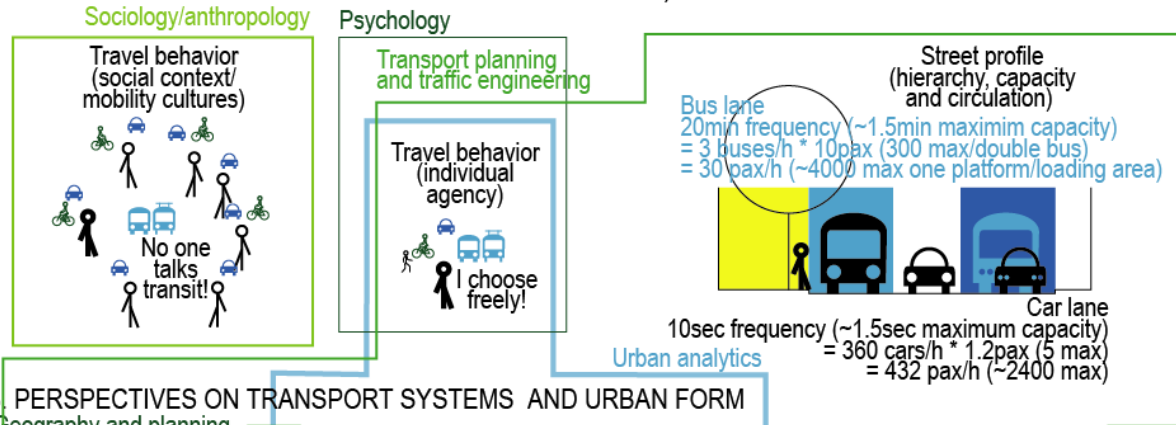
Sustainable mobility is a paradigm to understand the complex link between flow and form. **The emphasis is on accessibility and promoting multimodal access by creating a mobility pyramid with the pedestrian on the top, Urban Design (UD) and envisioning cities, futuristic thinking and mobilities as cultures of movement.** There are overlapping and often confronting perspectives on transport systems and urban forms, travel behavior and multimodality.

Figure 3: PERSPECTIVES ON TRANSPORT SYSTEMS AND URBAN FORMS (→)

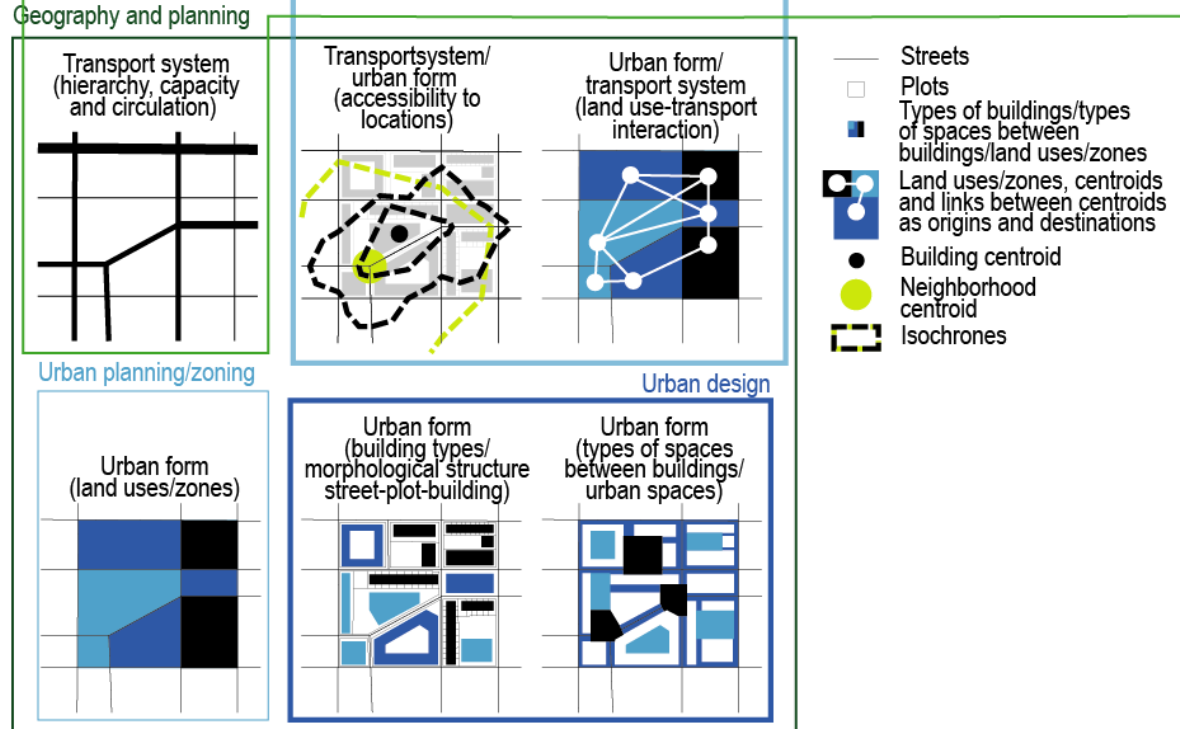
Urban Design (UD) is defined as the art of making and shaping cities by creating compositions of elements in physical space. Urban designers have a unique background to deal with *the experiential qualities of cities* in three dimensions (3D). They mix narratives, sketches and illustrations, photographs and orthophotos, maps and plans, cartograms and diagrams for analyzing and designing cities. The knowledge of urban designers is diagrammatic. TOD1 promotes a neighborhood of a transit-friendly community along a commercial strip to trigger the imagination. Peter Calthorpe mixes sketching and illustrations with zoning, masterplans and regional plans in two dimensions (2D) and a glimpse of architectural guidelines and building codes including building and planning regulations (needs for traffic circulation, parking regulations, etc.).

Urban designers explore transport systems and multimodality as (ideal) urban forms that support or

A. PERSPECTIVES ON TRAVEL BEHAVIOR AND MULTIMODALITY (PERSONALITY CHARACTERISTICS AND SOCIAL CONTEXT)



B. PERSPECTIVES ON TRANSPORT SYSTEMS AND URBAN FORM



hinder mobility. Transport planners and traffic engineers focus on individual travel behavior or road capacity and performance measures of transport infrastructures. Multimodality is a set of travel alternatives or performance measures for multimodal infrastructures. Additionally, psychology provides new concepts for better understanding of irrationality of agents such as behavioral scripts and travel habits, personality traits and social norms. Sociologists and anthropologists analyze social aspects of transport systems and mobility, emergence and creation of mobility cultures, individual agencies in social contexts, effects of mobilities of social life.

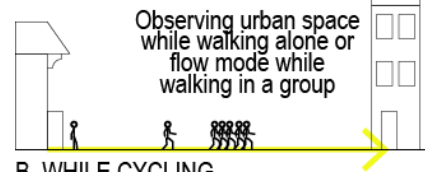
Figure 4: **URBAN EXPERIENCE OF A WHOLE JOURNEY AND IDEAL CITIES AS COMPETITION BETWEEN TRANSPORT MODES** (→)

Environmental perception defines the experience of travel and the theoretical framework of TOD2.

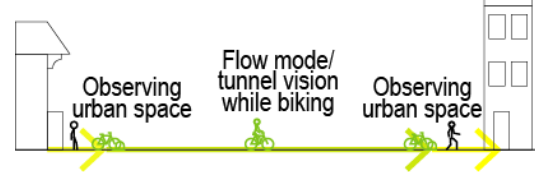
TOD2 pursues a UD perspective on PuT and multimodality highlighting accessibility while focusing on physical form and environmental perception of a whole journey. It recognizes emergence of mobilities in society and the adversity between old and new transport modes seeking development of ideal cities that support mobilities. Transport modes are socially constructed and in continuous (symbolic) struggle. There is fierce competition for a cut in the modal share, for dedicated space on streets, for delineating land for infrastructures in the urban plan, for visibility and status in society and media, developing mobility cultures and social groups with affinities to transport technologies (transit enthusiasts vs. dedicated motorists vs. cycling advocates).

A. ENVIRONMENTAL PERCEPTION AND URBAN EXPERIENCE OF TRAVEL

1. WHILE WALKING



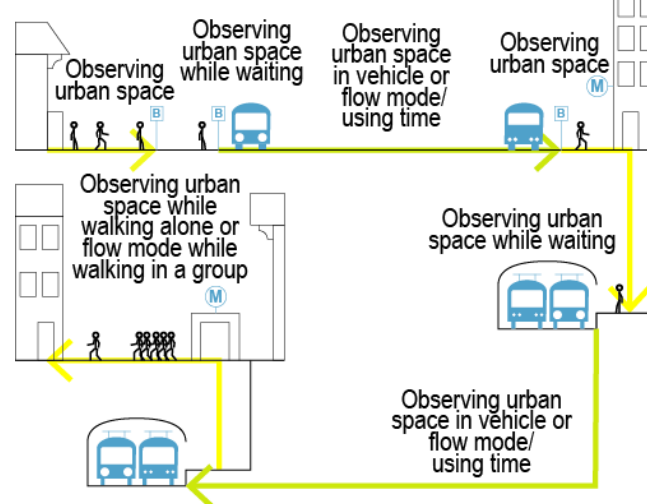
B. WHILE CYCLING



C. WHILE DRIVING



D. IN PUBLIC TRANSPORT



A. COMPETITION BETWEEN TRANSPORT MODES, IDEAL ACCESSIBILITY RANGES AND IDEAL CITIES

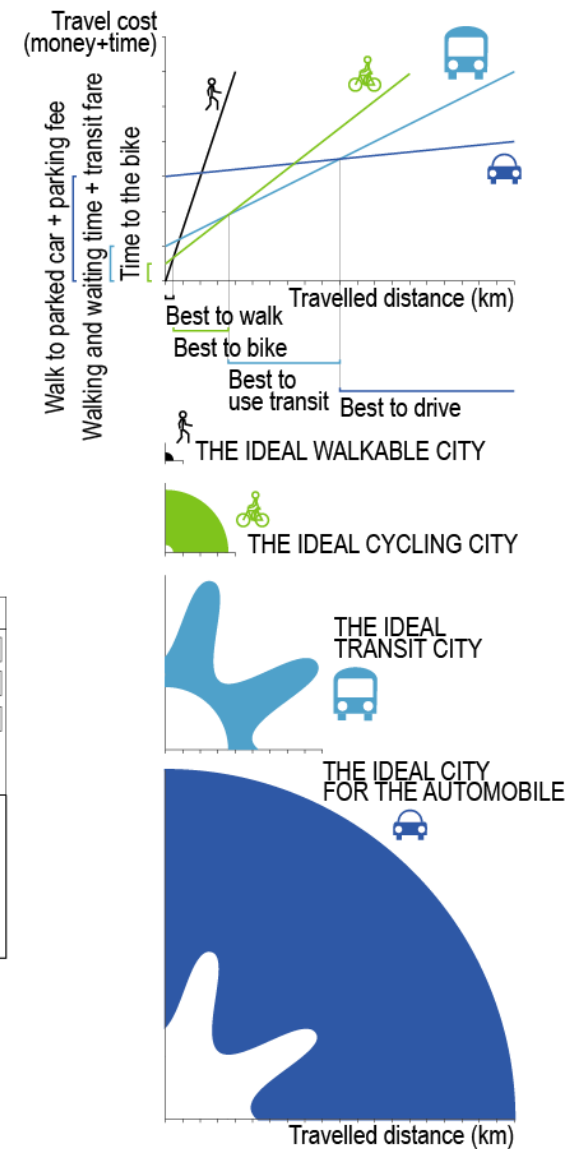
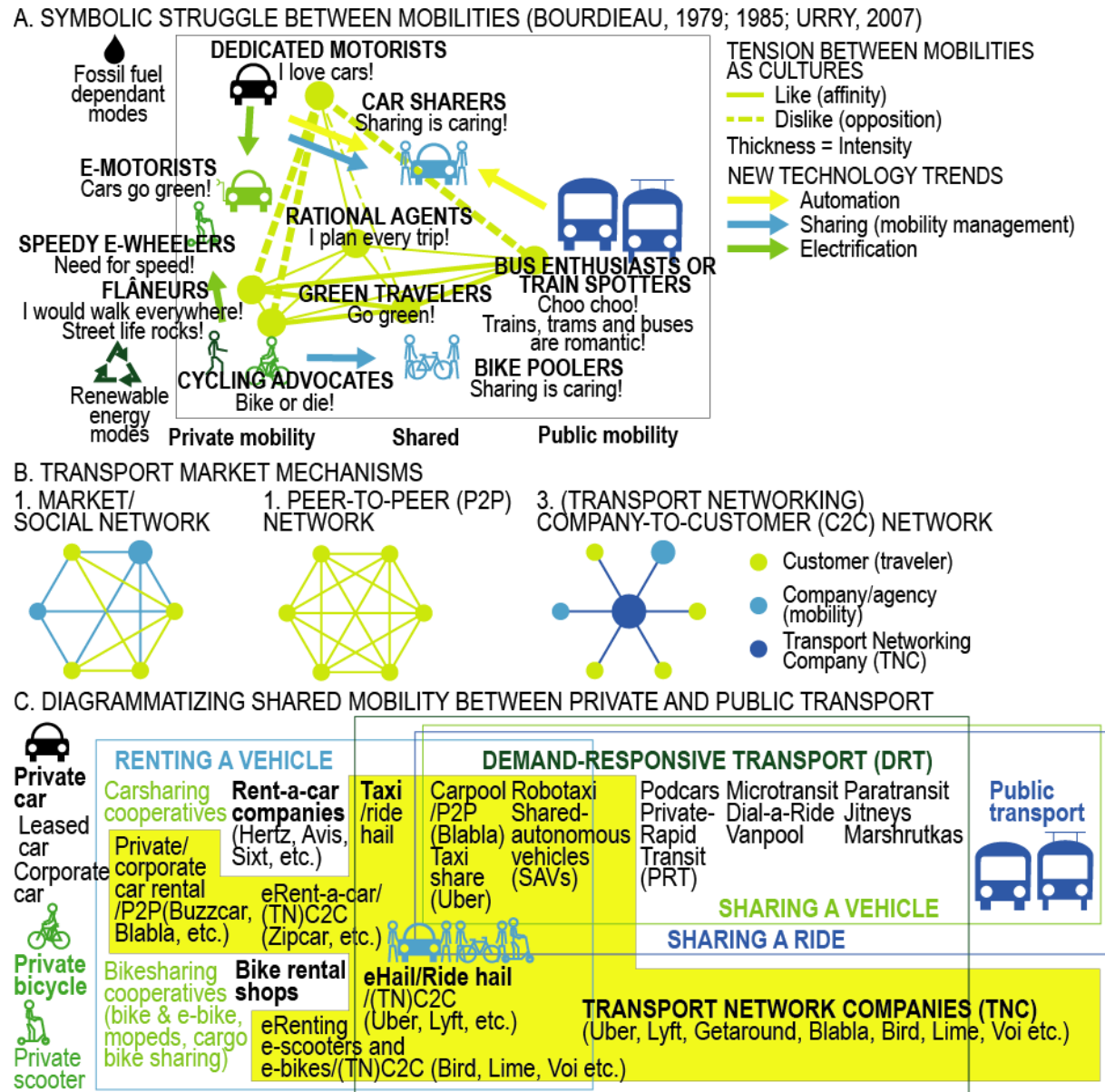
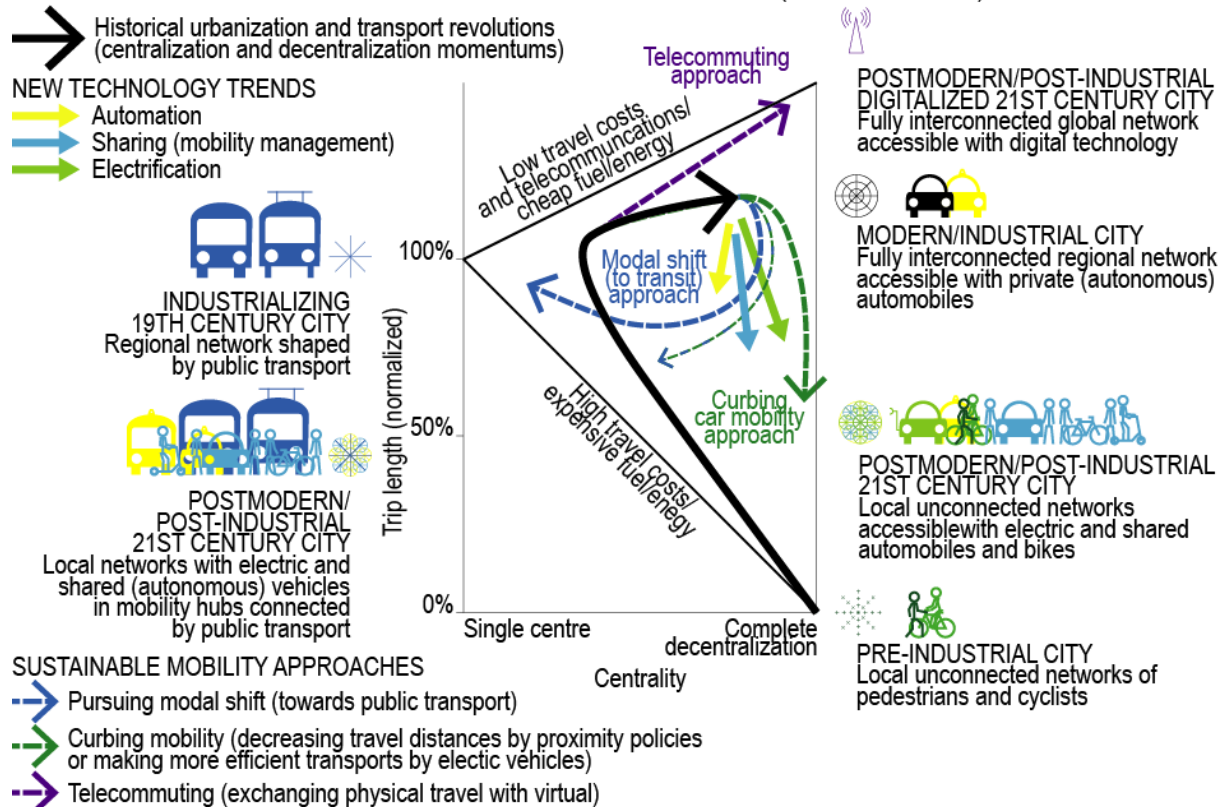


Figure 5: **SYMBOLIC STRUGGLE OF MOBILITIES AND DIAGRAMMATIZING TRANSPORT MODES** (→)

Mobility class defines groups and individuals with strong preferences or affinity towards transport modes combining social theory from Pierre Bourdieu and John Urry. There are established transport modes in each corner of the social field of mobilities: walking, cycling, public transport and private automobiles (Figure 5). New technologies and economics continually challenge their position and dominance in the field of mobilities. Electrification will be either liked and disliked, and different individuals will be placed closer or further away from the new poles of e-wheelers and e-motorists. *Shared mobility* defines *niches* between the private car and PuT, including a range of transport services from renting vehicles (from small cooperatives and tenant associations to specialized companies), taxis, podcars and Private-Rapid Transit (PRT), including robotaxis and Shared Autonomous Vehicles (SAVs) to carpooling, Demand-Responsive Transport (DRT) and paratransit. The widespread of smartphones enabled peer-to-peer (P2P) communication and establishing Transport Network Companies (TNCs) with company-to-customer (C2C) communication allow for dynamic adjustment of prices by second. Typically, a company will set a price for a transport service (e.g. hourly rate of a taxi), and customer interest will adjust the prices. P2P ideally creates perfect information and interactions between peers set and adjust prices in real time by bids and auctions (eBay model). In the C2C model, the TNCs announces bids for mobility services that are adjusted if the price is too high as an ideal

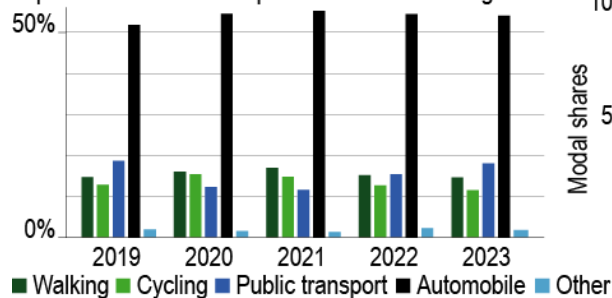


A. SUSTAINABLE MOBILITY APPROACHES AND IMPACT ON CITIES (BROTCHIE, 1984)

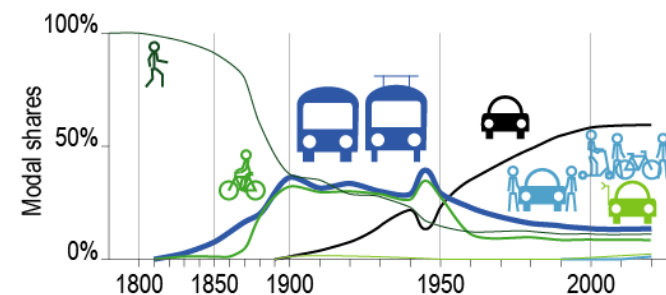


B. SWEDISH MODAL SHARES (JOURNEYS)

<https://www.trafa.se/transportmonster/RVU-Sverige/>



C. TRANSPORT MORPHOGENESIS AND MODAL SHARES



economic model for optimizing supply and demand in transports argued by the late Donald Shoup.

Figure 6: **SUSTAINABLE MOBILITY APPROACHES AND TRANSPORT MORPHOGENESIS** (←)

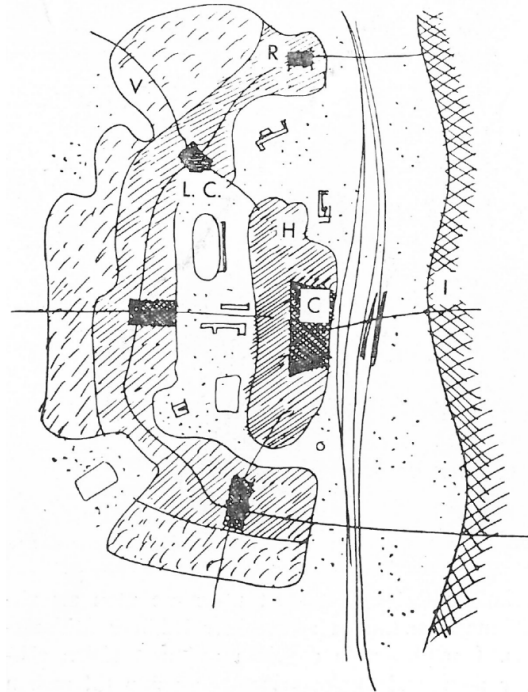
Society constructs and establishes mobility cultures through economic forces leading to transport morphogenesis as a process where society chooses its favorite transport technology as vehicles and infrastructure gradually integrating them into cities with trials and refinement. The morphogenesis includes experimentation and developing prototype that multiply and proliferate until they experience crisis. There are always historical cities in the background, like the railroad city of the 19th century that centralized suburbs or the motor city in the 20th century that are established mobility with infrastructure and bigger chunks in the modal split. The challenge is to converge sustainable mobility approaches together. One approach tries to create a modal shift away from private automobiles. The second seeks to curb car mobility by designing proximity and close-knit communities. The third to exchange physical travel by virtual. The fourth wants to optimize the system of automobility by electrification or sharing. Travel surveys show that an average person travels roughly one hour and makes around 1000 journeys per year and all transport modes are in a vicious cycle in a 1000-sum transport game in cities. **TOD2 belongs to the modal shift approach and recognizes the strong momentum of automobility as dominating the 1000 journeys modal share, infrastructure and mobility- TOD2 pursues diagrammatic UD visions (often utopian) and futuristic PuT scenarios (including shared mobility and mobility hubs) to solve the sustainable transport crisis.**

Infographics and utopias

Make big plans! (Daniel Burham)

Every city needs a sustainable mobility strategy with Urban Design (UD) scenarios for Transit-Oriented Development (TOD), with walkable neighborhoods and attractive Public Transport (PuT). There are no cheap and quick PuT and TOD solutions. Retrofitting sprawled suburbs with transit infrastructure is often incredibly expensive, but developing visions are needed to start the sustainability debates. **TOD2 must create big plans, grand utopias depicting place-specific wishes, dreams and futures with public mobility to stir the debates for sustainable transport.** Utopias come often as grand visions entangling storytelling with images, diagrams or memes. TOD1 promotes a neighborhood of a transit-friendly community along a commercial strip to trigger the imagination. Peter Calthorpe mixes sketching and illustrations with zoning, masterplans and regional plans in two dimensions (2D) and a glimpse of architectural guidelines and building codes including building and planning regulations (needed for traffic circulation, parking regulations, etc.). Similar visions exist historically e.g. the satellite city for the suburbs of Stockholm by Sven Markelius from 1945 that shows a hierarchy of regional and local centers adjacent to rail stations.

TOD2 highlights diagrammatics and infographics from UD and PuT to develop futuristic TOD scenarios. Infographics mean graphical visualizing of information, data, or knowledge. PuT planners utilize cartograms to illustrate stations, lines and system maps. Infographics became popular in the 19th century with time-space diagrams of railway traffic and cartograms of metro systems and. Urban



C = huvudcentrum, H = hyreshusbebyggelse, R = radhusbebyggelse, I, C = lokala centra, V = villa- och småstugebebyggelse, I = industriområde.

designers mix plans, sketches, illustrations, photographs, axonometries, perspectives, cartograms and diagrams for analyzing and envisioning cities. The (master)plans and walkshed radii are typically used to depict neighborhoods in TOD1, but there are three major UD paradigms defined by visual representations and infographics focusing on perspectives, street frontages and spaces between buildings (street sections or profiles).

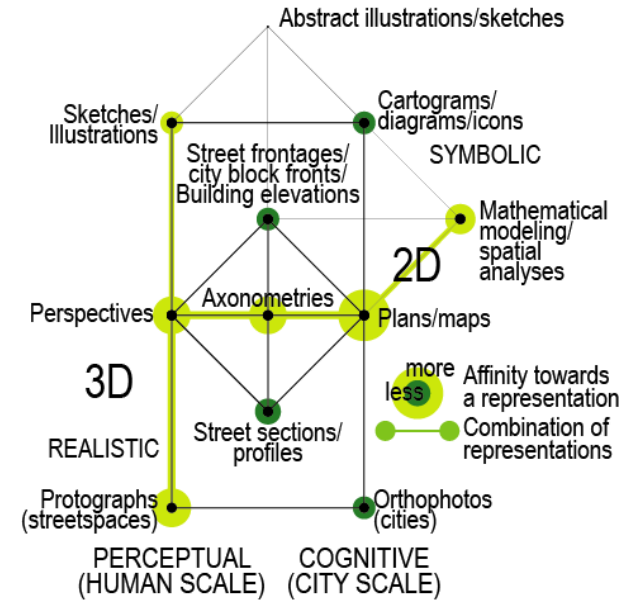
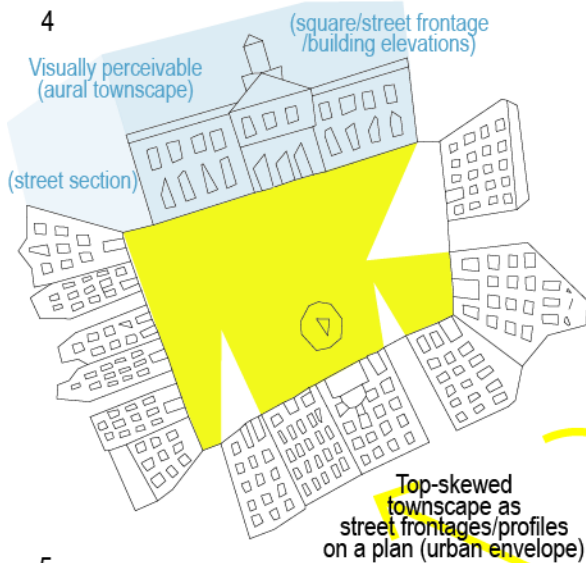
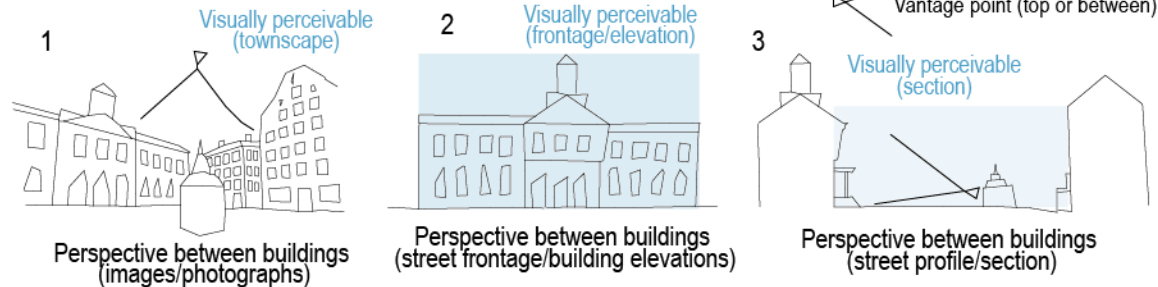


Figure 7: THE SATELLITE CITY VISION BY SVEN MARKELIUS AS PREDECESSOR OF TOD DIAGRAMMATICS (←) (C CENTER, LC LOCAL CENTER, H APARTMENT BUILDINGS, R ROW HOUSES, V DETACHED HOUSES, I INDUSTRIES)

Figure 8: URBAN DESIGN (UD) INFOGRAPHICS AND DIAGRAM OF REPRESENTATIONS THAT DOMINATE URBAN PLANNING AND DESIGN (↑)

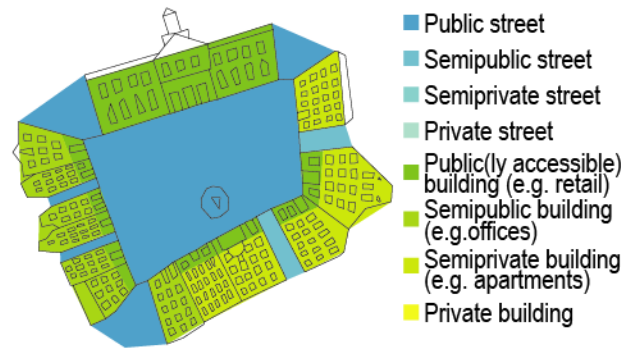
TOD2 builds up eclectic infographics by combining representations that characterize the major UD paradigms today. The townscape paradigm emphasizes images, the perceptual experience and picturesque qualities of cities and townscape analysts typically work with sketches, illustrations and photographs. The frontage paradigm accentuates architectural guidelines and building codes (advocated often as smart codes or Form-

A. URBAN DESIGN PARADIGMS

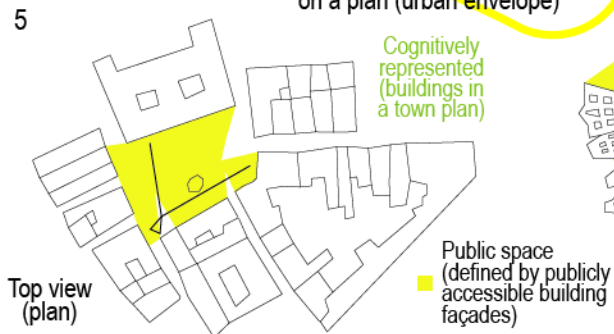
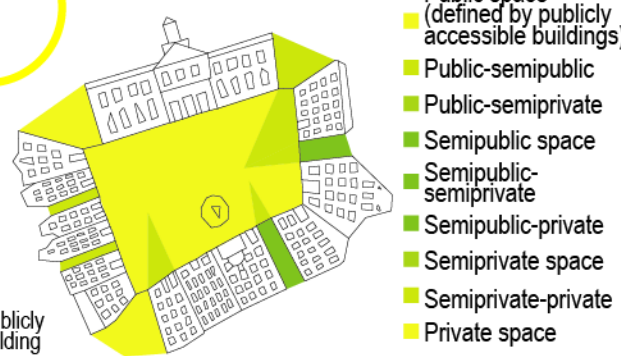


B. MAPPING PUBLIC SPACES

1. PUBLICNESS OF BUILDINGS AND STREETS



2. STREET FRONTAGES INTERACT AND PRODUCE GRADATING PUBLIC OR PRIVATE SPACES



Based Codes (FBCs) in New Urbanism) focusing on city block fronts and street profile as frontages. The third tradition emphasizes *the life between buildings* and *the city on eye level* highlighting proxemics in a street section/profile (referred to as **the pro(file)xemics paradigm**). Proxemics is the study of personal space in social situations and environmental interactions. **TOD2 integrates these paradigms into a collaged mix of street frontages/sections called urban envelopes for morphologically informed UD and operational urban morphology to depict human scale perceptually represent townscapes/streetscapes and concisely define and communicate public spaces.** The urban envelope defines aural audiovisual experience of cities as skewed vistas as viewsheds from a top vantage point illustrating public-private spaces interactions on a plan. Each transit stop is a public space or building. Transit vehicles can be understood as mobile public spaces. Some buses and trains hold density of up to eight people per square meter, (potentially) making them the densest public spaces in a city. TOD2 problematizes automobility and the car culture of too much driving, being stuck in traffic jams, long cruising to find a parking spot, car repairs, etc. with alternative often utopian visions for future cities integrated PuT and walkable neighborhoods. The urban envelope of each transit stop must be surrounded by commercial storefronts or public buildings to produce attractive public spaces.

Figure 9: **URBAN DESIGN PARADIGMS** (TOWNSCAPE, ARCHITECTS OF FRONTAGES AND PRO(FILE)XEMICS) AND INFOGRAPHICS OF MORPHOLOGICAL INTERACTION IN CREATION OF PUBLIC SPACES (←)

Morphologically informed design

It is important to postulate a prototype against which all forms could be compared as to points of agreement or divergence. It is an archetypal form, in essence, the concept or idea of the form (Johann Wolfgang von Goethe)

An ideal type is not a description of reality, but it aims to give unambiguous means of expression to such a description. In its conceptual purity, this mental construct is not found empirically anywhere in reality. It is a utopia. (Max Weber)

Urban morphology studies the physical form of cities, processes of formation and transformation, the dynamics of urban change and the underlying causes. The generic morphological structure implies a hierarchy from a street, lot, building to its land use with interactions between public streets and private/public lots or buildings. Urban morphologists dissect elements of cities and produce typologies, while urban designers create compositions of morphological elements in physical space and use typologies to structure design worlds. The design worlds act as holding environments for diagrammatic knowledge that consists of elements, rules and types.

TOD2 centers on morphological information about the integration of PuT and cities, processes of urban and transport morphogenesis driven by utopian visions and idealized urban designs with typologies and infographics. The knowledge and expression of urban designers is diagrammatic. The hierarchical morphological structure of cities and

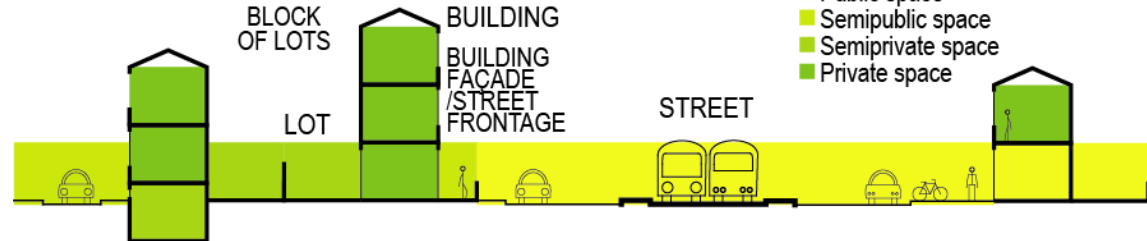
A. GENERIC MORPHOLOGICAL STRUCTURE (CONZEN 1960; MOUDON, 1992; 1997; KROPPF, 1996; 2014; 2018).

Urban tissue		
Street (element of urban tissue)		
Plot/lot series		Routes/ street spaces
Plot/lot		
Building	Areas/open spaces	
Rooms		

B. INCLUDING ENVIRONMENTAL PERCEPTION AND COGNITION (STOJANOVSKI, 2019) Cognitively represented

Neighborhood/district (city blocks & routes pattern)				Routes/ networks
Visually perceivable				
City block (plot/lot series)			City block frontage	Street/ street segments /street spaces/ routes
Plot/lot		Building façades		
Building	Building storey		Rooms	

D. MORPHOLOGICAL STRUCTURE AND PUBLIC-PRIVATE SPACES



the yellow color (info) defines public spaces in the street profile as interactions between public and private streets, lots and buildings. A morphological hierarchy is fundamental for TOD2 and it links to placemaking and public spaces as activators of PuT and TOD. Echoing William H. Whyte's needs for sun, wind, trees, water and food in public spaces, the morphological interactions between public streets and private/public buildings intertwined with a biological layer of green and blue infrastructure (natural vistas) preconditions social life and interactions needed for TOD, and PuT since transit vehicles are the densest (mobile) public spaces in cities.

Figure 10: MORPHOLOGICAL STRUCTURE OF CITIES AND PUBLIC-PRIVATE SPACES (↑)

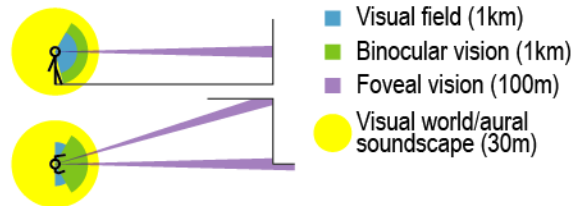
TOD2 as a framework defines morphological scales based on environmental (audio-visual perception) of cities and eclectically fuses the field of vision from the townscape paradigm (city is experienced on the move/onboard a PuT vehicle) as sequences of vistas/places (represented by urban envelopes, streets in plan, as sections and frontages). The morphological structure is thus interpreted within a framework of environmental perception that structures the preconditions to travel (as perceptual urban morphology). Environmental psychologists recognize layers of nested environments. In the behavioral environment, people are not only aware but also perform behavioral response.. The operational environment defines the space where people move and work. It is a movement space. The perceptual environment is the space where people

A. ANTHROPOMETRICS (NEUFERT, 1936)
AND PROXEMICS (HALL, 1959; GEHL, 1971; 1986)



- Intimate distance (>0.3m)
- Talking distance (0.8m)
- Armsreach (~0.9m)
- Hailing distance (6-30m)
- Social distance (max 30m), visual acuity (100-200m)

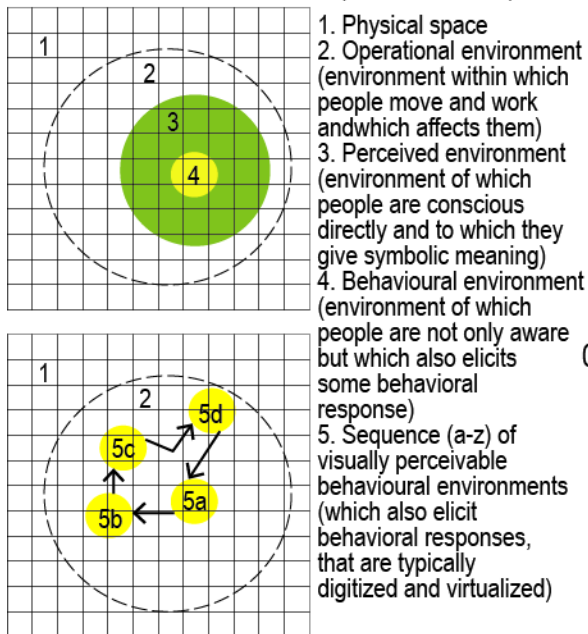
B. VISUAL PERCEPTION (GIBSON, 1950; 1986)
AND SOUNDSCAPES (SOUTHWORTH, 1967)



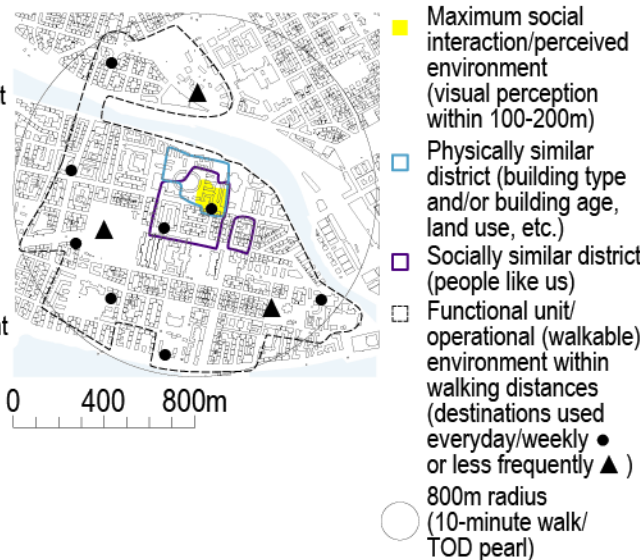
C. AUDIO-VISUAL PERCEPTION AND
URBAN PROXEMICS (GEHL, 1971; 1986)



D. ENVIRONMENTAL PERCEPTION FROM A
VANTAGE POINT (RAPOPORT, 1977) AND
MOBILE EXPERIENCE OF CITIES
AS A SEQUENCE OF VISTAS (CULLEN, 1960)



E. BEHAVIOURAL ENVIRONMENTS
AND NEIGHBOURHOOD TYPES (LEE, 1970)



are directly conscious and to which they give symbolic meaning. **Each trip/journey is a sequence of vistas/viewsheds as centers of behavioral environments.**

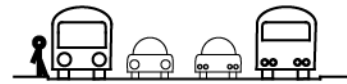
Figure 11: ANTHROPOMETRICS, PROXEMICS, ENVIRONMENTAL PERCEPTION AND NEIGHBORHOOD TYPES (←)

TOD1 is often illustrated as circular walkshed or a “half a mile pearl”. Peter Calthorpe presents a TOD pearl within 2000 feet walking distance and a regional plan with TOD pearls on a string. TOD2 defines furthermore scales as nested environments within a neighborhood (shaped by audio-visual perception) and within the region (defined by mobile experience of cities as a sequence of places/vistas). With placing transit infrastructures in a hierarchy of perceptual urban morphology TOD develops a typology of PuT systems based on the segregation from the (public) street as underlying element of urban form. The typology of PuT systems is based on how the transit stop links to streetspace and its surrounding buildings. This includes interactions between the street (sidewalk) and the transit stop (transit stop platform) and street (sidewalk) and building (as entrances and storefronts). **The PuT typology is crucial in understanding the TOD, UD and PuT scales from perceptual viewshed, to local walkshed (neighborhood/TOD pearl) and regional access (movement area as a TOD corridor along PuT line or a string of TOD pearls along PuT line creative a network as PuT system of many lines).**

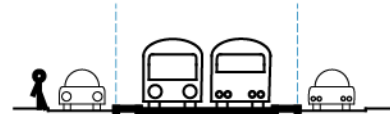
Figure 12: **TYOLOGY OF PUBLIC TRANSPORT (PUT) SYSTEMS** BASED ON ENVIRONMENTAL PERCEPTION AND URBAN DESIGN (UD) PERSPECTIVE AS STANDING ON A STREET AND LOOKING AT THE CITY IN 3D (→)

Cities today are conceived as extraordinary agglomeration of flows. They are spaces of flows, an assemblage of fixed and mobile spaces, flows and networks of spaces. Locations anchor interactions. In the TOD2 framework the structure of TOD is understood typo-morphologically as elements of spaces and flows in interactions. Cities create a hierarchy of centers (transit nodes and mobility hubs) and transport axes (along transit lines) at a scale of the city/urban region. Both cities and transport systems experience morphogenesis as prototyping and variations of physical form to integrate transport systems in urban space. Transport morphogenesis is a process of emergence of a transport system (e.g. railroads in the 18th century), that includes experiments, social evaluation and acceptance of transport technologies, envisioning and developing ideal urban forms (utopian neighborhoods) with a particular mix of transport systems, construction of transport infrastructures and establishment of mobility cultures in these experimental communities. Mobility cultures are sets of practices and knowledge on how to use transport technology including wayfinding and navigation (maps and apps). The establishment of mobility culture is a long process of social acceptance (e.g. of bikes in Pinch and Bijker, 1984) where society chooses the favorite transport technologies and embeds them in cities. When a prototype becomes accepted in society it spreads and turn typical for its age. Each

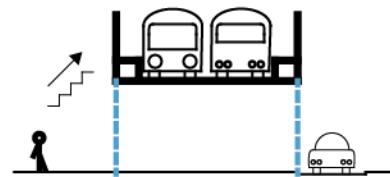
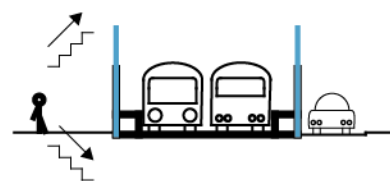
A. PUBLIC TRANSPORT ON STREETS



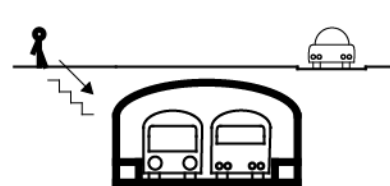
B. PARTIALLY SEGREGATED PUBLIC TRANSPORT



C. COMPLETELY SEGREGATED PUBLIC TRANSPORT

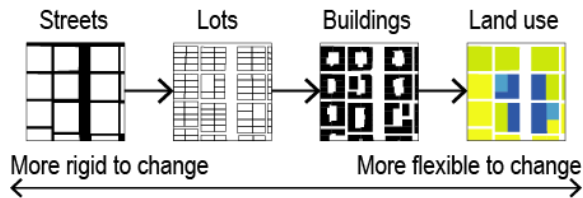


D. PUBLIC TRANSPORT UNDERGROUND

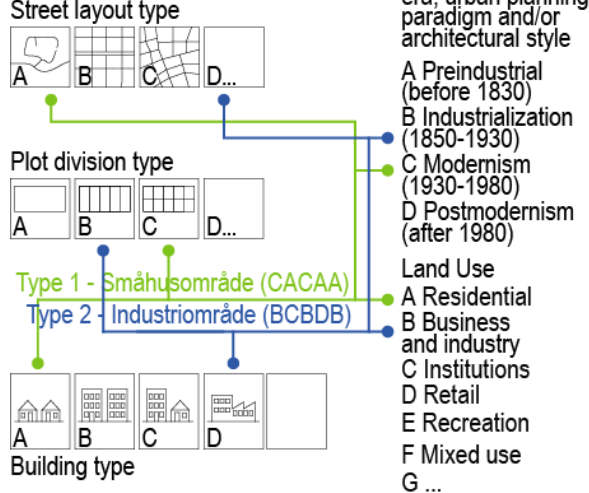


- Permeable edge/weak barrier effect
- Impermeable edge/strong barrier effect
- Permeable edge/strong barrier effect
- Public transport infrastructure
- Street

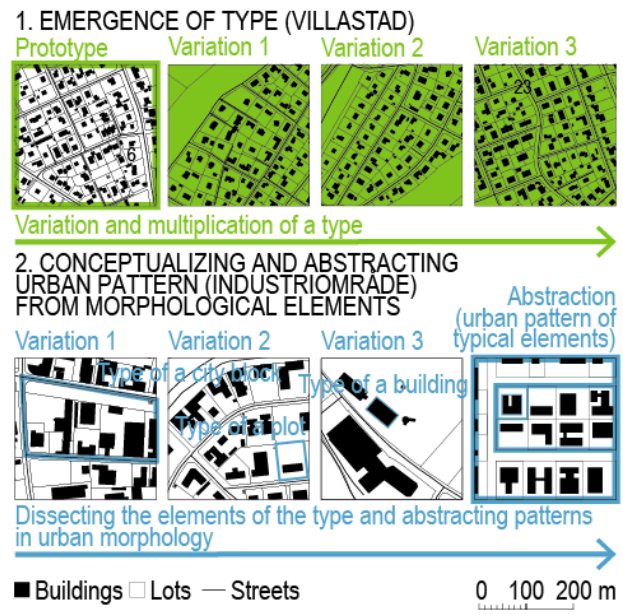
A. MORPHOLOGICAL ELEMENTS OF NEIGHBORHOODS (CONZEN, 1960)



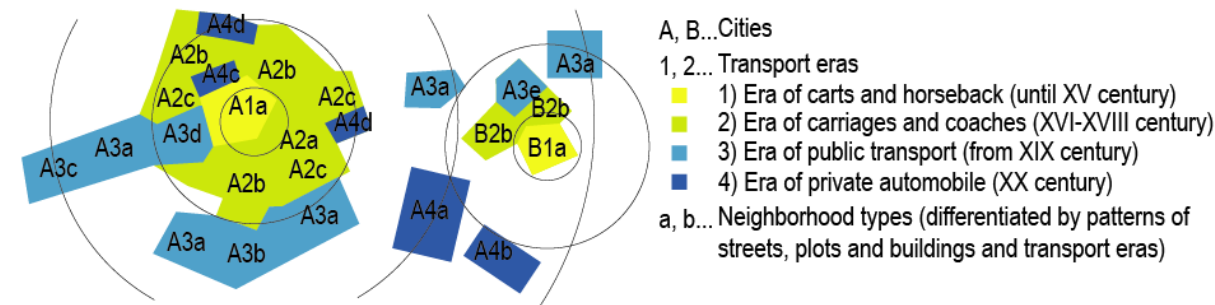
B. CLASSIFYING NEIGHBORHOOD TYPES BY COMPOSITIONS OF MORPHOLOGICAL ELEMENTS



C. EMERGENCE AND ABSTRACTING NEIGHBORHOOD TYPES



D. DIFFERENTIATING AND MAPPING NEIGHBORHOODS BY TRANSPORT ERAS (WHITEHAND, 2001; MARSHALL, 2005)



neighborhood type it incorporates housing and transport preferences (dream houses and vehicles).

Figure 13: MORPHOLOGICAL METHOD TO CLASSIFY NEIGHBORHOOD TYPES (←)

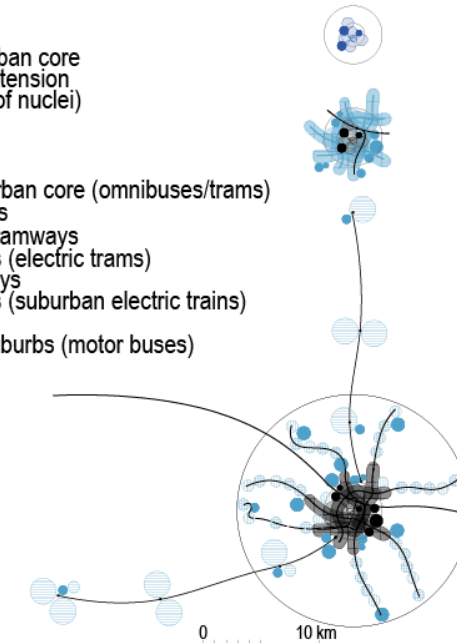
TOD2 favors morphological information as neighborhood types that characterize historical (and as utopias future) period in a process of urban and transport morphogenesis. Figure 13 shows how to classify and abstract neighborhood types by morphological theory of hierarchical structure of cities and transport eras. Technologies continuously inspire urban visions that involve prototyping streets, buildings and neighborhoods and new towns. Types continuously emerge. They have history and they tell histories. A type is a characteristic example of a place, the essence or the original place that makes it possible to understand its image and class. Similar to concepts in linguistic terms, a type packs much information into one icon: a set of architectural or environmental attributes; a set of rules for construction and for organization of space; a set of behaviors and defined roles that take place within it; and a set of qualities it should exhibit. Types are not static. They change over time and vary considerably between cultures and between different groups within the same cultures. Even though the typologies vary across cultures, the activity of creating types exists within all societies.

TOD2 seeks to combine neighborhood and PuT typologies in the context of transport morphogenesis where different mobility cultures struggle for dominance in processes of morphogenesis. There is a morphogenetic evolution from the walkable preindustrial city to industrializing city of PuT in the 19th century and modern/industrial cities in the 20th and postmodern in the 21st. Figure 14 shows models of a large and small city with transport morphogenesis. The flexibility of the private automobile in reaching any destination in the road network is superior to PuT that serves only suburban/town centers around the railway stations. Preindustrial cities before the 19th century and the industrializing cities in the 19th century developed around walking, cycling and public transport and these historical cities can be used as future urban patterns for new suburbs or retrofitting the existing suburbs, but as TOD2 as a 21st century *post-car* urban design and development policy needs more innovative solutions.

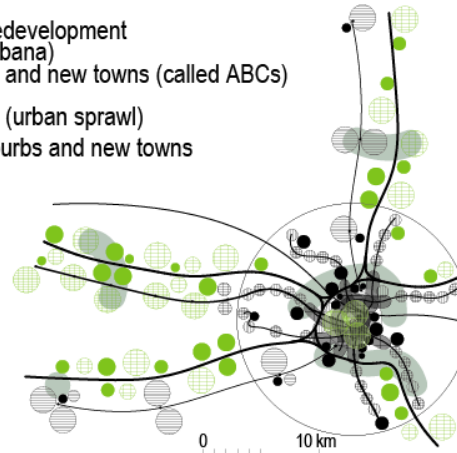
Figure 14: **TRANSPORT MORPHOGENESIS AND EVOLUTION OF SWEDISH CITIES** (→)

A. EVOLUTION (DEVELOPMENT CYCLES) OF A LARGE SWEDISH CITY AND ITS TRANSPORT MORPHOGENESIS

- Pre-industrial urban core
- Pre-industrial extension (agglomeration of nuclei)
- Industry
- Industrialising urban core (omnibuses/trams)
- Intercity railroads
- Omnibus lines/tramways
- Railway suburbs (electric trams)
- Suburban railways
- Railway suburbs (suburban electric trains)
- Motorbus lines
- Early modern suburbs (motor buses)



- Modern urban redevelopment
- Subway (Tunnelbana)
- Modern suburbs and new towns (called ABCs)
- Expressways
- Modern suburbs (urban sprawl)
- Postmodern suburbs and new towns



B. EVOLUTION OF A SMALL SWEDISH CITY

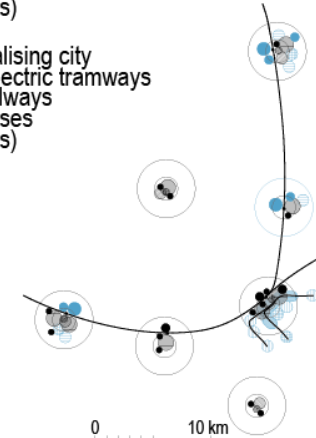
The pre-industrial city of flâneurs, carts and coaches until 19th century



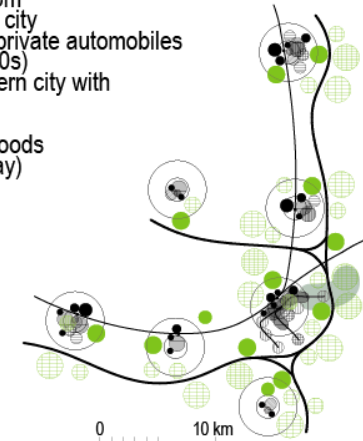
The industrialising city shaped by omnibus/tram lines (1830s-1870s)



The industrialising city shaped by electric tramways suburban railways and motorbuses (1870s-1930s)



The shift from the modern city shaped by private automobiles (1930s-1990s) to postmodern city with sustainable multimodal neighbourhoods (1890s-today)



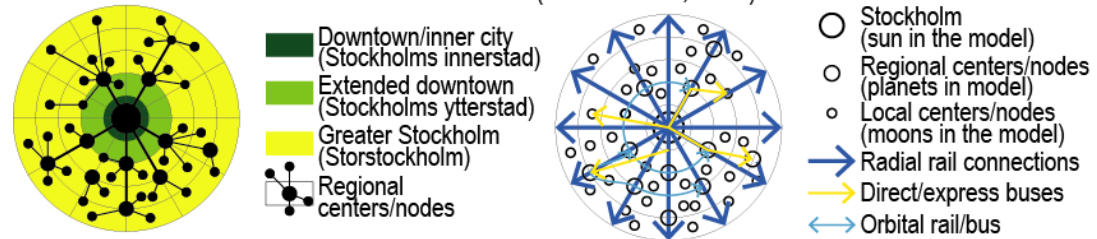
Public Transport (PuT) schools and transit manuals

Public Transport (PuT) planning is rooted in the paradigms of traffic engineering and transport planning. Empirical knowledge from observation and simulations studies is typically compiled and standardized in traffic engineering and transit manuals. There are many ways for planning PuT service, calculating frequencies and scheduling, displaying information, drawing lines and system maps, paying fares, etc. **Every city has a unique culture of planning and using PuT and unique public mobility culture.** Public Transport Authorities (PTAs) in every city or region develops unique PuT legislation and manuals. The PTA in Stockholm called Storstockholms Lokaltrafik (SL) publishes PuT guidelines diagrammatizing major regional nodes with different types of PuT. **The TOD2 handbook is inspired by the PuT planning tradition at SL (#StockholmsSchoolofTransit) and the infographics of Norwegian transit handbooks.** This approach can be called a Scandinavian school.

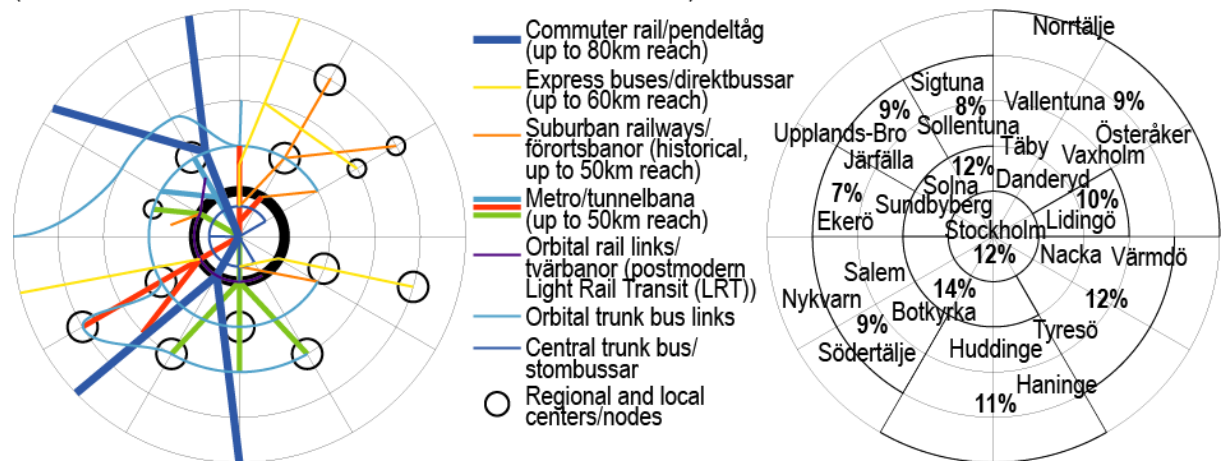
Figure 15. STORSTOCKHOLMS LOKALTRAFIK (SL) MODEL FOR PLANNING THE PUBLIC TRANSPORT (PUT) IN STOCKHOLM (→)

Stockholm developed as a satellite city with orbit suburbs orbiting around the downtown like planets and moons. The main characteristic of the PuT planning tradition at SL is a hierarchy of PuT lines, with radial and tangential connections to the sun system of suburbs. Many European cities use the hierarchical model, but in Stockholm many radial connections are served by express buses (direktbussar/direkttrafik). The trunk buses and

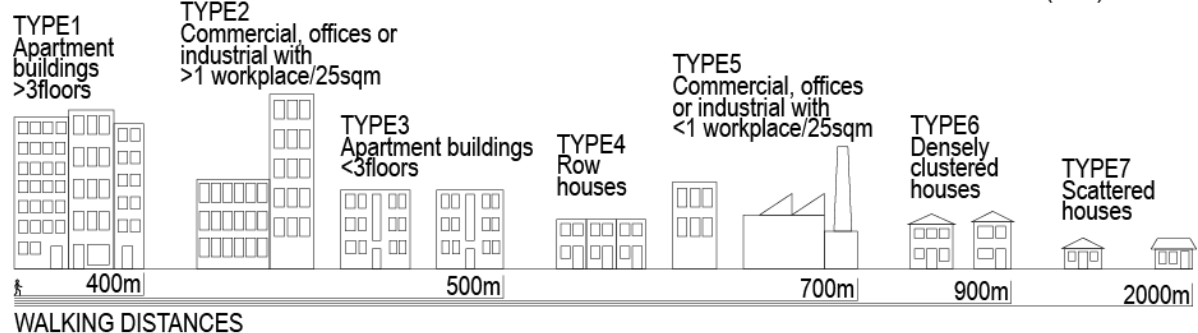
A. HIERARCHICAL CONCENTRATED DECENTRALIZATION OF STOCKHOLM (OHLSON, 1937) AND THE SATELLITE MODEL FOR DEVELOPMENT (MARKELIUS, 1945)

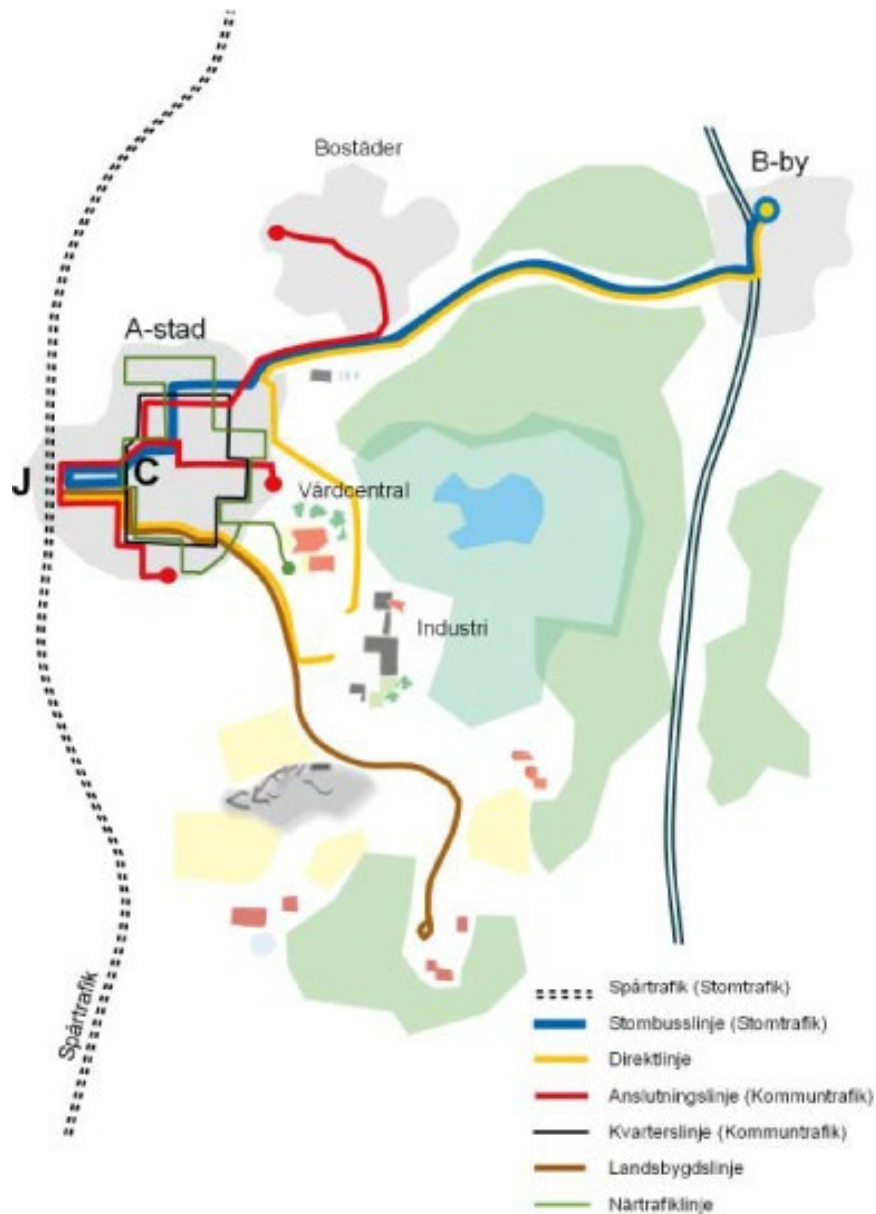


B. HIERARCHY OF PUBLIC TRANSPORT (PuT) SERVICE AND PuT TRAVEL RATIOS IN STOCKHOLM (PER POPULATION AND PER HOUR DURING RUSH HOURS)



C. TYPOLOGY OF NEIGHBORHOODS AND WALKING DISTANCES TO PUBLIC TRANSPORT (PuT)



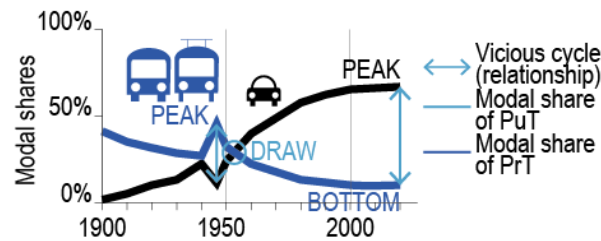


trains (stombussar/stomtrafik) are painted in blue, whereas the feeder buses and other special PuT lines (stadsbussar/kvarterlinje/kommuntrafik) are painted red (Figure 16). Scania is headquartered in the south of Stockholm Region and SL has collaborated and experimented with Scania buses for more than a century. The walking distances to PuT (as a core TOD1 concept) are calculated by the type of development, starting with 400m for tall apartment buildings to 2000m for scattered houses in the landscape.

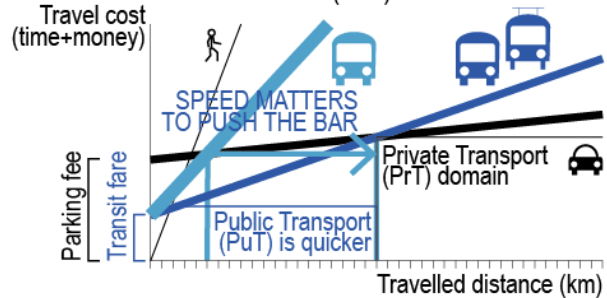
Figure 16. THE HIERARCHY OF PUBLIC TRANSPORT (PuT) LINES IN STORSTOCKHOLMS LOKALTRAFIK (SL) MANUALS (→)

The SL planners that are called “old foxes” (gamla rävar) have developed and tested different theories, concepts and indicators to plan for PuT service. In the core lies the vicious cycle with Private Transport (PrT). Every improvement of the road network and automobile travel influences PuT inversely, but it is not always proportional effect. The congestion charging created an instant shift to PuT, but some car traffic just disappeared (confirming Donald Shoup’s theory that car traffic acts like gas, it expands and compresses). Thus, the development of attractive PuT is preconditioned by improvement of the PuT speed measured as Perceived Journey Time (PJT) and Travel Time Ratio (TTR). The perspective on time is relative and TTRs are calculated by sequencing the time on PuT looking at the “whole journey”. TTR is the quotient of the PJT by PrT and PuT showing how much better the private automobile is from the PuT service. If the $TTR=1.5$ it means that it is (perceptually) 50% longer to take PuT along the same route. The “old foxes” claimed that the $TTR=1$, passengers in Stockholm almost

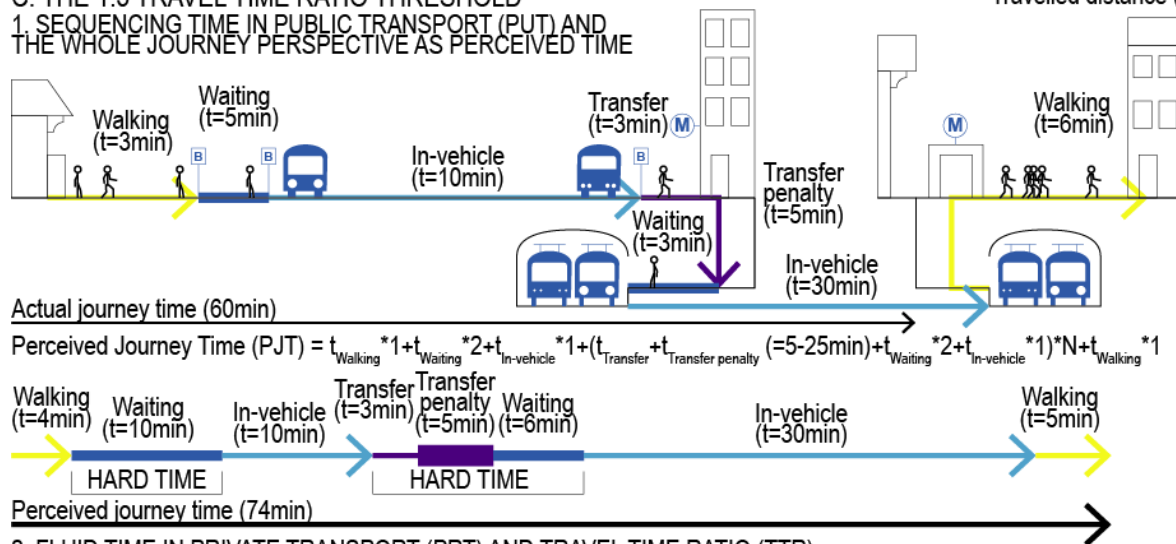
B. VICIOUS CYCLE WITH PRIVATE TRANSPORT (PrT)



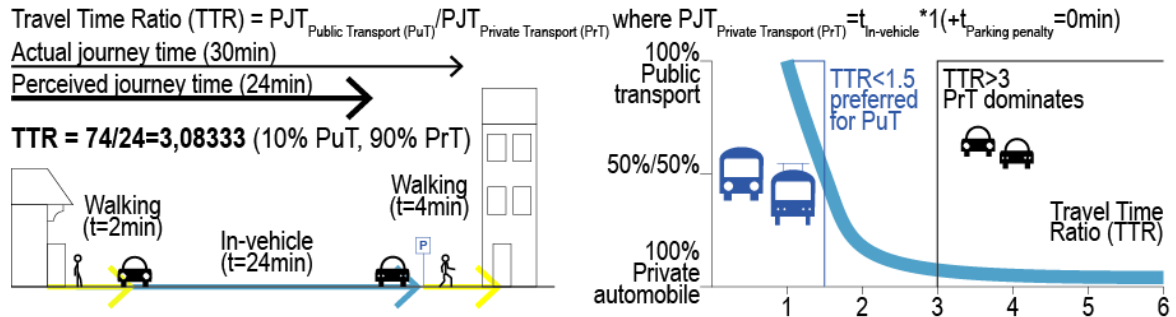
B. PUBLIC TRANSPORT (PuT) SPEED MATTERS!



C. THE 1.5 TRAVEL TIME RATIO THRESHOLD
1. SEQUENCING TIME IN PUBLIC TRANSPORT (PuT) AND THE WHOLE JOURNEY PERSPECTIVE AS PERCEIVED TIME



2. FLUID TIME IN PRIVATE TRANSPORT (PrT) AND TRAVEL TIME RATIO (TTR)



always chooses SL with exception of dedicated motorists and car lovers.

PJT is a measurement that is conventionally used in traffic engineering and PuT planning. PJT weighs “hard times” like waiting and transfers by adding penalty. In contrast, when driving, the PJT shrinks because typically parking is nearby and walking to the car does not show up on travel planners. Driving also creates a flow feeling and time becomes fluid. Transfers are the most difficult part of a “whole journey” by PuT (particularly if there is a need to pay extra while changing. The penalty can be up to 25min extra on PJT, but in Stockholm it is only 5min, because the satellite city model requires transfers and transfers are so embedded in the public mobility culture of Stockholm that they become negligible.

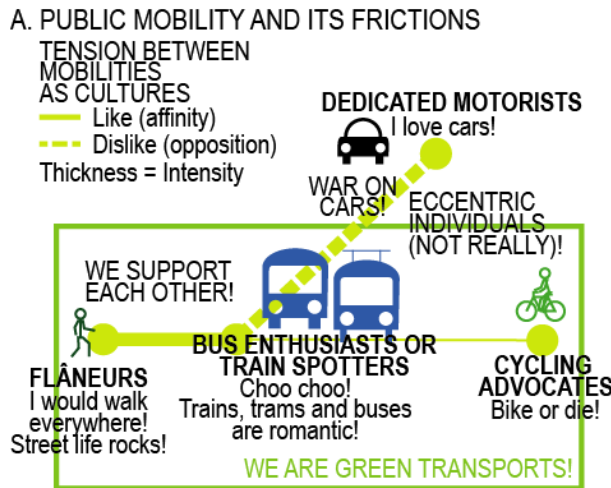
Figure 17. **THE VICIOUS CYCLE WITH PRIVATE TRANSPORT (PrT) IN THE STORSTOCKHOLMS LOKALTRAFIK (SL) MODEL FOR PLANNING THE PUBLIC TRANSPORT (PuT) LINES IN STOCKHOLM** (->)

Mobilities paradigm and public mobility as transit culture

Public Transport (PuT) should be inclusive and consider the needs of various customers. Mobilities is a term used by Mimmi Sheller and John Urry that incorporates travelers and vehicles on the move, mobility cultures as complex everyday procedures such as wayfinding and navigating, use of technologies and apps while travelling, physical facilities and infrastructures in cities and urban forms that support transport systems. Public mobility in the mobilities paradigm is a mobility culture to use transit. It includes of having a monthly card, understanding maps and using travel apps, figuring out timetables and organizing your life according transit schedules, remembering few important PuT lines (or depend on apps and maps), taking a book or mobile phone (to create private space in the densest public spaces in city) and tolerating a “can of sardines” situation. **TOD2 puts comfort and seamless mobility first as customer care assuring a cozy seat potentially avoiding claustrophobic “can of sardines” feelings.** The public mobility enthusiasts wage war on cars and motorists, while loving pedestrians. Walking supports transit and vice versa. There is an uneasy tension with cyclists that are typically individualists and tend to shift to their bikes in good weather.

Figure 18. CUSTOMER SEGMENTATION OF STORSTOCKHOLMS LOKALTRAFIK (SL) (→)

A part of the mobilities paradigm is just mobility or mobility of care that looks at social groups using public transport. *Understanding the local public mobility culture, the market segmentation as social*

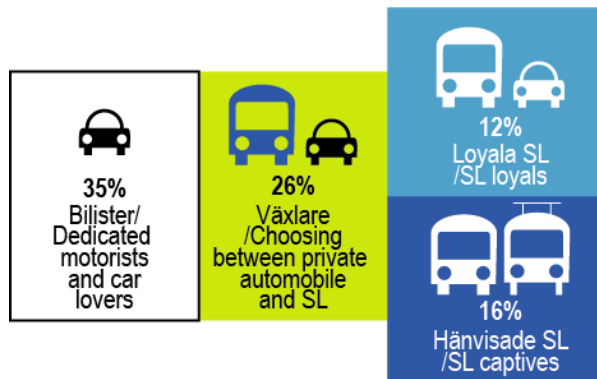


B. CUSTOMERS SEGMENTATION

1. Canadian Transit Handbook



2. Market segments in Stockholm by Storstockholms Lokaltrafik (SL) (2011)



groups and mobility classes and the customers is crucial. **TOD2 recognizes a diversity of customers with varied needs that must be satisfied.** There are different ways to do categorize and classify customers. Usually, market segmentations are made according to frequency of use and access to private automobiles. Frequent users are people who often travel by PuT, occasional users ride PuT approximately once a week or less, and finally there is the category of seldom users and non-users. **The two major market segments are captive riders and choice travelers.** The captive riders are too young, too old, too poor or anti-car to own or drive automobiles. The choice market is made out of people who own car, but who use transit because it is cheaper, faster and more convenient. It is also composed of people who can afford a car, but choose not to use it because of inconvenience of ownership such as licensing, maintenance, and garaging. These people tend to use taxis and rental cars, but use transit for commuting and other occasions when it is convenient. There is a “reluctant choice” group who do not drive because of frustration of congestion, problems with parking or environmental concerns. Stockholm has a very strong transit culture that coerces many to use PuT frequently. SL uses market segmentation to define three user groups: 1) loyal SLs who own a car, but always choose SL (12%); shifters who rationally choose between SL and their automobile (26%); 3) captives (16%) and 4) (stubborn) motorists (35%) who never consider SL.

TOD2 HANDBOOK

“A fundamental purpose of Transit-Oriented Development (TOD) is to create a land use pattern which will ultimately support transit” (Peter Calthorpe)

Design and infographics matter!

Make it simple! (HiTrans2)

Sustainable mobility paradigm promotes access with multiple sustainable mobility choices by highlighting human scale and understanding transport infrastructures as spaces creating a pyramid with the pedestrian on the top. **The TOD2 handbook contributes to the sustainable mobility paradigm with human-centric diagrammatic Public Transport (PuT) and Urban Design (UD) solutions for improved walkability and PuT.** The focus is on models and rules, as infographic PuT hacks and UD interventions to improve PuT service and travel experience, create TOD visions for integrating PuT in cities at various scales.

Figure 19: **SCALES OF PUBLIC TRANSPORT (PUT), URBAN DESIGN (UD), AND TRANSIT-ORIENTED DEVELOPMENT (TOD) (→)**

While TOD1 highlights the walkshed as a “half a mile pearl” in a “pearls on a string” approach, **TOD2 promotes a range of scales starting with public spaces shaped by commercialization within the viewshed and expanding the TOD pearl to corridors and networks.** The viewshed describes what a passenger sees and feels while traveling by PuT. The travel experience should be smooth and seamless in transit vehicles and between station

exists and entrances, in corridors, on loading platforms etc. The perceptual scale of travel experience is cognitively nested in the transit station walkshed as a mental map or travel, transit line corridors and the transit network seen as a system map or travel planner. There should be smooth integration with the elements of urban form. Pedestrians walking to and from transit stops and

stations should enter public spaces with visible commercial storefronts and public buildings as suggested by Peter Calthorpe in TOD1.

Public transport and TOD policies are expensive and A strong public commitment to finance PuT is a prerequisite for planning and design. The 19th century formed networks of profitable, but

ARCHITECTURE/URBAN DESIGN (UD) SCALES	PUBLIC TRANSPORT (PUT) SCALES	TRANSIT-ORIENTED DEVELOPMENT (TOD) SCALES
Room (windows, doors)	Vehicle/vehicle interior/mobile public space	VIEWSHED/aural space of audio-visual perception (vehicle interior/mobile public space/platform stop/station design, TOD amoeba=street building/block front interactions, superhero block= “one great block”)
Building story		
Ground floor (entrances, storefronts)	Boarding and alighting (vehicle-platform interactions)	
Building façades (windows, doors, entrances, storefronts)	Platform	
Front yards/open spaces		
City block front		
STREET/STREETSCAPE		
Buildings	STOP/STATION (exits/entrances+platforms +corridors+transfers/node/ mobility hub, hierarchy: regular, nodal, central, terminal,	THE HALF-MILE PEARL (walkshed, D-variables, place/node, zoning/Design guidelines and Form-Based Codes (FBCs)/street network/traffic hierarchy) and service area of mobility hub (as extended service area)
LOT/PARCEL/LAND USE		
Lot division		
CITY BLOCKS	Line (character: local, rapid, express/limited, hierarchy: trunk/corridor vs. feeder)	CORRIDOR (mix of neighborhood types)
STREETS/ROUTES (as a street layout traffic hierarchy)		
NEIGHBORHOODS/DISTRICTS (urban tissue)	Line (character: trunk, commuter)	STRING OF PEARLS (mix of fragmented neighborhoods types)
Street network (as a regional pattern/hierarchy)		
City (urban tissue)	PuT network (character: regular, trunk & feeder commuter, hybrid)	SYSTEM (the PuT network, hierarchy of lines, system maps)

- Viewshed scale (environmental perception, experiential qualities from a vantage point and audio-visual proximity)
- WALKSHED SCALE (walking experience and experiential qualities while moving)
- Corridor scale (accessibility experience and direct connection with a PuT line)
- Network scale (cognitive understanding of the system map, accessibility experience of transfers between PuT lines)

disconnected PuT lines. To consolidate the chaos of many PuT lines, cities and regions formed transit agencies or Public Transport Authorities (PTAs) in the 20th century who took a network perspective. The PTAs have local knowledge and traditions, and each city has a distinctive mobility culture as way of planning PuT lines and networks, paying fares, marketing, advertising and presenting information as well as scheduling and creating timetables. **The TOD2 handbook is based on Scandinavian tradition (#StockholmSchoolOfTransit) and selection from transit manuals.**

Designing PuT requires good understanding of the local government and market, the customer demands and requirements and the public mobility culture in the particular city or urban region. What role does the society want the PuT system to fulfil? Many cities just have minimum standards of PuT service. The task of PuT in other cities can be to relieve car traffic congestion, and to improve the transport efficiency of the city. **In the TOD2 handbook, the main emphasis is on attractive PuT that can outcompete the automobile.**

The TOD2 handbook picks cherries of various cakes cooked by PTAs and private consultants, to inform TOD planning. TOD seeks to transform cities and prioritize PuT from a scale of street, to development of station areas, PuT lines and corridors to effective PuT networks. The knowledge, concepts and conceptualizations are often anecdotal and collaged in diagrammatic posters eclectically mixing theories, methods and approaches to make a story. **The success of TOD2 as a sequel of (the Hollywood blockbuster) TOD depends on the quality, wit and clarity of the story.**

TOD2 also recognizes the need for heroes (and antiheroes) in developing TOD visions and scenarios. Anyone can be an urban designer and transit planner, and everyone is shaping cities (like it or not). Urban designers come from a variety of disciplines, usually drawn from professional design-oriented disciplines such as architecture, landscape architecture and (paradigms of) urban planning. **Grand visions and (super)heros can trigger changes! (not only in Hollywood blockbusters)** This TOD handbook includes short chapters of PuT hacks and UD tips for developing TOD visions for future sustainable cities. The PuT hacks session starts with lines, stops and ends with designing networks. The UD tips section starts with the conventional TOD1 pearl approach and expands to the human scale and audio-visual perception of the TOD2 amoeba, TOD2 corridors and mobility hubs. Some cities plan towards more adaptive PuT lines and networks, whereas other city governments prefer fixed PuT infrastructures where the city adapts to the PuT network. The following subsections discuss both visions as quick PuT hacks, UD tips and TOD interventions.

The TOD2 handbook is written for layman, and the motto is “Make it simple!”. The importance of “simplicity” is both in providing easy-to-use travel information, and also enable passengers to have pleasant and smooth travel experience along PuT corridors and in the whole network that can be hierarchical and very complex. **Highlighting the important information and delivering concise sets of diagrams, timetables and maps.** This help with the cognitive load and stress of sharing vehicles and orienting along lines and at transfer point.

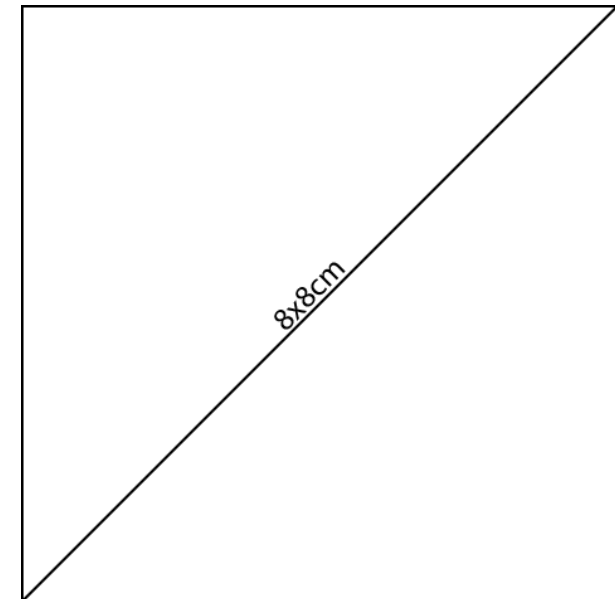


Figure 20: THE GRAND 8x8CM TOD2 VISION? (↑)

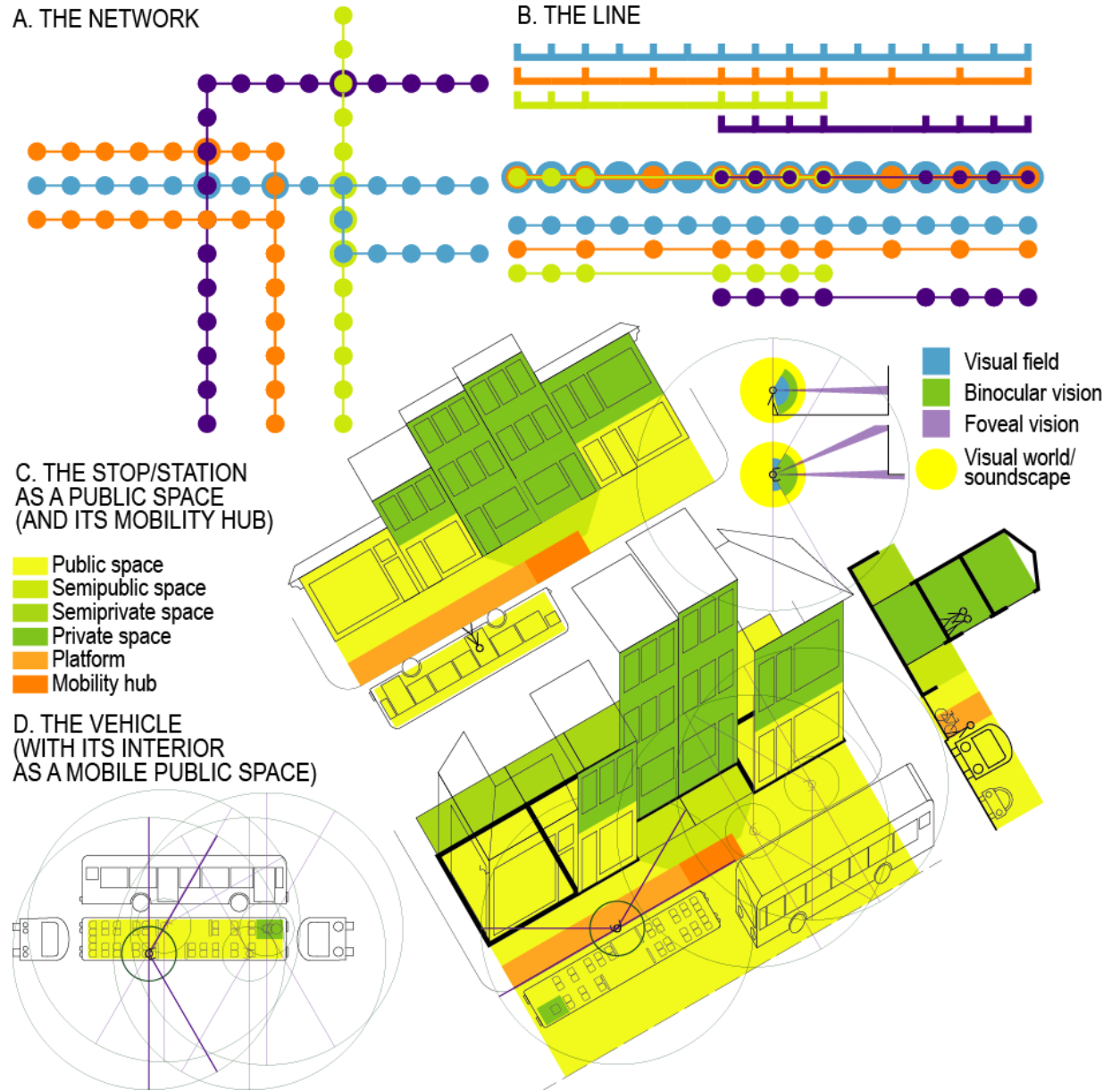
Public transport (PuT) hacks

In this TOD2 handbook, transit and Public Transport (PuT) are used interchangeably to define not only the transport system of vehicles, lines and depots, but also the mobility culture or taking a public train or bus.

Figure 21: PUBLIC TRANSPORT (PUT) SCALES (→)

The TOD2 handbook suggests a number of PuT hacks based on the Scandinavian tradition and the #StockholmSchoolOfTransit and selection from transit manuals. It structures PuT elements at scales: A) the network (TOD typically considers a regular trunk-feeder network, but there are other networks); B) the line as a composition of stops/stations and segments and as a mobile community (TOD considers the station as the center of the urban growth radius, the TOD pearl); C) the stop/station and its interactions with the street as public space and its mobility hub; and D) the vehicle and its interior as a mobile public space. The PuT elements correspond to morphological Urban Design (UD) scales. The PuT network covers the city and its region. The lines define corridors and sectors of the city. The station as a public building creates indoor and outdoor public spaces. The transit vehicle is seldom considered an element of TOD even though they are the densest public spaces in cities. *The TOD2 handbook seeks to coordinate all the elements at various scales into a complete vision for attractive PuT that can offer quick and pleasant journeys between stations and TODs.*

TO BE COMPLETED



Lines shaping cities

To make public transport work, many passengers need to travel along the same line, at the same time (Karl Kottenhoff)

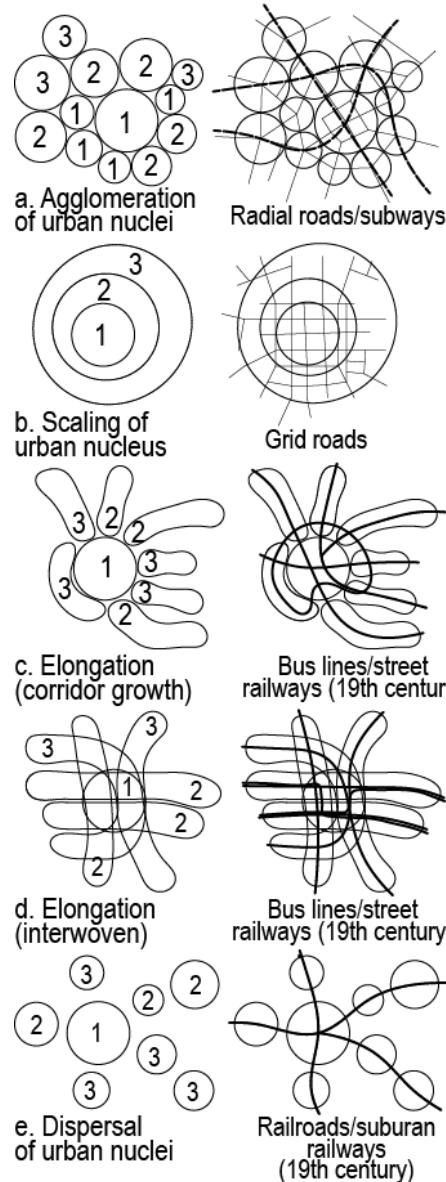
Frequency means freedom! (Jarett Walker)

Public Transport (PuT) emerged from the need to connect destinations in the vibrant, industrializing cities in the 19th century. Transport companies, innovators and entrepreneurs prototyped various kinds of vehicles and established PuT lines with omnibuses, streetcars/trams, suburban railways, cable cars, and subways competing for access to attractive destinations. Construction companies laid rail tracks into the countryside speculating on land values and developing suburbs around rail stations. The PuT had a profound effect on the growth of cities in the 19th and the early 20th century with corridor (sector) growth or dispersal of fragmented suburbs like pearls on a string. The PuT lines that shaped these neighborhoods and communities intertwined with their urbanity. There is nostalgia even if the line was removed.

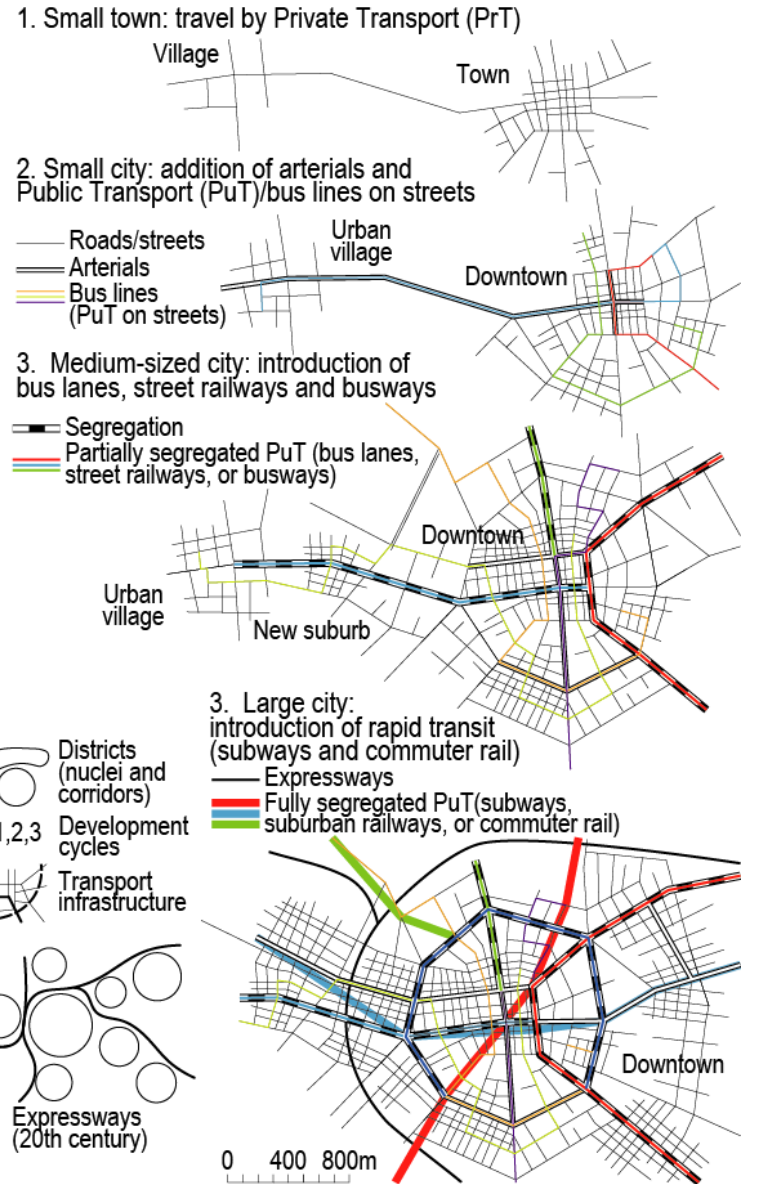
Figure 22: IDEALIZED URBAN GROWTH MODELS AND EVOLUTION OF TRANSPORT SYSTEMS (→)

The PuT line is a sequence of destinations and stops that creates a mobile community. The vehicles collect and distribute passengers that travel along the same line, at the same time. Capacity is defined by the number of passengers that the vehicles can transport along a line at certain period of time (typically in one hour). The maximum vehicle capacity can be defined by the number of seats, or the sum of passengers standing and seating in a vehicle. The transit agency can

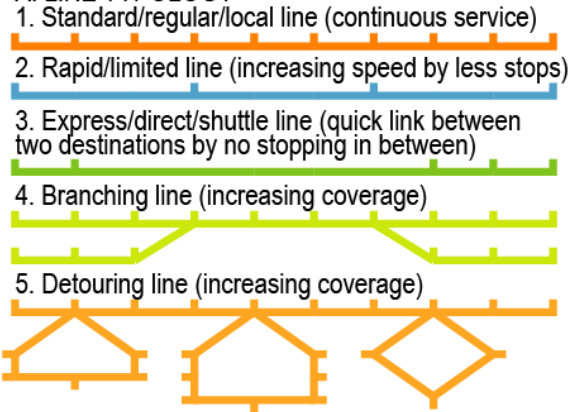
1. URBAN GROWTH MODELS



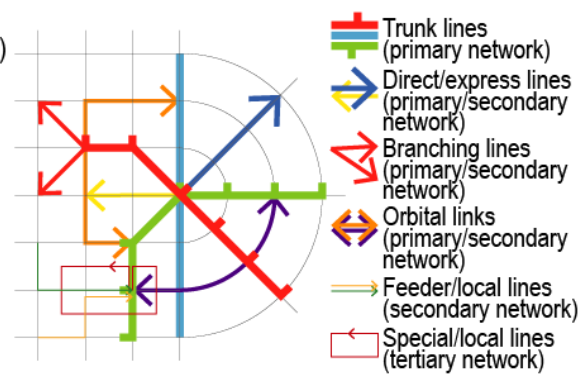
B. EVOLUTION OF TRANSPORT SYSTEMS (VUCHIC, 1980)



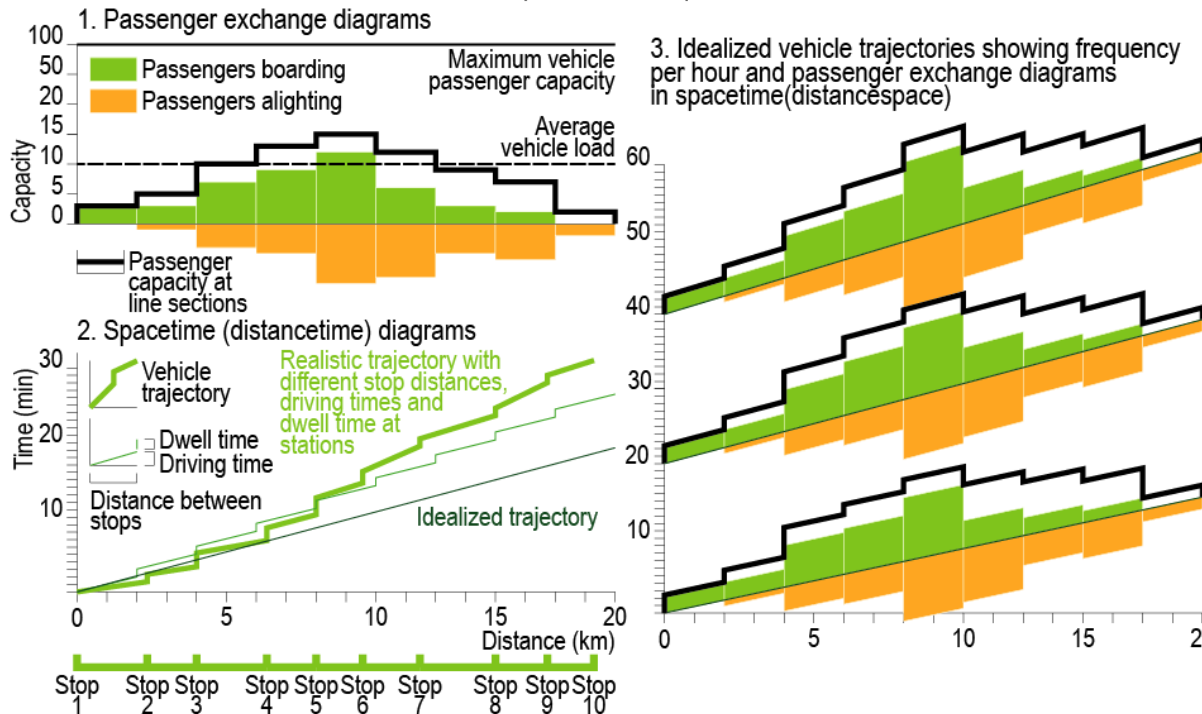
A. LINE TYPOLOGY



B. LINE TYPOLOGY (BY NETWORK HIERACHY)



C. DIAGRAMMATIZING LINE CAPACITY (VUCHIC, 2005)



accept “one seat for passenger” (particularly on commuting lines from the suburbs by direct bus lines that lack the ride comfort of trains) or can set maximum vehicle capacity for specific lines.

The line is the fundamental element of PuT planning and design and there are different kinds of lines depending on the design/geometry, capacity, stop spacing and stopping pattern as well as the position in the hierarchy. **The standard/regular line** is uniform and stops at every station. **The rapid/limited line** highlights few important destinations and increases operation speed. **The express/direct line** creates a quick connection between two major destinations by not stopping at stations in between (a shuttle line typically connects two destinations). There are also branching and detouring lines that seek to increase coverage, while decreasing operation speed. The line also plays different roles in the hierarchy. **The trunk lines** have high frequency and operate at high speeds to create a primary network of passenger flows. The primary network is supported by **branching lines, orbital links, feeder and special lines** that create secondary and tertiary networks to increase coverage and collect passengers that are not located at prime transit locations.

Figure 23: **LINES, DESIGN AND CAPACITY** (→)

There are several hacks for designing successful PuT lines. First, **each PuT line has unique character and role to play in the hierarchy**. There should be a clear differentiation and designation for the lines in the hierarchy. The lines should have logical number and name that will be part of the character and identity. Numbers as 1, 2, 3 etc. should be kept for the main lines. Specific corridors

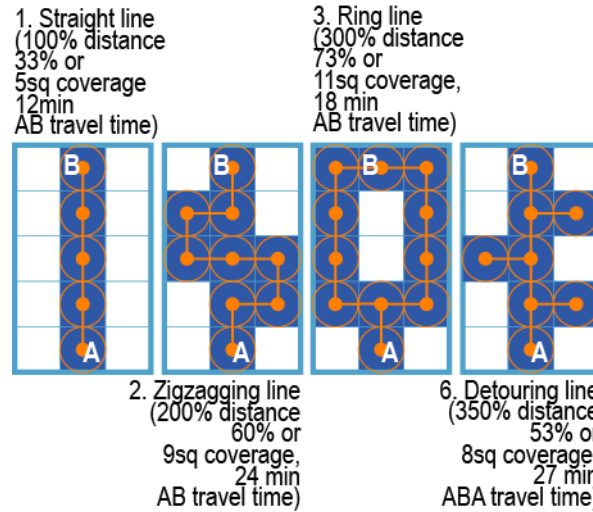
should have unique numbers (lines As for corridor A and Bs for corridor B, lines 60s, lines 610s, etc.) In Stockholm, direct trunk bus 670 is also known as (blue) Vaxholm's bus, while direct line 676 is known as Norrtälje's bus and they share the same trunk of 670s line. In the past Vaxholm's buses operated blue articulated double buses while Norrtälje buses were blue doubledeckers making possible to visually differentiate between them before seeing the number and destination. Choosing a special color or type of vehicle helps with line identity.

Figure 24: LINES, SHAPES AND STOPS (←)

Secondly, the service on **the PuT line should be as speedy as possible**. Speed increases with straight lines, segregated infrastructure, increase of distances between station and rapid/direct services. Turns and loops should be avoided, particularly 90 degrees turns (that influence also driving comfort) or repetitive passing in circular lines. Furthermore, speed in PuT includes a "whole journey" perspective where walking and waiting, and walking distances can prolong or shorten the perception of time and speed depending on pedestrian experience.

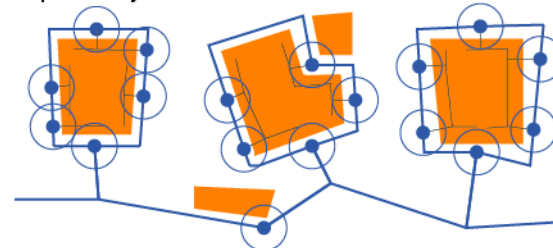
Thirdly, the **PuT line should be as straight as direct as possible connecting a set of (important) destinations and transfer nodes with shortest links**. The line is the underlying element of PuT systems, in a same way that the street is the underlying element of urban form. But unlike streets that are rigid and inflexible (due to adjacent lots and buildings), the PuT lines achieve a robust status only with direct connection (as the bird flies) between the sequence of destinations.

A. LINE TYPOLOGY (I, S, O/Q, E) BY DIRECTNESS AND COVERAGE

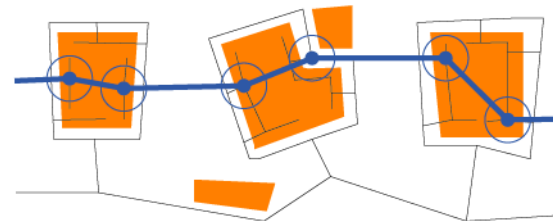


B. PROBLEMS WITH FITTING THE TYPOLOGY

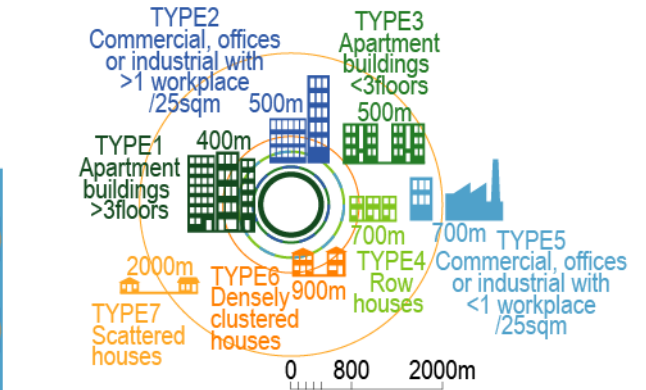
1. Detouring lines serving sprawled suburbs along expressways and arterials



2. Fitting straight lines requires major changes in the road infrastructure



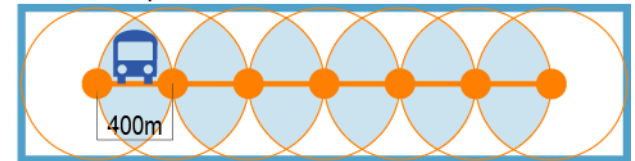
C. WALKING DISTANCES AND STATION SPACING



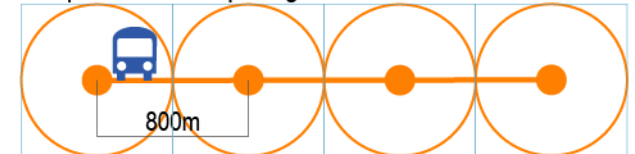
D. OPTIMIZING STATION SPACING

With a normal walking speed of 5 km/h or 80m/minute, it takes 5 minutes to walk 400 metres. 400m/5min/walk

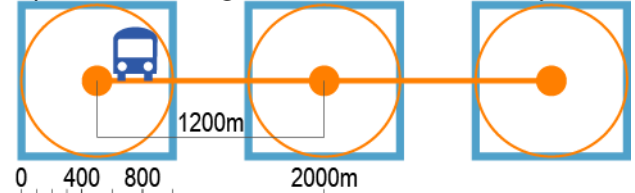
1. Decreasing distances between stations will lower speed and overlap catchment areas, but there is potential for TOD2 corridor creation



2. Optimal station spacing for catchment areas

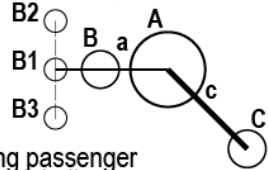


3. Decreasing distances between stations will increase speeds, but will fragment the corridor into TOD1 pearls

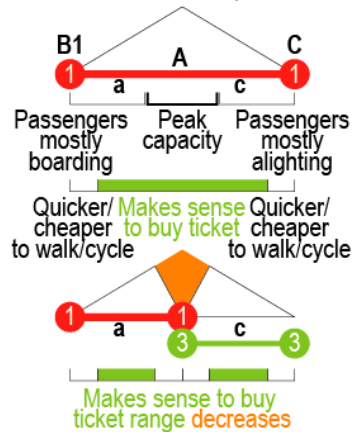


A. PASSENGER FLOWS AND LINE ADAPTATIONS

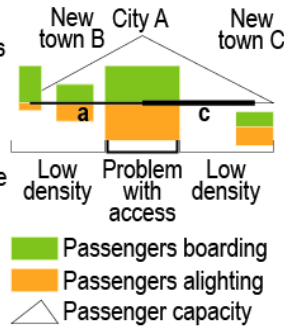
1. Example line connecting city A with new towns B and C



2. Understanding passenger flows and line metabolism (avoid short lines and design pendulum lines that swing between destinations)

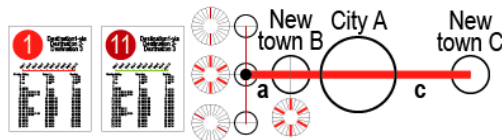


3. Improve density at the ends of the lines by new urban development and improve access and speed (by introducing segregated infrastructure) in cities

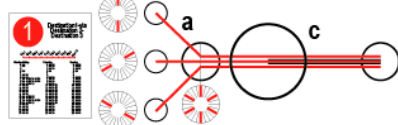


4. Feeding and branching lines

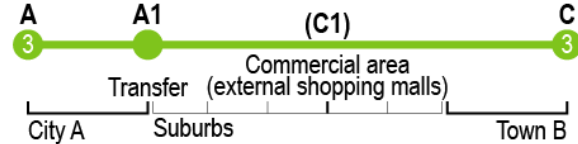
a. Trunk-feeder connections (one trunk with feeder lines, two timetables and transfer)



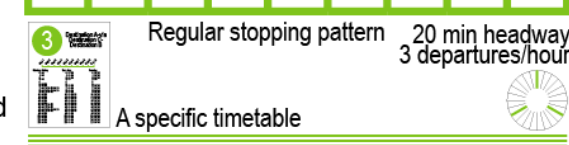
a. Branching trunk line links (increases coverage, under the brand of the trunk line)



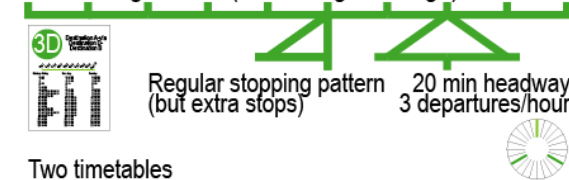
B. TRADEOFF BETWEEN SPEED AND COVERAGE



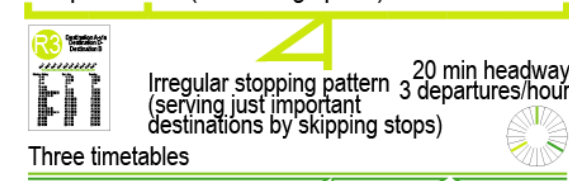
1. Standard line 3 (continuous service)



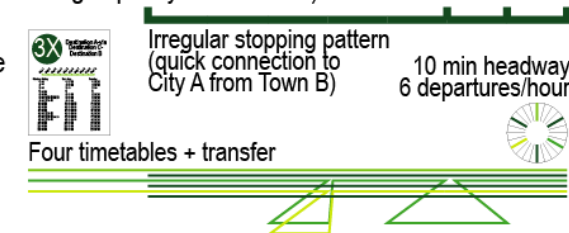
2. Detouring line 3D (increasing coverage)



3. Rapid line R3 (increasing speed)



4. Express/direct line 3X (increasing speed and adding capacity in rush hour)



Fourthly, it is important to understand the trade off between line character, speed and coverage.

Different lines have different priorities. **The PuT lines in the primary network should operate a minimum threshold 6 departures/hour (or 10min headway) at main corridors in small towns or in low density suburbs.** PuT lines with frequencies of 6–12 departures per hour (5–10 min headway) will allow customers to “forget the timetable” and walk to the transit stops without considering departure times.

Higher frequencies can be achieved by conjoining several branches into one trunk lines (2 lines with 20 min headway and 3 branching lines with 30 min headway will produce maximum 10-minute headway on the trunk. There are tradeoffs between speed and coverage for secondary and tertiary networks. **A line may have** different frequencies on different sections. This allows for the adjustment of capacity to varying demand along the line. Coverage increases with detours and branching, while speed with introducing rapid and express lines and branching. If the market base along the route varies considerably, it will be better to divide the line into separate lines. Then the lines may be run by different types of vehicles resulting in more efficient use of capacity. Each “subline” (R for rapid, D for detouring, X for express, etc.) will then also have its own timetable, so that a section of the route may be without any service at certain periods.

Figure 25: LINES AND FLOWS, TRADEOFFS BETWEEN SPEED AND COVERAGE (←)

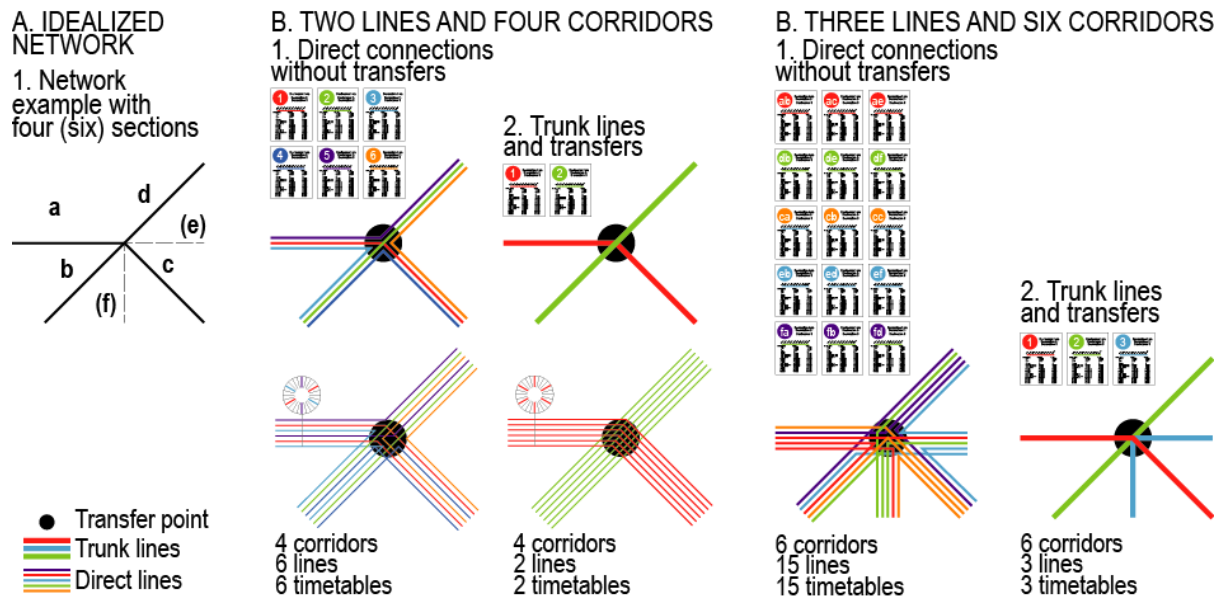
Fifthly, the line metabolism of passenger exchange shapes the length of the line. Passengers tend to board in the start of the line and alight along the way and there is a peak capacity. **The line should not be very short or very long.** The is an optimal length of

the line as distance and travel time. The line should not be shorter than 5 km. It is often difficult to justify paying fare for distances within 1 and 5 km if there is walking or biking as alternative. **The PuT line should not be shorter than 30 minutes of longer than 45 minutes.** Accepted travel distances are between 30 and 45 minutes.

Figure 26: NETWORK PRINCIPLES OF CONVOYING LINES (NO TRANSFERS) VS TRUNK-FEEDER TRANSFERS (→)

Sixtly, **the PuT lines should have clear and smooth transfer points.** There should be major nodes specifically designed to facilitate transfers between lines and/or modes with possibility to exchange over platform. Changes between vehicles may also take place at ordinary stops, but we designate stops as interchanges only when they offer clearly different travel directions and have physical facilities and information systems that support passengers when they transfer from one line to another. Long walks during transfer can be hard. Alternatively, in cities that highly penalize transfers there is a possibility to introduce conveying lines. The BRT systems in Bogota and Brisbane are examples of many “no transfer” lines conveying (and often bunching) in different corridors and widely distributing passengers in the suburbs.

Sevently, each line should have customer friendly information design. **Lines and their stopping places, timetables, fares and ticketing systems and information systems must be integrated to form a single, understandable, user-friendly and efficient system.** It is important to simplify and standardize information with uniformity and clearness of design as well as coherent and

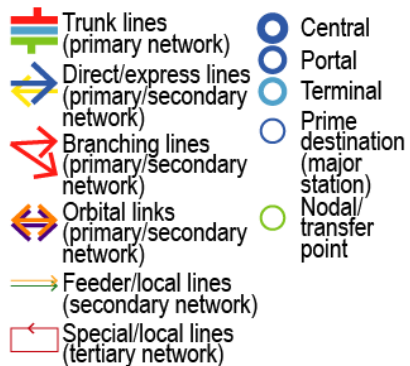
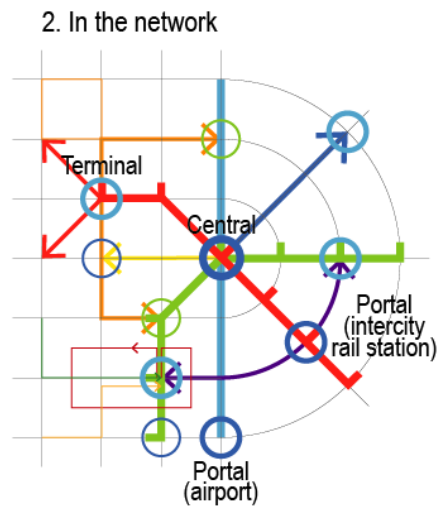
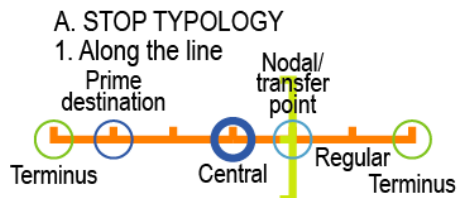


homogeneous information by symbols, names, vocabulary, layout etc., Integrate information about the city and the PuT system through location and naming of lines, stations and stops, and on maps and diagrams. Use one common well-known name for all stops in the vicinity of each other, irrespective of mode, operator and line. Information about the exact locations of the different stops should be provided at a more detailed information level.

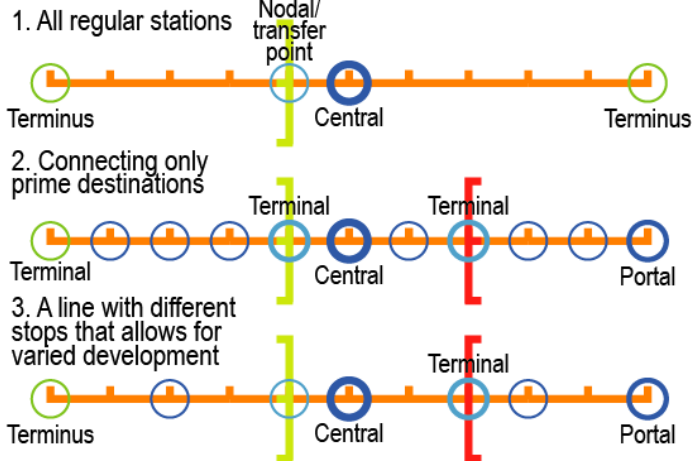
Eightly, **PuT lines create a mobile community** of passengers, drivers, security officers, traffic control staff, etc. Passengers experience the line as a sequence of transit stops and stations. But for the drivers, the line is a journey to the depot, a journey from the depot to the first station and layover time at the terminus. The drivers and conductors are crucial for social interaction with passengers as

customers and feeling welcome while traveling. The depots should be strategically placed along transit corridors and neighborhoods who will not only provide drivers and conductors, but the drivers feel attached to certain lines and the community that it serves. TO BE COMPLETED.

In the end, to succeed in the transport market, the PuT system must offer a network that ideally integrates all lines and stops with the activities in the city.



B. CREATING LINES WITH DIVERSITY OF STOPS



C. PINNING STOPS IN CITIES

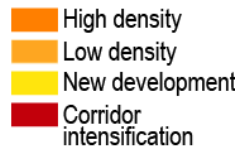
1. Centrality matters (avoid peripheral locations)



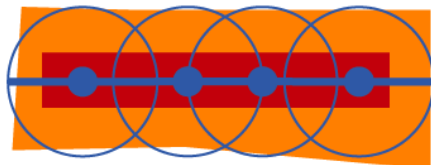
2. Density is important



3. Development (potential) can create infill opportunities



3. Stations spaced closely create corridors (but speed suffers)



Pinning stops

The transit stop is an overlaying element of Public Transport (PuT) line. The stops/stations consist of exits/entrances, platforms, corridors, overpasses, underpasses, kiosks and commercial spaces, public spaces, etc. that allow for transfers between PuT lines and act as nodes in the PuT network. Their complexity and size vary. There is nothing more trivial than a bus stop in a city and there should be nothing larger and more luxurious than the central rail station.

Figure 27: **STOPS AND CITY PINS** (←)

The position of the stop/station in the line and network defines its character and hierarchy: regular, nodal (interchange/transfer point), terminal, as well as portal or central stations (in the network), etc. Nodal stations are interchanges on the intersection of two or more PuT lines and terminals or terminuses are the end stops/stations of the lines. Portals are stops that serve as entrance points to the network such as airports, ports or intercity rail stations where flow of passenger arrives from another city by air, water, rail or road. **Lines should be designed with diversity of stops.** The stop defines the center of Transit-Oriented Development (TOD) and it acts as a trigger for urban development. Diverse transit stops will inspire varied TODs along the lines. The transit stops, particularly portals, large terminals and interchanges are important public buildings and destinations that attract many passengers and attract commercial development.

TO BE COMPLETED

Designing networks

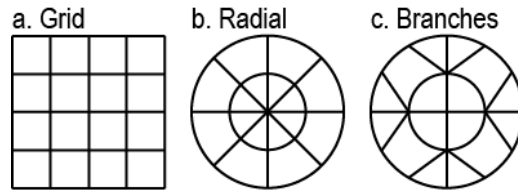
The Public Transport (PuT) in the 19th century created profitable lines and cities developed in proximity to the stops and stations. But the cities sprawled with rapid urbanization driven by individual mobility and the flexibility of the private automobile and the road system that evolved a hierarchy of expressways and access roads. In a vicious cycle, densities decreased everywhere, and PuT lost its profits deterring business. There was a need for a system perspective on the city in its region that sprawled and grew dependent on automobiles. In the 20th century, transit agencies or Public Transport Authorities (PTAs), consultants and academics devised ways to optimize lines and networks, conceptualize and collect fares, produce timetables and system maps and assess willingness to walk, wait, and make transfers between lines.

The TOD2 handbooks presents a variety of networks that might be collaged with local morphology traditions into future PuT networks. Each city is unique in its urban growth as agglomeration, scaling (expansion), elongation (sector growth) and dispersal of urban nuclei (town and village centers, new towns, etc.). Designing PuT networks should follow the historical urbanization and local traditions that shaped the morphology of cities. **The shape of the PuT network follows cultural preconditions shaped by PTA traditions and historical urbanization.**

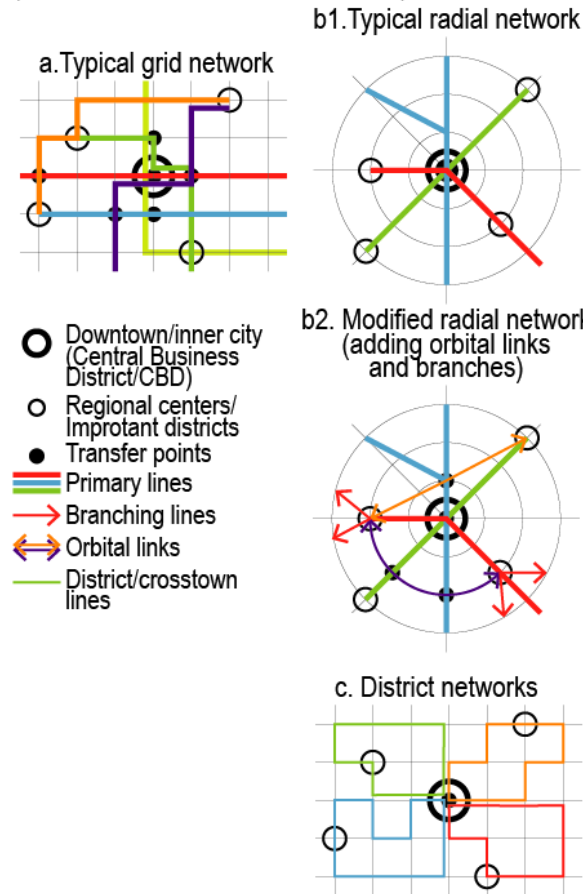
Figure 28: **IDEALIZED NETWORKS AND TRADEOFFS BETWEEN ADAPTIVE AND FIXED (→)**

Robert Cervero discusses four types of *transit metropolises: adaptive cities*, cities with *adaptive transit*, hybrid cities which are *adaptive cities with*

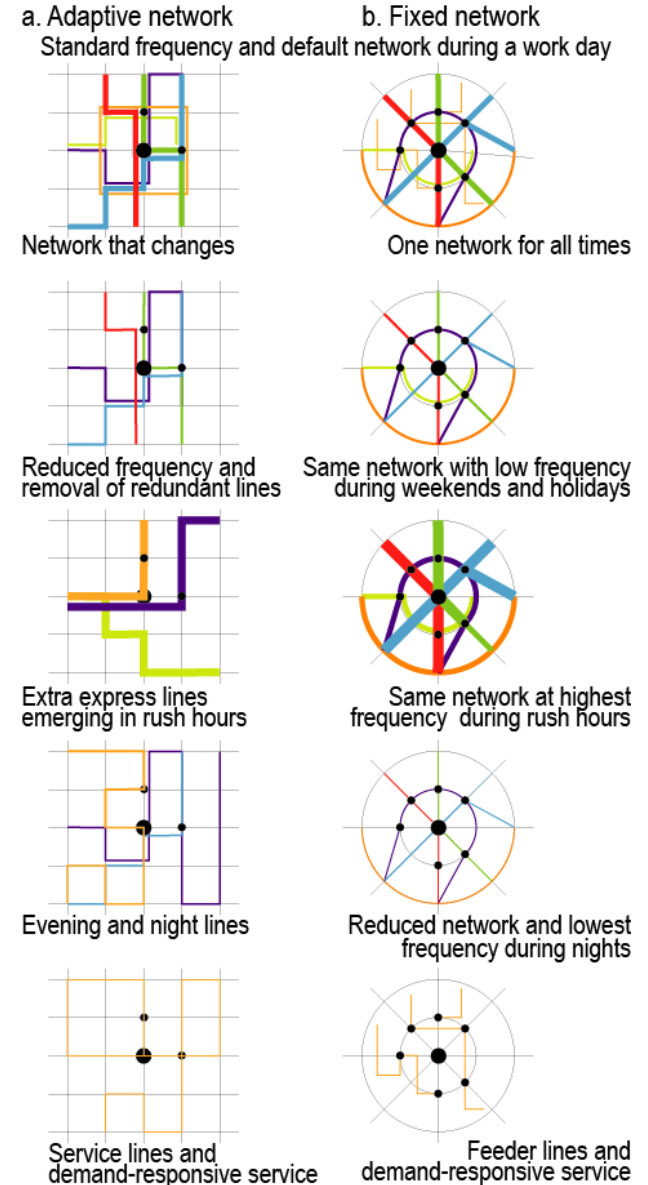
1. IDEALIZED URBAN NETWORKS



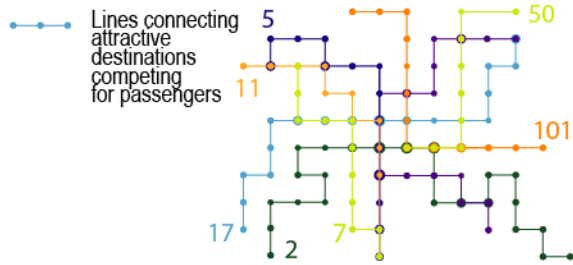
2. PUBLIC TRANSPORT (PuT) NETWORKS (CANADIAN TRANSIT HANDBOOK)



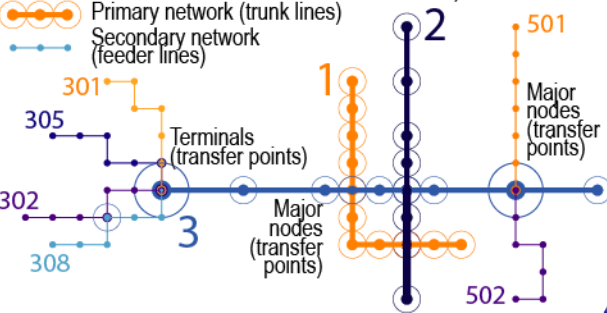
3. ADAPTIVE AND FIXED NETWORKS



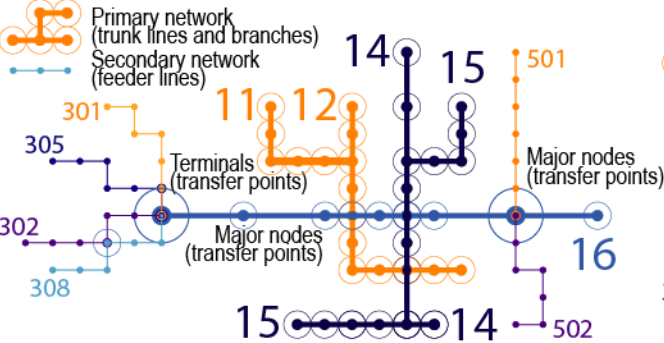
A. DISCONNECTED NETWORK (19TH CENTURY INDIVIDUAL LINES MODEL)



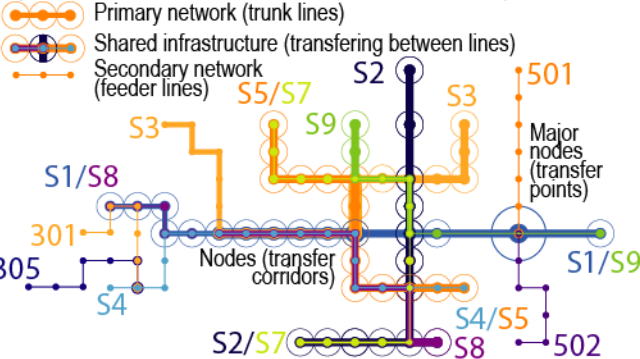
B. TRUNK-FEEDER NETWORK (EUROPEAN MODEL, E.G. LONDON, PARIS, CURITIBA'S BRT)



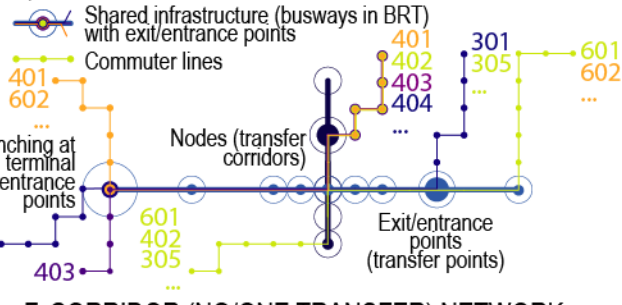
C. TRUNK-FEEDER (BRANCHING) NETWORK (EUROPEAN MODEL, E.G. STOCKHOLM)



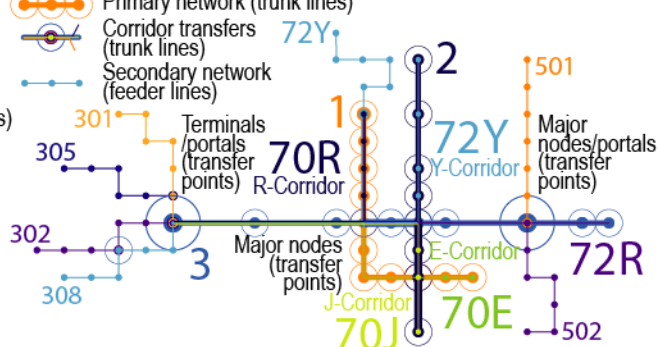
D. TRUNK-FEEDER (ONE TRANSFER) NETWORK (EUROPEAN MODEL, E.G. BERLIN S-BAHN)



E. COMMUTER (NO/ONE TRANSFER) NETWORK (AUSTRALIAN BRT MODEL, E.G. BRISBANE, ADELAIDE)



F. CORRIDOR (NO/ONE TRANSFER) NETWORK (E.G. BOGOTA'S BRT, KARLSRUHE TRAM-TRAIN)



adaptive transit and cities with *strong cores* where the urban activity in the urban cores dominates the urban region. Stockholm and Copenhagen are examples of *adaptive cities*, Karlsruhe is an example of a city with *adaptive transit*, Bogotá is an *adaptive city with adaptive transit* and Zürich is a city with *strong urban core*. Many different regional models are workable according to HiTrans. Nielsen et al., discuss two models. the Demand-oriented Bangkok where the public transport adapts itself to the needs of travelers often with paratransit (taxibuses, jitneys, motorcycle taxi, tuk-tuks, etc.) where the network is tailored and adapted to changing needs, and supply-oriented Zürich model where the supply/network is fixed and the users/customers/travelers and the city and its urban development and growth adapt to the PuT service. Jarett Walker discusses a spectrum between flexible, tailor-made network designs that adapt to ever-changing demand in cities and fixed network that seeks to localize urban growth.

Figure 29: PUBLIC TRANSPORT (PuT) NETWORK MODELS IN DIFFERENT CITIES (→)

When designing or conceiving a PuT network it is important to combine structural stability with market adaptability. Few high-speed fixed lines can compete with the private car at main transport corridors, where PuT can influence urban growth but also allowing for commuter direct bus lines that can compete with the private car on expressways. **The TOD2 handbook recommends a combo of a fixed network as system map and a flexible network that captures changes in demand (express, feeder and special lines).**

Every city is unique on the flexible (no transfers) and fixed (trunk-feeder) network spectrum. The network planning starts with a **simple and legible primary network with few lines**. It is important to highlight the fixed network and heavy infrastructure at main transport corridors in the future where PuT will compete with private automobiles. The first step is to identify all main corridors and design a PuT network with as few high frequency (pendulum) lines as possible. *Few high frequency and high speed (regional) lines (ideally between three and seven) should create a system map, with one line (that can branch out) operating in one main corridor.* In the second step it is important to look for suitable tangential routes or corridors that might work together with the primary network to form a more complete network for the city region through the integration of services and interchanges. **The flexible lines supports the fixed network!** Analyze the possible roles of different rail modes and different types of bus line operations to figure out how access to the trunk line network can be improved through bus service improvements, interchange development, development of mobility hubs, the provision of bike-and-ride and park-and-ride facilities, and through the improvement of roads for bicyclists and pedestrians.

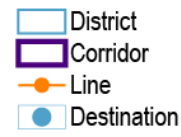
Figure 30: UTILIZING THE **NETWORK EFFECT** (→)

Exploit the network effect! When the aim is to compete with the private car two crucial qualities of the system are short waiting times between departures and an integrated network of services between all areas of significant transport demand. A system without these two qualities can never be a real competitor to the car as the main mode of transport. The key concept is the “network effect” or

NETWORK EFFECT HACKS! (ADAPTED FROM MEES, 1996)

A1. DISCONNECTION CREATES PROBLEM!

There is an idealized 19th century town where transport entrepreneurs have established five Public Transport (PuT) lines to interconnect with different districts. The frequency of PuT is 10min and it competes with Private Transport (PrT) ideally. The Travel Time Ratio (TTR)=1.5 and 50% of the journeys are done by PuT, 50% by driving autos. Each district generates 100 journeys and attracts 100 passengers that are distributed proportionally to all the districts. Each of the 25 districts attracts 4 passengers and they equally split between PuT and PrT (2 passengers travel by PuT). Since the PuT network consists of five disconnected lines, every line serves five districts in the town, the number of passengers on the line will be 40 (2 passengers going to 4 districts = 8 passengers * 5 districts = 40 passengers). 20 passengers walk locally in the five districts and the remaining 440 journeys will be made by automobiles. Out of the 2500 journeys on the network, 100 will walk, 200 will use PuT and 2200 will drive. The modal share will be 8%.



A2. FREQUENCY MATTERS!

If the frequency of PuT doubles and there is 5min minute. Elasticity is a measure that expresses the percentage change of one responsive travel variable as response to one percent change of an explanatory urban form or travel variable. The elasticity of increased frequency is 0.5. If we double the frequency, we can expect to get 50% more passengers (300 journeys) and the modal share will increase to 12%.

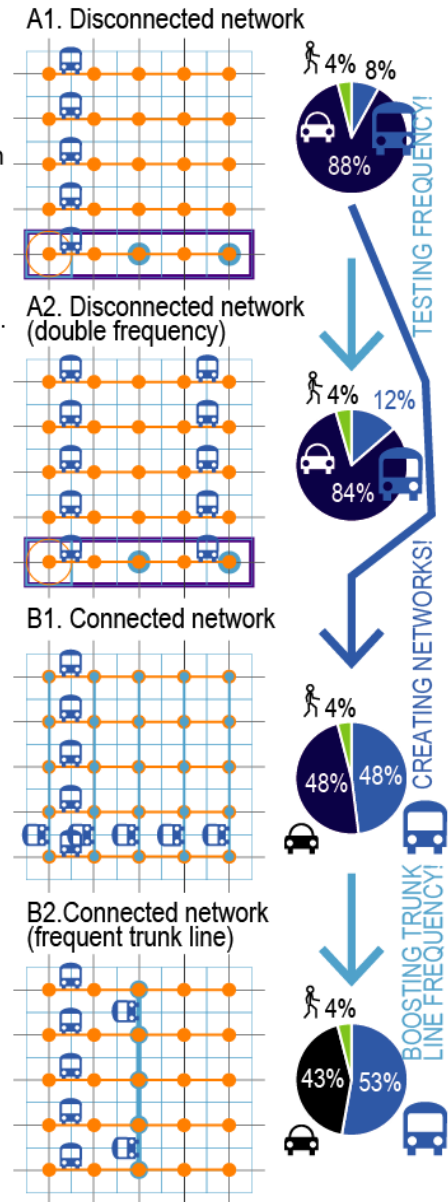
B1. HARNESING THE NETWORK EFFECT!

If the disconnected network of five lines is intersected by perpendicular lines, it will create 25 transfer points and passengers can access all the districts in the town with only one transfer. Then each district will generate 2 passengers going to 24 districts = 48 passengers * 25 districts = 1200 passengers. Out of the 2500 journeys on the network, 100 will be walking, 1200 will use PuT and 1200 will drive and the modal share of PuT will dramatically increase to 48% (SIX TIMES!!!).

B2. BOOSTING TRUNK LINE FREQUENCY! NETWORK OPTIMIZING!

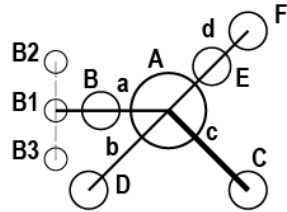
If the five perpendicular lines join in one central trunk line with double frequency of 5 min, there will be 5 transfer points and the network access will have two transfers, but there will be 50% bonus in 5 districts (24passengers * 5 districts = 120 passengers that will shift from PrT) because of higher frequency elasticity. Then 100 passengers will walk, 1320 will use PuT and 1080 who will drive out of 2500 that translate to 52,8% modal share for PuT (with less operation costs).

NOTE: The calculations consider idealized town and ideally competitive PuT service. The size of the town or city matters for networks and the conditions for PuT are not always ideal. In a city with 100 districts, where a 10 PuT lines serve 10 districts (Paul Mees example), the share will drop down to 4% (4.5 passengers going to 9 districts = 40 passengers * 10 districts = 400 out of 10000 journeys in the network). A typical region can have hundreds of districts, and a PuT line can connect up to 30 districts.

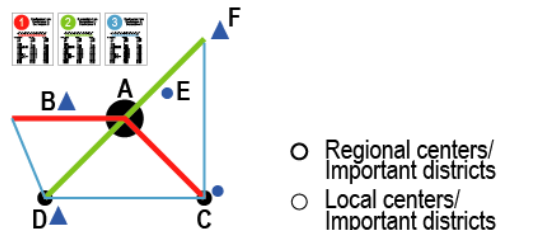


A. NESTED NETWORKS/SYSTEM MAPS AT VARIOUS SCALES

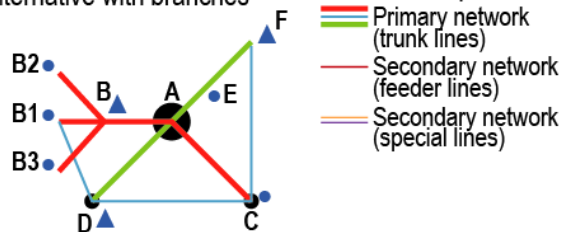
1. Example of city A with new towns B, C, D, E and F



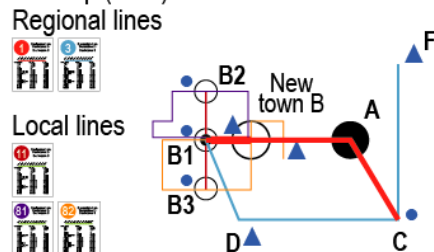
2a. System map (regional) alternative without branches



2b. System map (regional) alternative with branches



3. System map (local) alternative without branches



creating a network of disconnected PuT lines by enabling seamless transfer between the lines. If more points are connected in a network with high frequency PuT service, the effect increases. The private automobile has 100% network effect (on its maximum), because every point of the network is accessible by any point in the network around the clock. High frequencies in the entire network would create a “network effect” that means every destination can be reached from every origin. This can be achieved by delimiting the growth of the city only within the station areas of PuT lines with high frequencies (trunk lines served by feeder lines to boost the network effect) or creating specialized PuT lines that connect residences and jobs (commuter lines, special lines or on-demand services). In the first case, the city adapts to the PuT network, and in the second, the PuT network adapts to the travel demand of the city (there is no sense of a network, but the PuT system creates a system that like the private automobile links many origins with destinations). To strengthen the network effect, **locate important destinations (public spaces, open spaces and regional services such as hospitals, high schools, universities) at regional transit nodes.** The network creates nodes and poles. Public spaces, landscape/green spaces and commercial activities (as a combinations) are both transit-supportive and the lifeblood of the public domain. PuT is very efficient feeder of commercial centers with loading platforms taking much less space than parking lots).

The PuT primary network cannot make compromises on speed. Fast and punctual operations at the highest possible speed (mix of trunk and direct lines) are a key factor. The

operational speed determines both the cost efficiency and the attractiveness of the PuT. Network planning must find ways to concentrate resources to enough high frequency lines that form a travel network that caters for a major part of the demand for motorized transport in the city region. **Frequency is freedom!** The optimum frequencies of some 6–12 departures per hour will allow many customers to “forget the timetable”.

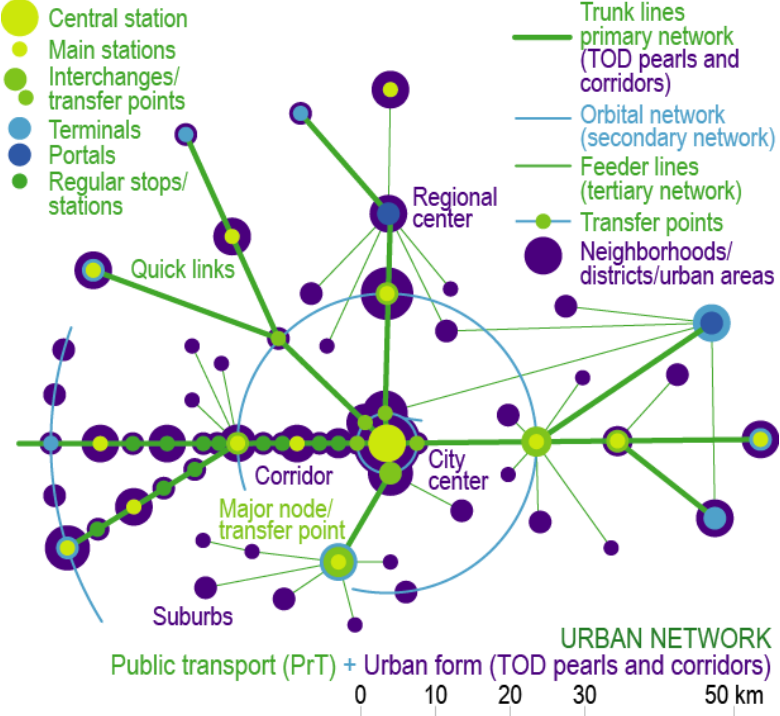
Make use of analytical tools for the assessment of solutions and development of scenarios such as accessibility analysis and trip generation models, corridor analysis and scenario development, impact studies and elasticity modes. High quality PuT can only be achieved through good decisions based on analytical assessments of solutions founded on sound theory and knowledge of the real world.

The networks are typically nested throughout the hierarchy. **The PuT must have a legible system map at various scales highlighting main lines, corridors, destinations and transfer points.** It is not only important to create a system map of the city region, but also to look at networks at local scales. The secondary network also creates a smaller “system map” with lines and transfer points (regional nodes) to the primary network. It is important to link important destinations.

Figure 31: NESTED NETWORKS AT REGIONAL AND LOCAL SCALE (←)

TO BE COMPLETED

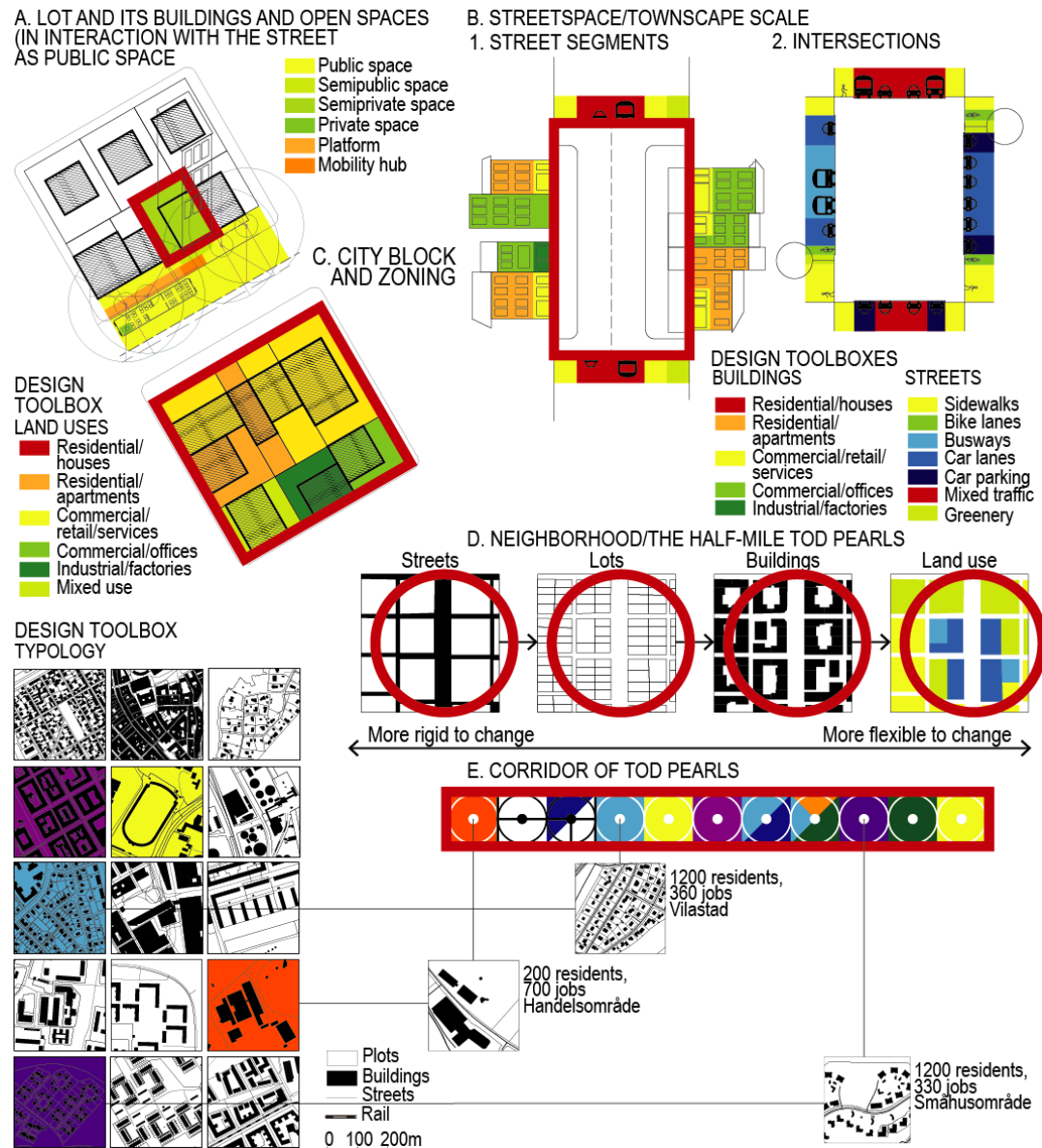
Figure 32: **STOCKHOLM'S "SATELLITE MODEL"** HAS A CENTRAL STATION, WITH IMPORTANT TERMINALS AND ACCENTUATES EVERY THIRD STATION AS NODAL (INTERCHANGE/MAJOR TRANSFER POINT) WITH MIX OF LAND USES AND A LOCAL SHOPPING CENTER. (→)



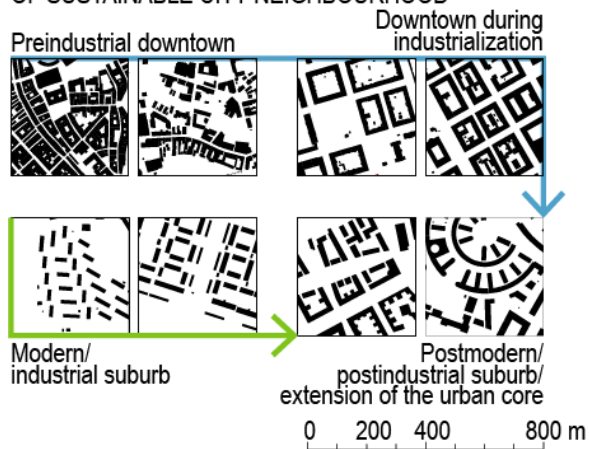
Urban design (UD) tips

Urban Design (UD) is defined as the art of making and shaping cities by creating compositions of elements in physical space. **TOD2 pursues an eclectic perspective in development of utopian visions of future PuT with mobility hubs and TOD design guidelines continuing Peter Calthorpe's tradition.** TOD2 handbook cities considers nested scales for analyses and design of TODs: A) lot/parcel with its buildings, interacting with the street as public space within a city block (it can be referred as small scale lot-by-lot or parcel-by-parcel urbanism), B) streetscape, the 3D extend of the street segment through interactions with the elements of the city block front (typically involving plan, street section and frontage or axonometries as representations); C) city block (zoning and land uses) in interaction with the street/route pattern and PuT infrastructure and its hierarchy; D) neighborhood or the half-mile TOD pearls as patterns of city block, street/route and PuT infrastructures, E) corridors as patterns of TOD pearls and typology of neighborhoods characterized by a morphological structure (patterns of streets, lots and buildings); and F) the city as constellation of neighborhoods (typo-morphologically classified) interconnected by major road and PuT infrastructure (shaping the public mobility culture). Two perpendicular TOD corridor with their main PuT lines and their secondary network that feeds passenger can delineates a section of the PuT network that can be evaluated as intermediary local scale between a single corridor and the whole regional network.

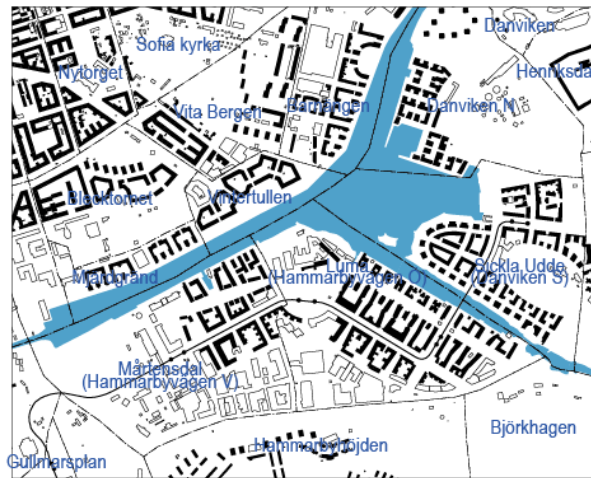
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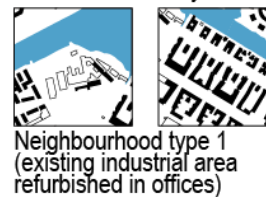
A. THE URBAN PATTERN OF HAMMARBY SJÖSTAD AS A PROTOTYPE OF SUSTAINABLE CITY NEIGHBOURHOOD



B. MAP OF HAMMARBY SJÖSTAD



C. CLASSIFICATION OF NEIGHBORHOOD TYPES IN HAMMARBY SJÖSTAD
Neighbourhood type 2 (new mixed use partially enclosed city blocks)



- Commercial/industrial buildings
- Residential buildings
- Tvärbana (light rail system)
- Water
- Administrative borders

apartments and sustainable city neighborhoods and Hammarby Sjöstad is a Swedish prototype and model for development. Morphologically the urban pattern of Hammarby Sjöstad is a postmodern combination of the downtown pattern of the preindustrial period and period of industrialization with elements of a modern suburb pattern. The development pattern is repeated widely with small variations both in large and small cities across Sweden as a city block model. The replications are sometimes at a scale of city block without multimodal boulevard and PuT axis that hinders sustainable mobility. **There is always a dominating neighborhood type that addresses the housing crises and mobility challenges of the age.**

Figure 34: MORPHOLOGICAL REFLECTION ON THE PERCEPTUAL EXPERIENCE AND HISTORICAL INFLUENCES OF HAMMARBY SJÖSTAD AS SUSTAINABLE CITY NEIGHBORHOOD (←)

TOD2 recognizes the local context in designing TODs as dream houses, favorite mix of transport modes and utopian neighborhood that should be integrated in TOD visions and scenarios.

Élisée Reclus (1905 [2013], p.354[173]), a French geographer, argues that the correct way to study an urban agglomeration is to examine the development in detail, paying careful attention to the conditions of its growth, starting with its center and ending with its periphery (factories, graveyards and garbage dumps on the end of the 19th century). He argues that each city has unique individuality, life and countenance, tragic and sorrowful in some cases, joyful and lively in others. The city is also a very complex individual with each neighborhood distinguished from the others by its own particular

morphology and character. Andrés Duany refers to the regional section of the city as transect.

Understanding the transect is crucial for TOD2.

Every city has a transect of favorite historical neighborhoods and a vision for future favorites. For TOD2 it is not only important to understand the morphology of the typology, but also their social status, the communities that live, love and hate these neighborhoods, the lifestyles and mobility cultures. The neighborhood as type embeds not only physical similarities, but also a set of social norms and behavioral cues. **Each neighborhood is an extension of personality and PuT narratives have to be embedded to the local community through the neighborhood history and planning.**

Figure 35: **MATRIX OF TYPICAL SWEDISH NEIGHBORHOODS AND DREAM COMMUNITIES** (→)

TOD1 originates from an American tradition to define cities by density and number of inhabitants. In Sweden, historically a city (stad) was established by charter of the king. The Swedish neighborhood typology as matrix and well as the transect diagram seek to model Swedish towns and cities for urban design practices. Words such as “villastäder”, “stenstad” were specifically coined in Swedish to describe these types of neighborhoods. The typologies cannot be directly transcribed in English, but these typologies can be very useful in understanding urban history and discussing future urban design and planning. The building and neighborhood types can be identified and recognized by the general public, particularly in a Swedish context. They can be compiled in a typology and described by architectural and urban historians or new types of buildings and neighborhoods can be proposed by architects, and

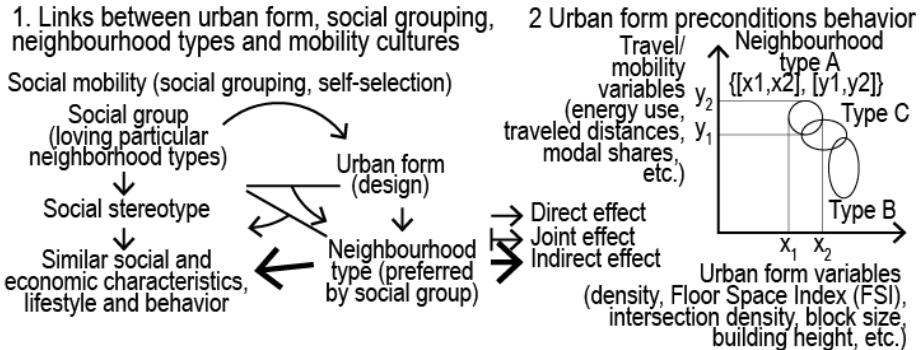
A. MATRIX OF TYPICAL NEIGHBORHOODS (EINARSSON, ET AL, 2018)



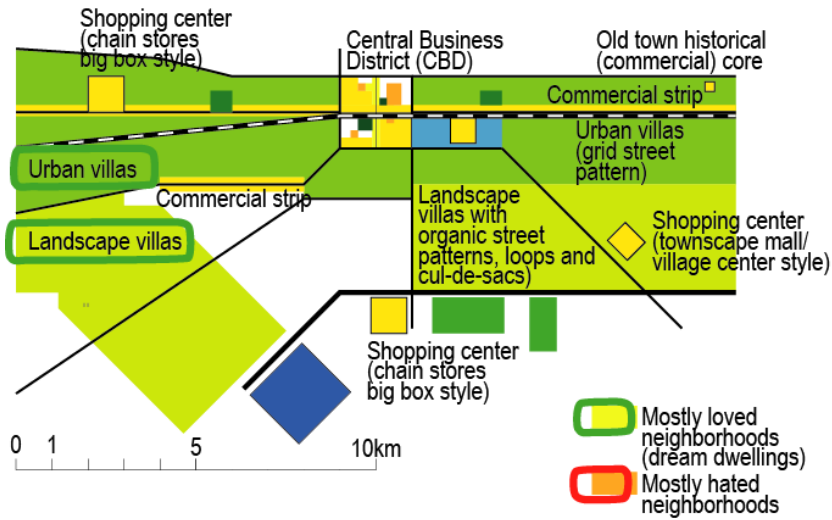
1. Pre-industrial city (walking and carts)
 - A. Trästäd/wooden cities
 - B. Kringbyggd (sluten) storstadskvarter (stenstad)/stone cities
 - C. (Urban) by/villages
2. Industrialising city (walking, cycling and transit)
 - D. Kringbyggd (sluten) småstadskvarter (stenstad)/stone cities
 - E. Kringbyggd (sluten) storstadskvarter/stone cities
 - F. Trädgårdsstad/garden cities
 - G. Villastad/neighborhood with villas
 - H. Industriområde/industrial area
 - I. Institutionsområde/institutions
 - J. Idrotts-, kultur- eller rekreatiomsområde/sports and recreation
3. Modern/industrial city (private automobiles)
 - K. Tidigare lamell- eller punkthusområde /early modern apartment blocks
 - L. Centrum/modern downtown (small town)
 - M. Centrum/modern downtown
 - N. Centrum/suburban downtown
 - O. Senare lamell- eller punkthusområde /modern apartment blocks
 - P. Handelsområde/external retail or kontorkomplex/office parks
 - R. Småhusområde/detached houses
 - S. Radhusområde/ row houses
4. Postmodern/post-industrial city (multimodal transport)
 - T. Kvasi-små och storstadskvarter (stenstad) /postmodern city

- Mostly loved neighborhoods (dream dwellings)
- Mostly hated neighborhoods
- Mixed use
- Residential
- Commercial/ Central Business Districts (CBD)
- Industrial zones, office parks and sports

B. TYPICAL NEIGHBORHOODS AND COLLECTIVELY LOVED DREAM HOUSES INSPIRE SIMILAR BEHAVIOR, LIFESTYLES, AND MOBILITY CULTURES

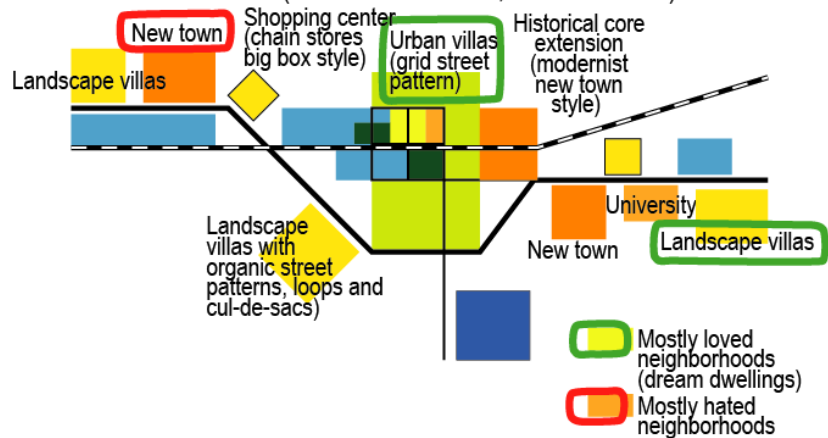


A. AMERICAN TRANSECT (1M CITY REGION, E.G. BIRMINGHAM, ALABAMA)



- Typical neighborhoods
- Arterials
 - Expressways/freeways
 - Railroads (Amtrak)
 - Light green: Landscape villas
 - Green: Urban villas
 - Dark green: Social housing
 - Dark green: Urban villages (gated communities)
 - Dark green: New townhouses (mixed development)
 - Yellow: Historical core (typically main streets, grid street pattern)
 - Orange: Administration, healthcare, sports, public buildings and services (hospitals, stadiums, museums, etc)
 - Yellow: Commercial/shopping centers and business districts (edge cities inc.)
 - Blue: Light industry/business
 - Dark blue: Heavy industry

A. SWEDISH TRANSECT (100K CITY REGION, E.G. UPPSALA)



- Typical neighborhoods
- Arterials
 - Expressways/freeways
 - Railroads
 - Light green: Landscape villas
 - Green: Urban villas
 - Dark green: New towns/apartment blocks
 - Dark green: New townhouses (mixed development)
 - Yellow: Historical core (grid or organic street pattern)
 - Orange: Administration, healthcare, sports, public buildings and services (hospitals, stadiums, museums, etc)
 - Yellow: Commercial/shopping centers and business districts (edge cities inc.)
 - Blue: Light industry/business
 - Dark blue: Heavy industry

urban designers and planners. **The TOD2 handbook utilizes neighborhood types, their underlying elements (building and street types) into guidelines for designing TOD pearls and corridors.**

Figure 36: TRANSECTS OF NEIGHBORHOODS IN IDEALIZED MEDIUM SIZE AMERICAN AND SWEDISH CITY (→)

The spatial practices of any society both structure and are structured by the activity of creating and classifying types. Type is more of an idea, a preconception that can lead to the creation of many objects, elements and things, while the model can only repeat itself- The types have history and they tell histories. They change over time and vary considerably between cultures and between different groups within the same cultures. Even though the typologies vary across cultures, the activity of creating types lives within all societies.

The application of typologies must be used with caution. The typologies e.g. Swedish neighborhoods cannot be directly transcribed, but it is possible to use the method to create building and neighborhood typologies capturing cultural and linguistic uniqueness. Secondly, the typologies are predominantly historical. The retrograde disposition and nostalgic attachment to specific neighborhood types can result in repetitiveness and stereotypes. Typologies are history, whereas the future is to be invented. If a historical pattern of a neighborhood (e.g. a railway suburb of the early 20th century) is replicated as a new TOD today, the neighborhood will be different in the historical context, despite similarities in neighborhood design.

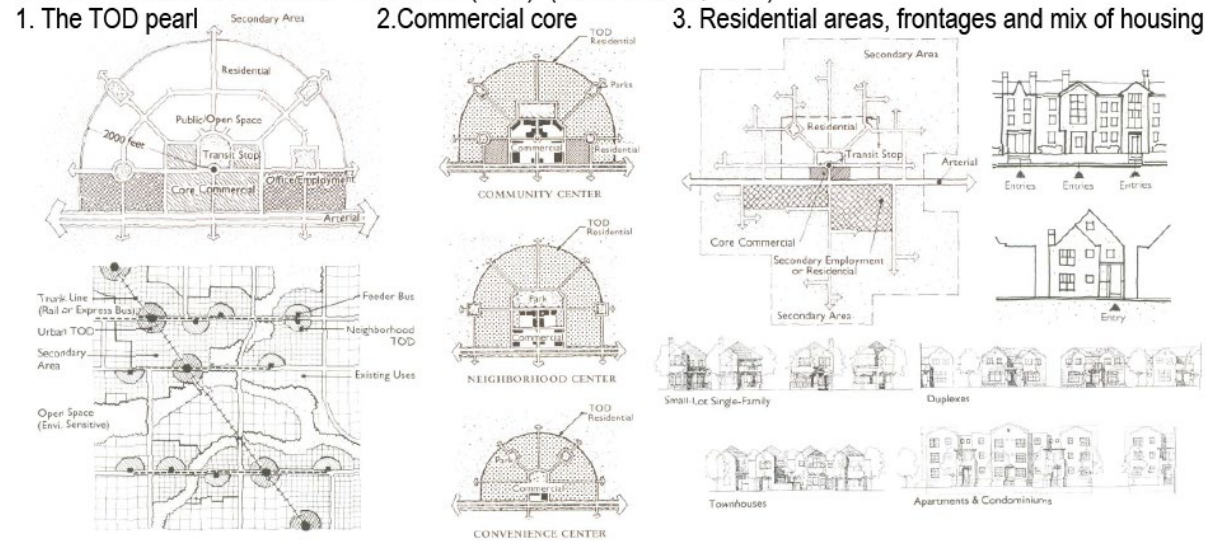
The half-mile TOD1 pearl

Peter Calthorpe drew a transit-friendly community along a commercial strip with walking distances defining service areas for PuT and urban growth boundaries for TOD. Each TOD looks like a pearl (the station area) on a string (the line) with its radial walkshed. There is much unclarity about the length of the walking distances and it is typically a convention. Different people walk at different speeds, and 10-minute walk is typically a half mile (800 meters) length. Peter Calthorpe uses 2000 feet (600 meters) walking distance. The TOD2 handbook accepts the length of Chinese mile li (Chinese: 里, lǐ, or 市里, shìlǐ) for TOD analyses. Li is standardized to 500 meters, as a traditional Chinese unit for distance in cities describing an urban quarter.

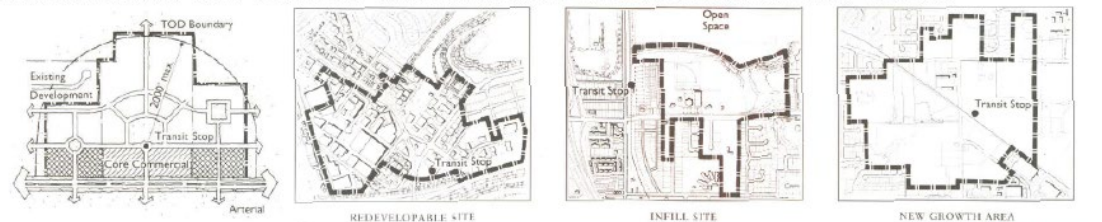
Figure 37: COLLAGE OF PETER CALTHORPE'S TOD PEARL DIAGRAMS (→)

The fundamental purpose of TOD is to create a land use pattern which will ultimately support transit according to Peter Calthorpe. The typical scales are regional plans, land use diagrams for towns and new towns, neighbourhood and station area plans. The TOD1 pearl is diagrammatized as a composition of transit-supportive land uses within 2000 feet (600 meters) walksheds delineating urban growth boundary. Peter Calthorpe highlights the commercial core and residential periphery. It is interrupted with public spaces, parks, plazas and public buildings. Mixed-use core commercial areas are the primary link between transit and land use. **The size and mix of uses in each core commercial area can vary depending on the size, location, and overall function of the at its minimum, serving as a convenience shopping area for TOD.**

A. TRANSIT ORIENTED DEVELOPMENT (TOD) (CALTHORPE, 1993)



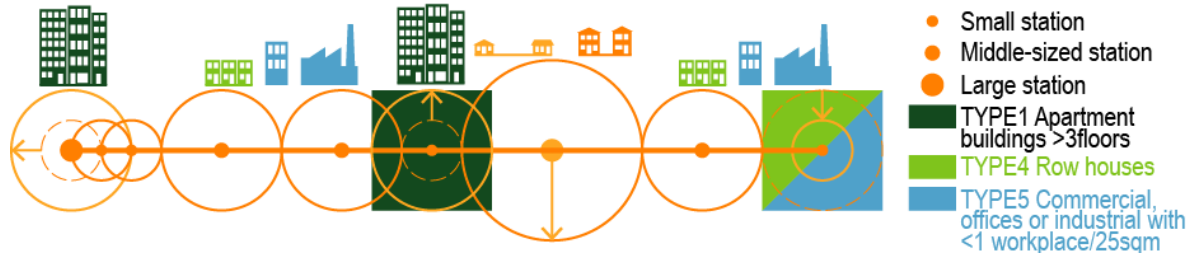
B. TOD BOUNDARY AND TYPES OF LOCATIONS FOR URBAN DESIGN INTERVENTIONS



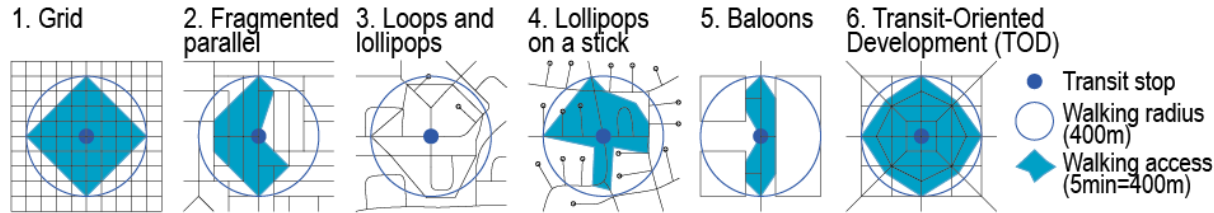
C. TOD SCALES (FROM REGIONAL, TOWN TO NEIGHBORHOOD PLANS)



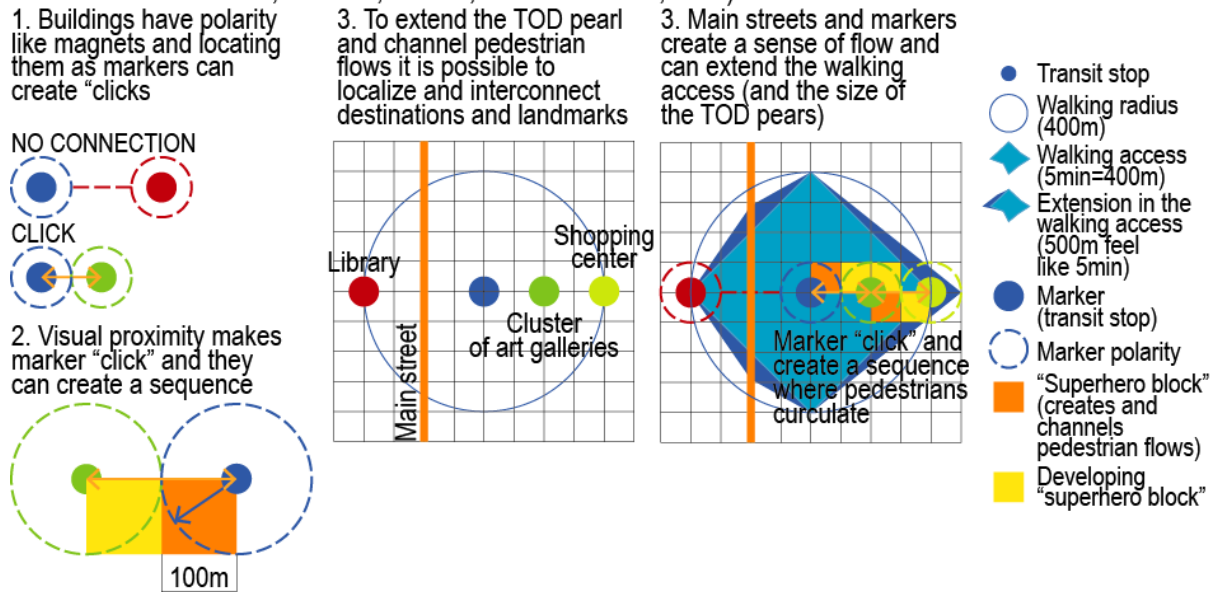
A. THE INTERACTIONS BETWEEN NEIGHBORHOOD DENSITY/TYPE AND STATION SIZE/TYPE CAN TENTATIVELY EXTEND OR SHRINK THE SIZE OF THE TOD PEARL.



B. TYPOLOGY OF STREET LAYOUTS AND WALKING ACCESS



C. MAGNETIZING AND EXTENDING THE TOD PEARL (LOCALIZING DESTINATIONS, LANDMARKS, SUCH AS PUBLIC BUILDINGS, PLAZAS, PARKS, MAIN STREETS, ETC.)



The residential areas should have a mix of housing types. Residences should include design elements that enhance the streetscape and address the street. Porches and bays should face the street. Facades should vary from one building to the next to avoid a monotonous streetscape. As with commercial uses, residential entries should face the street to encourage public activity and to welcome visitors from the on-street guest parking. In the end, parks, plazas and civil buildings should provide a public focus for each neighborhood.

Figure 38: THE WALKING PATHS TO PUT STOPS/STATION DEPEND ON THE PATTERN OF STREETS AND CITY BLOCKS

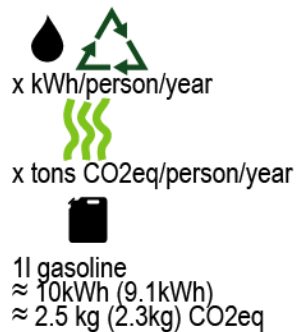
The TOD2 handbook diagrammatizes extensions of the TOD pearl and the discusses creation and channeling pedestrian flows. Firstly, **the type of neighborhood and station size define the walking distances and the urban growth boundaries of the TOD pearl.** It is important to understand the transect and typology of the neighborhoods with their underlying street layouts in the city region section. The design of the commercial core can further extend and deform the TOD pearl. **TOD2 seeks to create a destination pattern in the TOD pearl with localizing markers such as public buildings, main streets, plazas, parks, civil service, etc.** There should be a good balance of public spaces and civil buildings, parks and green spaces (including even urban agriculture). The public-green pattern should be strengthened with local and regional services as markers on the urban plan and landmarks that improve path attractiveness, orientation and walkability.

Make use of analytical tools for the assessment of solutions. High quality public transport can only be achieved through good decisions based on analytical assessments of solutions founded on sound theory and precise knowledge of the real world. Integrate sustainable mobility tools. TOD entangled in studies on land use and travel emphasizing a set of D-variables crafted by Robert Cervero. Various TOD methods, notably the Luca Bertolini's "place-node model" were developed in the 1990s to assess the integration of station areas as nodes in neighborhood as places. **TOD2 seeks to further develop the TOD metrics and link them to environmental carbon neutrality and transport energy efficiency goals.** There are not many discussions about sustainable mobility metrics, even though there are straightforward conversions. Travel surveys show that an average person travels roughly one hour and makes around 1000 journeys per year and all transport modes are in a vicious cycle in a 1000-sum transport game in cities. These are shared between transport modes, and every liter/gallon gasoline has energy and carbon emission costs (1l gasoline \approx 10kWh (9.1kWh) \approx 2.5 kg (2.3kg) CO₂eq) that are easily calculated.

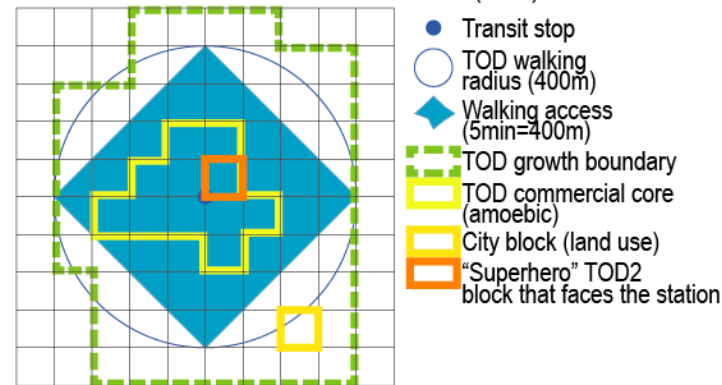
Figure 39: SUSTAINABLE MOBILITY PERFORMANCE, TRANSIT ORIENTED DEVELOPMENT SCALES AND TRIP GENERATION (→)

One method is the "mobility choices model" (transportdeklaration in Swedish) that estimates trip generation (modal shares of walking, cycling, PuT and private car). The mobility choices model uses a measure Level of Integration (Lol) for each transport mode that combines and weighs urban form and accessibility factors at three scales. The Lols illustrate preconditions to travel embedded in the

A. SUSTAINABLE MOBILITY PERFORMANCE METRICS



B. TRANSIT-ORIENTED DEVELOPMENT (TOD) SCALES



C. TRAVEL FORECASTING (TRIP GENERATION MODEL/MODAL SHARES ESTIMATIONS)

1. Select important factors (used in urbanist practices) for each transport mode
2. Set weights for factors
3. Calculate level of integrations (Lols)

$$LoI_m = \sum_{i=1}^n (w_i \times c_i)$$

Level of Integration (Lol) of transport mode m

w_i weight for criterion/urban form or accessibility factor i
 c_i criterion/urban form or accessibility factor i and accessibility factors

4. Modal shares estimations

$$S_m = LoI_m / \sum_{i=1}^n (LoI_i)$$

Modal share for transportation mode m (in percentage)

$$LoI_m \quad Lol \text{ for specific transport mode } m$$

$$LoI_i \quad Lol \text{ for transport modes } i$$

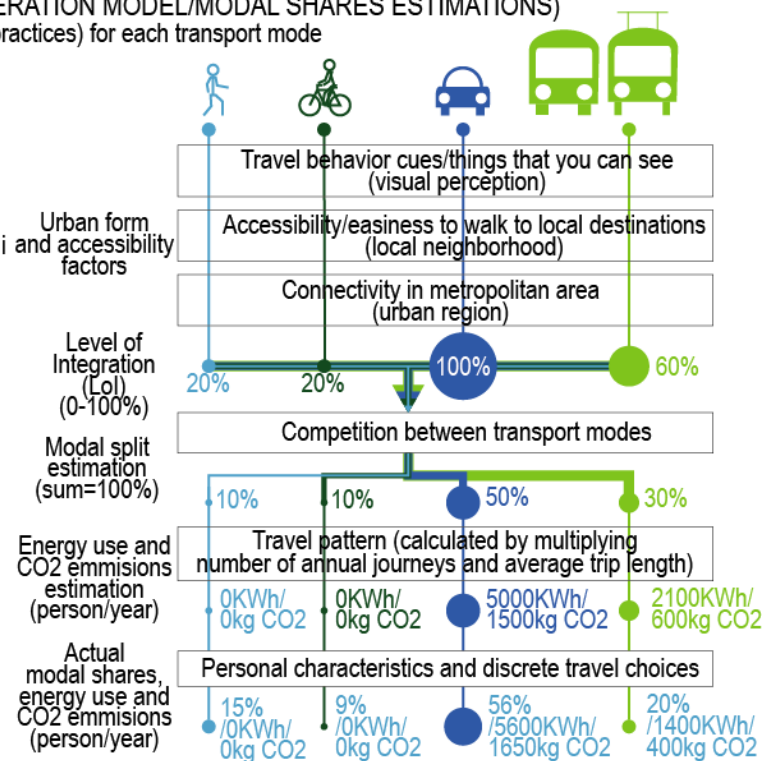
$$N_m = S_m \times 1000$$

Number of annual journeys for transport mode m

$$S_m \quad \text{Modal share for transport mode } m \text{ (in percentage)}$$

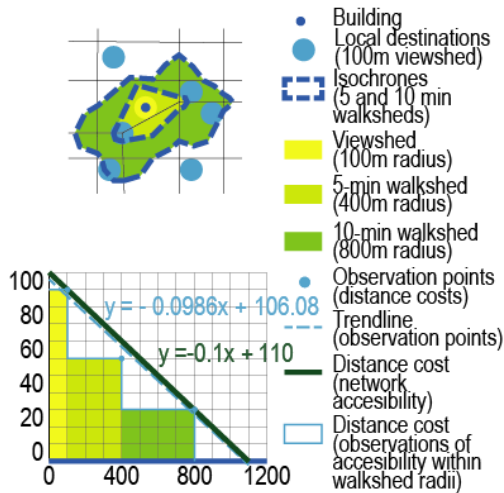
The CO₂ emissions are calculated by using average values for Swedish gasoline (2.75 kg/l) and diesel mix (2.78 kg/l) for average travelled distance.

An average journey by a public bus is 15 km with fuel use of 7 KWh/km, whereas a journey by private automobile averages 17.9 km and consumes 10 KWh/km.

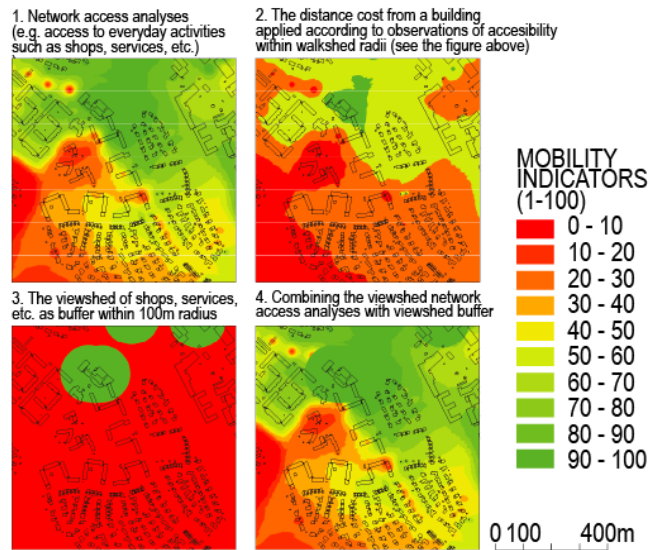


A. ACCESSIBILITY ANALYSIS (WALKSHEDS)

1. NETWORK ACCESS AND DISTANCE COSTS

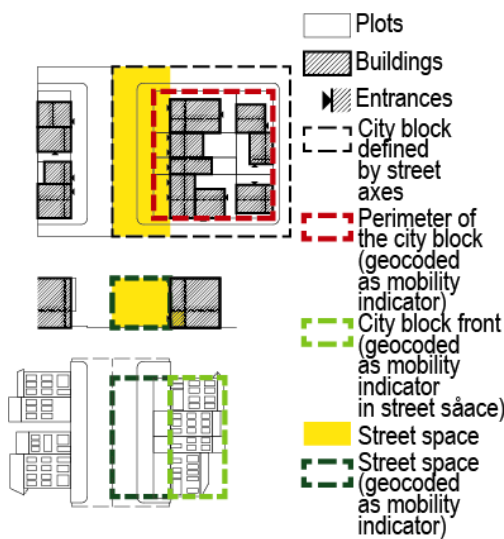


2. GIS NETWORK ANALYSIS AND BUFFERS

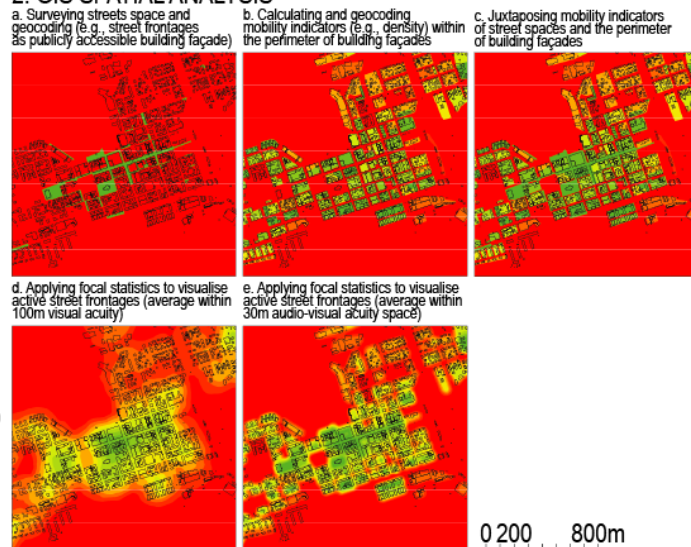


B. ANALYSING STREET SPACES (VIEWSHEDS) IN GEOGRAPHIC INFORMATION SYSTEMS (GIS)

1. STREET SPACE INDICATORS



2. GIS SPATIAL ANALYSIS



built environment and they vary in complexity. A private automobile needs parking space at the destination and quick access to an expressway. These two crucial factors give 100% integration. Walking, cycling and PuT require a very complex combination of urban form and accessibility factors. The integration with PuT includes more than ten weighed factors (including the factors for walking). Based on the LoIs for the transport modes (0–100%) as precondition to travel, the modal choices model calculates modal shares proportionally. Better preconditions to travel with particular transport modes means better integration with the buildings and that would arguably result in higher modal shares for that transport mode.

Figure 40: **METHODS AND GEOGRAPHIC INFORMATION SYSTEM (GIS) ANALYSES** IN THE “MOBILITY CHOICES MODEL” (→)

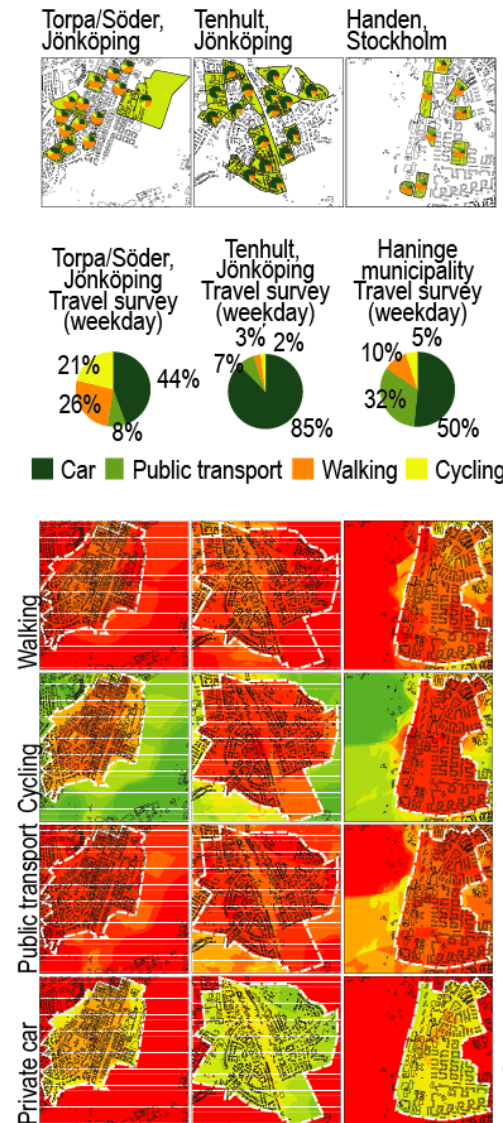
The “mobility choices model” combines a set of urban form factors (including D-variables) that are geocoded as perimeters of blocks and street spaces. The mobility choices model produces reasonable results considering the limitations of travel forecasting based on urban form and accessibility factors. Typically, the trip generation is induced from observation studies and it typically accepts fixed low shares of PuT, because the observations are done in car-dominated city regions. The forecasted modal shares correspond to the actual modal shares with a variation of 10%. The error goes to 20% for walking share in downtown or driving automobiles in the suburbs, but this can be explained by strong mobility cultures of walking in downtowns and driving in suburbs. Travel behavior directly depends on personal characteristics such as economic rationality, personality traits, irrational

commitment to specific modes, etc. New studies in China verify the margins of 10% error and confirm the usability of the model in predicting modal splits.

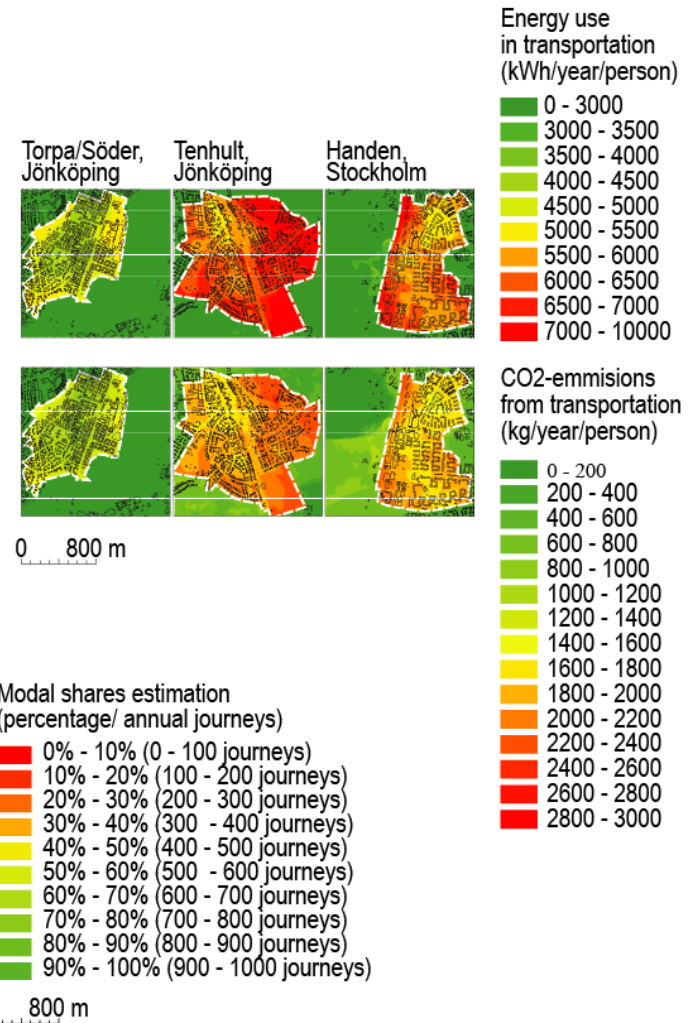
Figure 41: **METHODS AND GEOGRAPHIC INFORMATION SYSTEM (GIS) ANALYSES IN THE “MOBILITY CHOICES MODEL”** (→)

The mobility choices model links environmental goals (carbon emissions from transportation measured in t CO₂/year/person) with urban form and accessibility factors commonly used in urban planning and design practices (density, building heights, building setbacks, street widths, parking standards, distance to transit, access to different services, etc.). It visualizes integration with transportation modes, modal shares, energy use and carbon emissions from transportation as heat maps to bring concise information about environmental performance of transportation systems to urban planners and designers, municipal officials and developers. The research into carbon performance and sustainable transportation lacks specific measurements and tools. Many Swedish municipalities have ambitions environmental goals and carbon management initiatives towards low or zero-carbon urban futures. The estimates for CO₂ emissions are crucial in the environmental and transportation policy of municipalities in Sweden and Nordic countries [12-14]. The model introduces additionally a measure for transportation energy use (kWh/year/person) conversable with the measure for annual energy consumption with energy certificates for buildings (measured in kWh/m²/year). The standard for an average person living in Sweden is 50 square meters (with average energy performance of around 100-120 kWh/m²/year it would result in a yearly use of

A. SUSTAINABLE MOBILITY PERFORMANCE/ TRIP GENERATION/MODAL SHARES



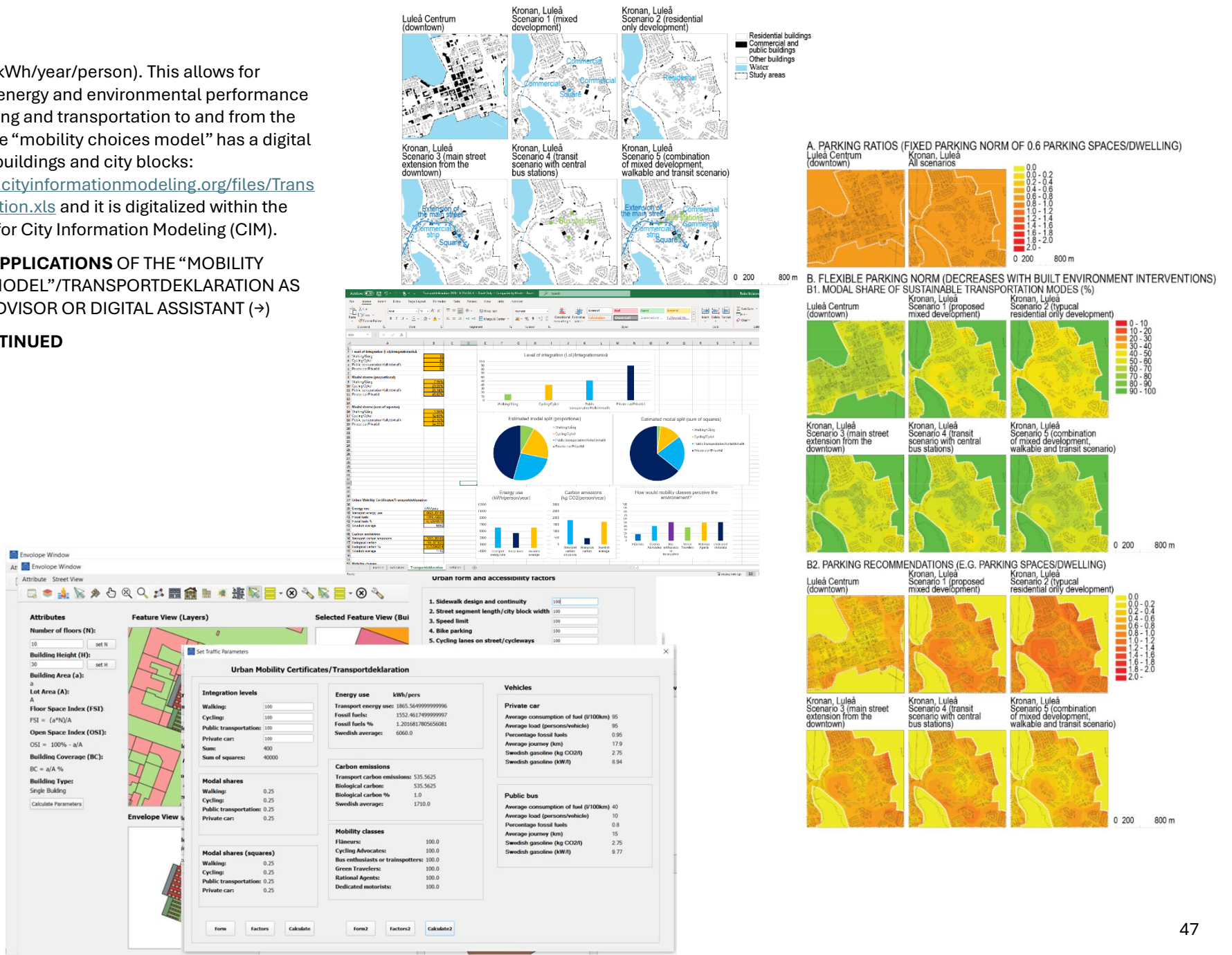
B. SUSTAINABLE MOBILITY PERFORMANCE/ ENERGY USE AND CARBON EMISSIONS



5000-6000 kWh/year/person). This allows for comparing energy and environmental performance of the building and transportation to and from the building. The “mobility choices model” has a digital version for buildings and city blocks: <http://www.cityinformationmodeling.org/files/Transportdeklaration.xls> and it is digitalized within the framework for City Information Modeling (CIM).

Figure 42: APPLICATIONS OF THE “MOBILITY CHOICES MODEL”/TRANSPORTDEKLARATION AS PARKING ADVISOR OR DIGITAL ASSISTANT (→)

TO BE CONTINUED



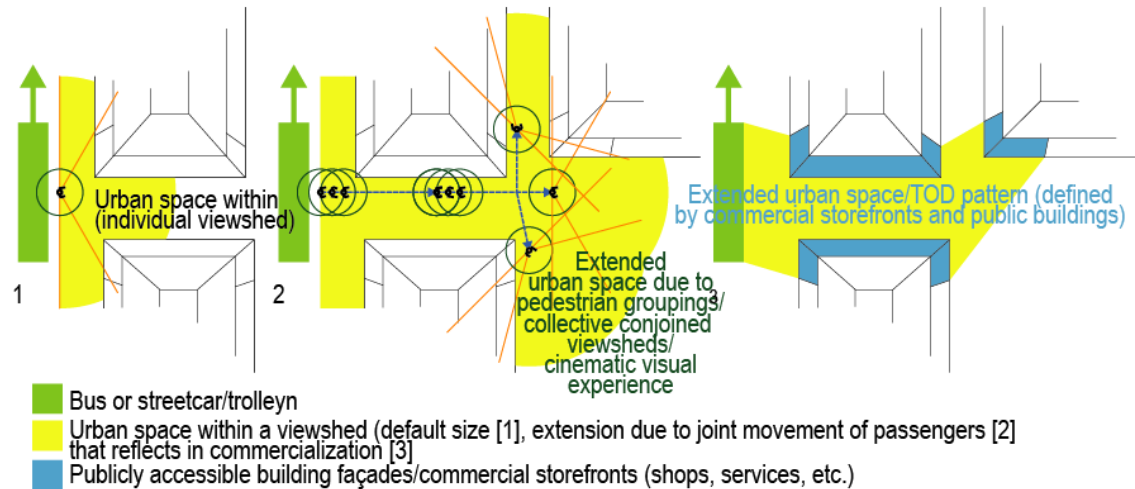
The viewshed amoeba of TOD2

Transit Oriented Development (TOD) is conventionally understood as a neighborhood diagram, a TOD1 pearl defined by a circular walkshed. **The TOD2 handbook highlights a viewshed perspective on TOD with amoebic patterns of commercialization public spaces in visual proximity to transit stops.** *Visual proximity is defined by viewsheds from transit stops. The viewshed is an urban space with clear visual acuity of roughly 100 m.* Pedestrian activity triggers commercialization within the viewsheds of transit stops and creates a pattern of public spaces. Peter Calthorpe refers to these commercialization and public space patterns around transit stops as commercial core areas of TODs. He intuitively draws larger or smaller commercial cores in different types of TODs, but does not discuss markers and elements that influence the expansion of the commercial core.

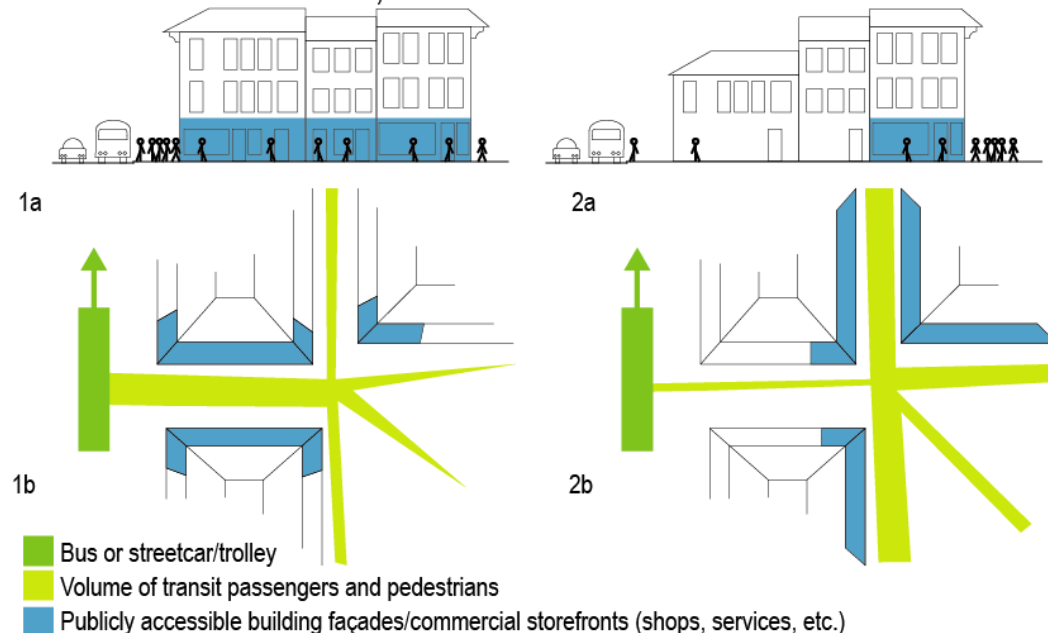
Figure 43: AMOEBIC TOD PATTERNS EMERGING AT THE CROSS OF COMMERCIAL STOREFRONTS, PUBLIC BUILDINGS, AND STREETSPACES (→)

The viewsheds and hearing ranges of pedestrians and transit passengers, the environmental perception and cognition of cities influence travel and urban experience. If a person steps out alone from a bus or train, an individual viewshed opens. If an individual joins a group in movement, the vantage point can move across urban space. The mode of observing space emerges later as the urban space elongates and encompasses several vantage points, one for each member of the group. Transit and commercial activities form a virtuous circle. Transit, depending on the level of service,

A. SEQUENCE OF COLLECTIVE/CONJOINED VIEWSHEDS OF TRANSIT PASSENGERS THAT CAN RESULT IN COMMERCIALIZATION AND PUBLIC SPACE PATTERN

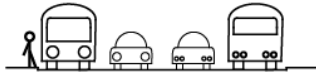


B. COMMERCIALIZATION OF BUILDINGS (INCREMENTAL CHANGES IN CREATION OF COMMERCIAL STOREFRONTS IN BUILDINGS DUE TO PEDESTRIAN AND TRANSIT PASSENGERS FLOWS)

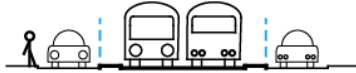


A. TYPOLOGY OF TRANSIT STOPS BY SEGREGATION FROM STREET

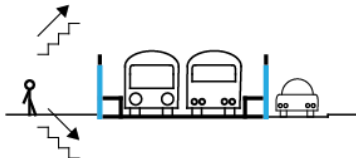
1. Bus lines or tramways on streets (no segregation/no barrier effect)



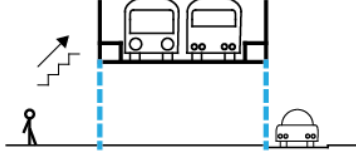
2. Segregated railways or busways on streets (partial segregation/weak barrier effect)



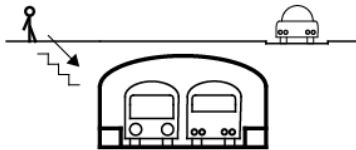
3a. Segregated railways or busways on the ground (full segregation/strong barrier effect)



3b. Elevated railways or busways (full segregation/strong barrier effect)



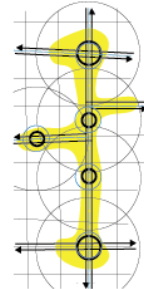
4. Subways (full segregation/no barrier effect)



- Permeable edge/weak barrier effect
- Impermeable edge/strong barrier effect
- Permeable edge/strong barrier effect
- Public transportation infrastructure
- Street

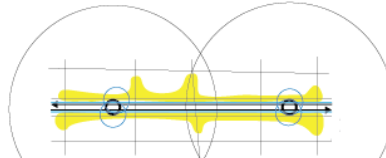
B. TOD PATTERNS OF PUBLIC SPACES AROUND TYPICAL TRANSIT STOPS (TYPO-MORPHOLOGICAL ABSTRACTIONS BY URBAN ELEMENTS, LYNCH 1960)

1. Typical TOD pattern for transit stops on streets

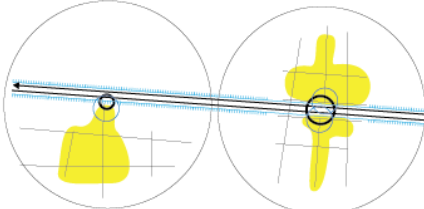


- ✗ Paths (transit infrastructure)
- Nodes (transit stops)
- Districts (urban spaces)
- TOD patterns (urban spaces)
- Viewsheds (100m radius)
- Edges
- Impermeable barrier
- Permeable barrier
- No barrier
- △ Landmarks

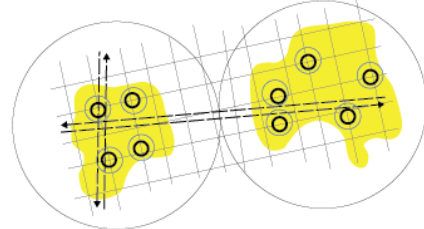
2. Typical TOD pattern for partially segregated transit stops



3. Typical TOD pattern for completely segregated transit stops



4. Typical TOD pattern for subway exits



attracts crowds of passengers that are potential customers. More traffic and passengers attract more surrounding businesses. Established commercial storefronts and entrances to public buildings along pedestrian paths create a pattern of public spaces in visual proximity to transit stops. The PuT vehicle as mobile public space need to enter public space surrounded by public buildings and commercial storefronts as potential destinations. The presence of commercial activities also attracts people and moving and waiting in crowds improves the PuT travel experience, Empirical evidence shows that the generation of passengers is at its maximum within 100-200 m walking distance from a transit stop (the distance where the transit stop is visible from the building). This number halves beyond this distance. This distance also corresponds to the size of a traditional city block and the range of visual acuity. **Visual proximity is crucial for the TOD2 handbook as creation of public spaces and commercialization of buildings adjacent to transit stops.**

Figure 44: TYPOLOGY OF PUBLIC TRANSPORT (PUT) SYSTEMS AND AMOEBIC TRANSIT ORIENTED DEVELOPMENT (TOD) PATTERNS EMERGING DEPENDING ON THE SEGREGATION OF THE STREET (←)

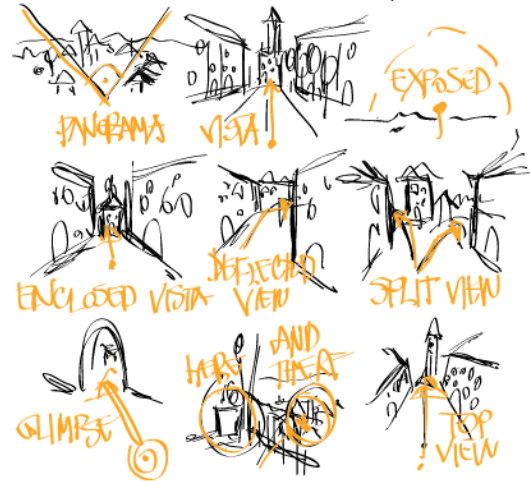
Transit stops create elongated and amoebic patterns of public spaces caused by commercialization (referred to as commercial core by Peter Calthorpe) that are markedly different from circular walksheds. Four types of PuT systems and transit stops can be classified by their level of segregation: 1) transit stops on streets; 2) train and bus stations of completely segregated transit systems (on the ground or elevated); 3)

subway stations; and 4) bus or tram stops on partially segregated busways or railways on the ground. Each type of transit stop connects to the street space in a unique way and produces specific development patterns with the surrounding buildings. Transit stops on the streets integrate with cities without any barrier effect. The loading platforms are on the sidewalks and the street works as one urban space. Segregated train and bus stations have exits and need a complex network of corridors, stairs and escalators to reach the loading platform. Partially segregated transit stops are also part of street spaces, but it is not always possible or safe to cross the street. This gives a unique context of permeable and impermeable barriers along the street because of additional urban design elements such as greenery, fences, and so on.

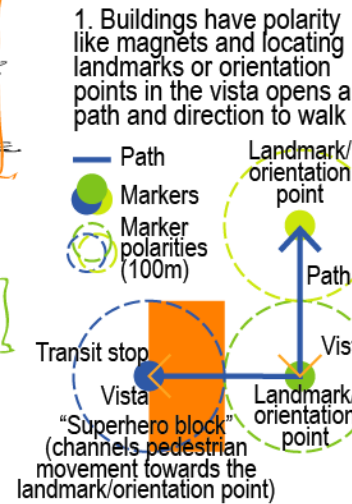
Figure 45: TOWNSCAPE ANALYSIS, VISTAN AND PLACING SUPERHERO BLOCKS AND MARKERS TO EXPAND THE SIZE OF THE TOD2 AMOEBA (→)

It is important to consider a range of Urban Design (UD) interventions to create a successful TOD2 amoeba. Firstly, **think of a TOD “superhero block” that will create attractive public space by combining commercial activities and storefronts, public buildings, green spaces and mobility services (or mobility hub elements).** The TOD2 amoeba should start with a superhero block that is ideally designed to welcome exiting passengers from stations. The superhero block should be facing the main entrance. The TOD2 amoeba is a dynamic sequence of markers or landmarks such as public or commercial buildings, parks, plazas, etc. along a pedestrian path. The pedestrian path should start with a superhero block in the viewshed of the main entrance of the transit stop or station and the space

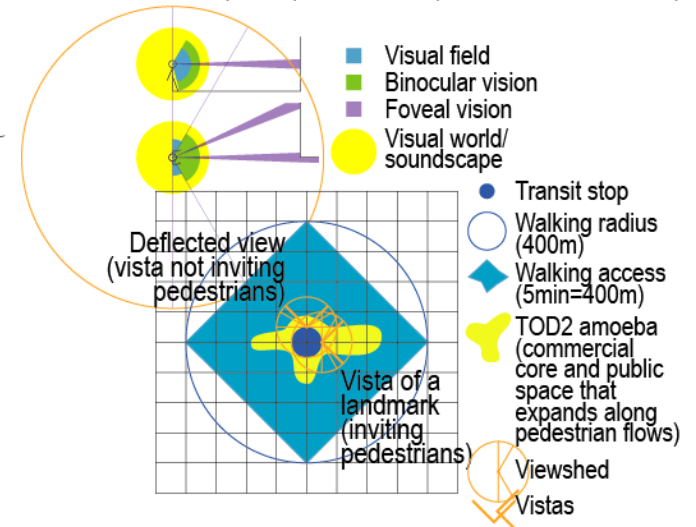
A. TOWNSCAPE ANALYSIS AND VISTAS AS ENVIRONMENTAL PERCEPTION (CULLEN, 1961)



C. THE TOD2 AMOEBAS SHOULD START WITH A “SUPERHERO BLOCK”, A BLOCK WITH INVITING COMMERCIAL STOREFRONTS AND PUBLIC BUILDINGS

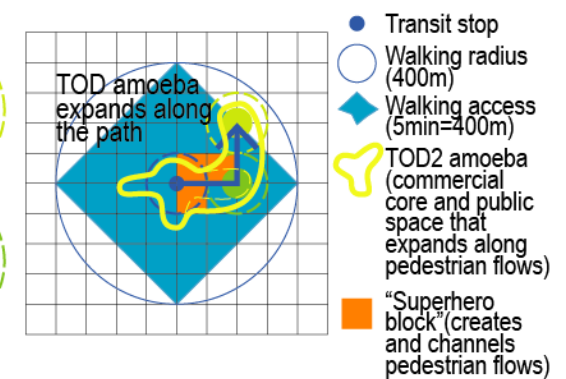


B. VISUAL PERCEPTION: VIEWSHEDS; WALKSHEDS AND TRANSIT-ORIENTED DEVELOPMENT (TOD2) AMOEBAS (STOJANOVSKI, 2020)



D. THE TOD2 AMOEBA EXPAND WITH PEDESTRIAN FLOWS AND IT IS IMPORTANT TO CREATE A SEQUENCE OF VISTAS THAT LAY AHEAD PATHS

2. Creating dynamics in the TOD2 amoeba by placing markers and creating movement momentum towards landmarks



A. VARIETY ALONG PATHS



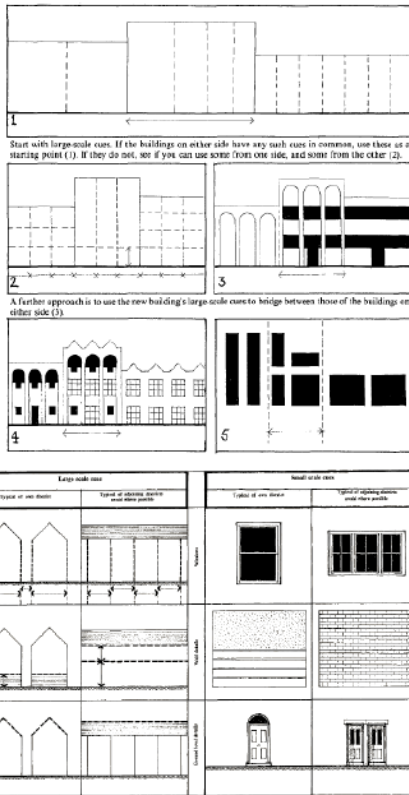
DIVERSITY MATTERS

SHOPPING CENTRE DESIGN

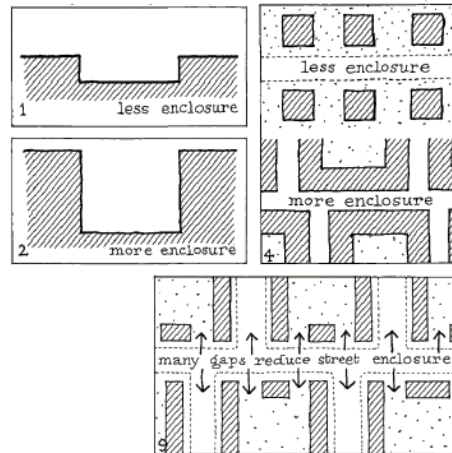
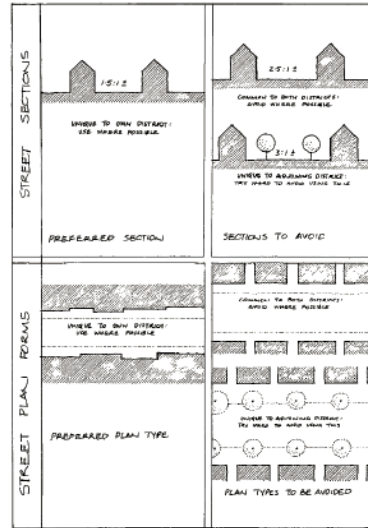


B. VISUAL APPROPRIATENESS

The horizontal and vertical rhythm of building façades create pleasant urban and travel experience.



C. ENCLOSURE ATTRACTS AND CHANNELS PEDESTRIANS



between the city block and the station, but it should have a clear path forward to the next marker, The **TOD2 amoeba extends if there are pedestrians walking from marker to marker.** The flow of pedestrians makes the amoeba spread a tentacle. The pedestrians should feel comfortable walking. **The street layout should be permeable and directly linking the transit stop with interconnected streets without cul-de-sacs, loops, lollipops and balloons.** The block size defines walkability, with long city blocks being typically less eventful thus less walkable. The city blocks should be under 100m wide. The TOD pearls should have a mix of blocks avoiding superblocks with large sizes and focusing on small size “superhero blocks” (withing viewsheds of transit stops) that will define the commercial core.

Figure 46: PATHS, ENCLOSURE, VARIETY (→)

Variety matters! Urban experience is shaped by viewpoints and vistas that comprise the viewshed.

The horizontal and vertical rhythm of building façades of the TOD superblock in the viewshed create visual appropriateness.

Beautiful architecture is not prerequisite, because ugly architecture can create beautiful townscapes. Plot by plot urbanism within the and diversity by age, architectural style, function/land use, etc. can create a functional townscape for flows of pedestrians. **Enclosure attracts pedestrians.** Many stations are surrounded by parks and many bus stops are pinned in open space areas that are windy and exposed. Active street frontage and orientation of the buildings to the street matter in the creation of public spaces and sequence of markers.

TO BE CONTINUED

The TOD2 corridor mix

The TOD2 highlights the dynamics of the PuT line, the mobile community that circulates in the corridor and the mix of stations and neighborhood types. The PuT corridor develops only along the main lines with high frequency and speeds, typically radial or pendulum trunk lines, but also direct lines quickly connecting a regional core (new town or town) with the downtown. The corridor analysis includes typology of lines, stops and neighborhoods.

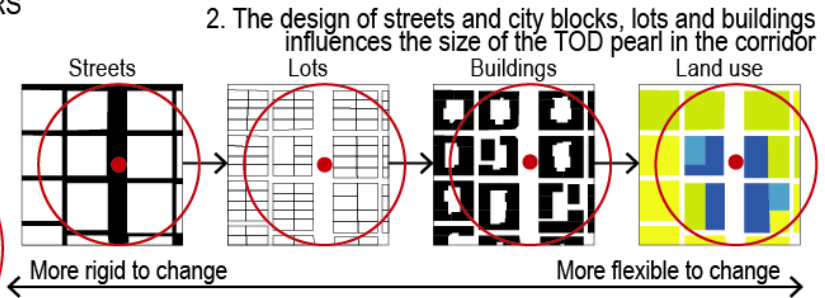
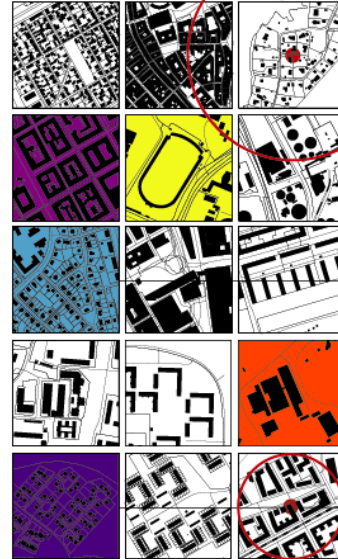
Figure 47: TOOLBOX FOR DESIGNING TRANSIT-ORIENTED DEVELOPMENT (TOD2) CORRIDORS. IT STARTS WITH NEIGHBORHOOD MATRIX THAT IS APPLIED ON THE CORRIDOR. IN THE END, A SET OF DESTINATIONS ARE LOCATED IN THE CORRIDOR TO IMPROVE ITS DYNAMICS (->)

The TOD corridor is an agglomeration of TOD pearls, the main PuT lines and its feeding network of secondary PuT lines. The **design toolbox for TOD2 corridors in a neighborhood typology preferably with a mix of neighborhood along the line.** The diversity of neighborhoods will allow for different kinds of densities along the line and variety of customers that will create the mobile community. **Diversity of stops is preferred that will create a desired diversity of neighborhoods.** Stop uniformity should be encouraged, but in hierarchical and size variety along the corridor. With different sizes of stops and stations the sizes of the walksheds expand and accentuating large stations, particularly in low-density suburbs it will give visibility to the station and potentially anchor commercial development. **Transfer points should be highlighted.** The TOD2 corridor analysis allows focusing on major nodes.

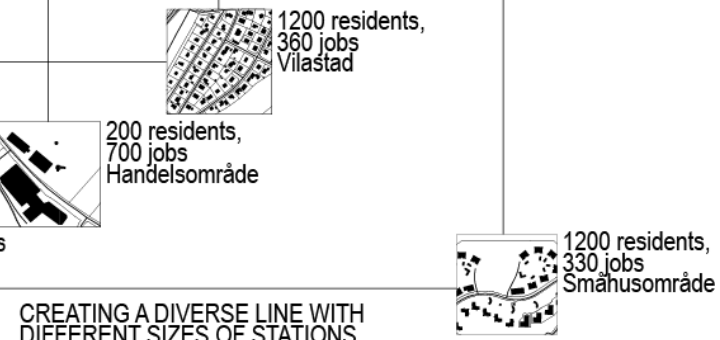
A. DESIGN TOOLBOX FOR TRANSIT-ORIENTED DEVELOPMENT (TOD) CORRIDORS

NEIGHBORHOOD TYPOLOGY

1. Neighborhood density/type and station size/type can extend or shrink the size of the TOD pearl.



TOD2 CORRIDOR OF TOD1 PEARLS

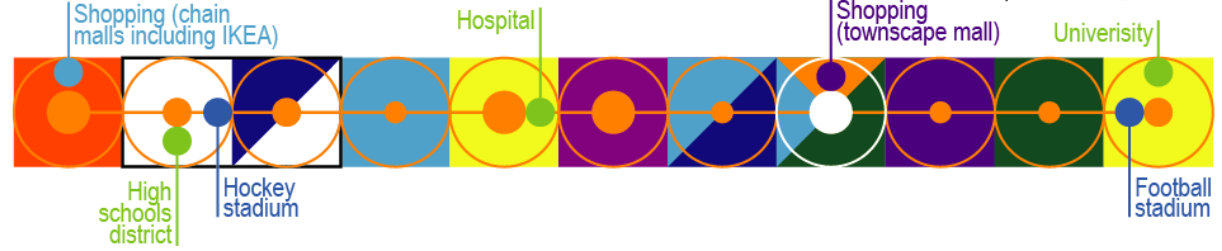


CREATING A DIVERSE LINE WITH DIFFERENT SIZES OF STATIONS

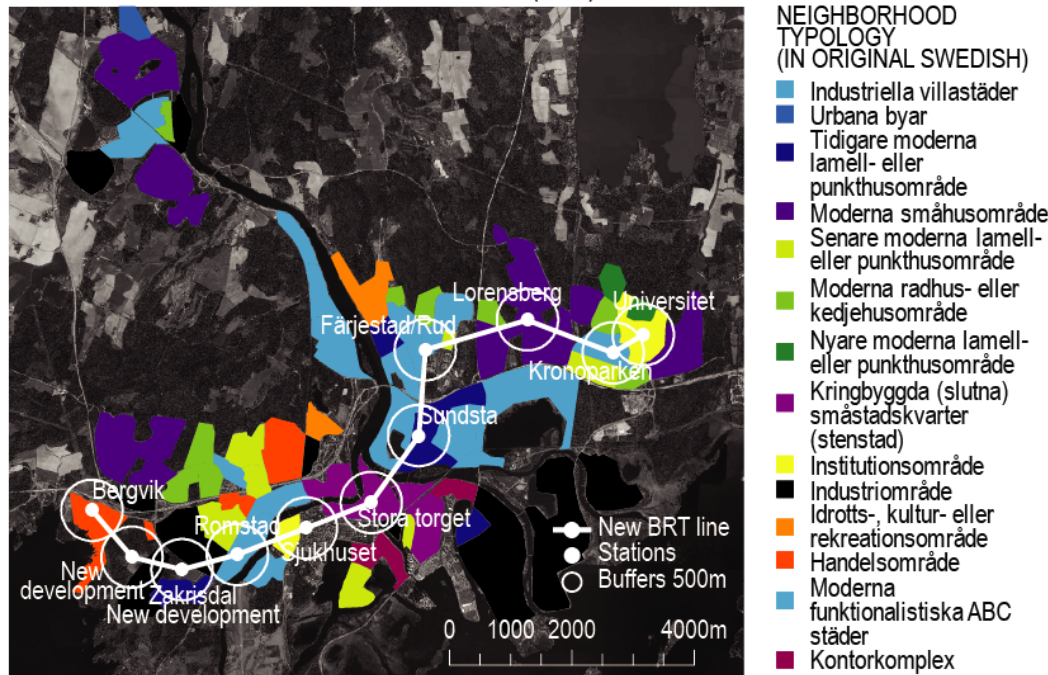


- Small station
- Middle-sized station
- Large station

B. PLACING MARKERS TO BOOST CORRIDOR DYNAMICS AND CHARACTER (THE LINE MUST CONNECT TO DESTINATIONS THAT WILL CHARACTERIZE THE TOD2 CORRIDOR)



A. PLANNING A TRANSIT-ORIENTED DEVELOPMENT (TOD) CORRIDOR WITH BUS RAPID TRANSIT (BRT)



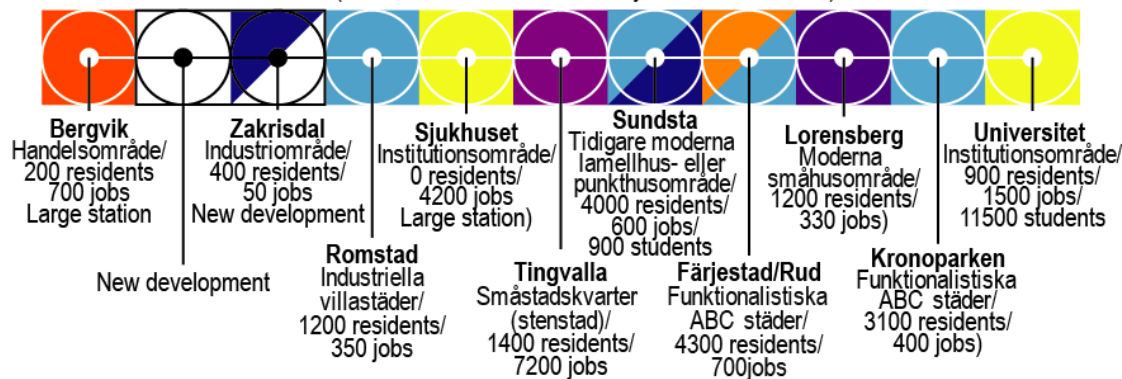
The TOD corridor should include a variety of destinations and services that will define its character. Linking important destinations such as access to major public buildings and complexes such as hospitals, universities, museums, sport complexes, cultural and administrative buildings, boosts the use of PuT. Hospital staff, seniors, students etc. tend to be loyal PuT users as well as students It should connect also to anonymous neighborhoods and low-density suburbs, that will get access to regional destinations. **The TOD2 corridor analysis can be used also to analyze the intersection of two corridors.** The goal of designing PuT networks with high network effect is to coordinate seamless transfers between lines.

Figure 48: EXAMPLE OF DESIGNING TOD2 CORRIDORS ALONG A NEWLY PLANNED BUS RAPID TRANSIT (BRT) LINE IN THE SWEDISH CITY OF KARLSTAD. IT SHOWS THE NEIGHBORHOOD TYPOLOGY (IN SWEDISH) AND DENSITIES THAT IS APPLIED ON THE CORRIDOR. (→)

B. CORRIDOR DYNAMICS, DENSITY AND NEIGHBORHOOD TYPES (MINIMUM 10 MINUTE HEADWAY)

West section (205ha/1400 residents/5100 jobs/0 students) East section (410ha/12300 residents/3200 jobs/12400 students)

Sum (670ha/14800 residents/15700 jobs/12400 students)



The interaction between the neighborhoods as TOD pearls and the PuT line creates a mobile community. The TOD2 corridor inherits the character of the PuT line and a particular focus should be made on type of PuT service and vehicles, branding the line and creating attachment with the communities. Simple and clear design profile and information design supporting the branding of an attractive and reliable high quality service which is actively marketed to all citizens and visitors of the city would greatly help with corridor identity and visibility.

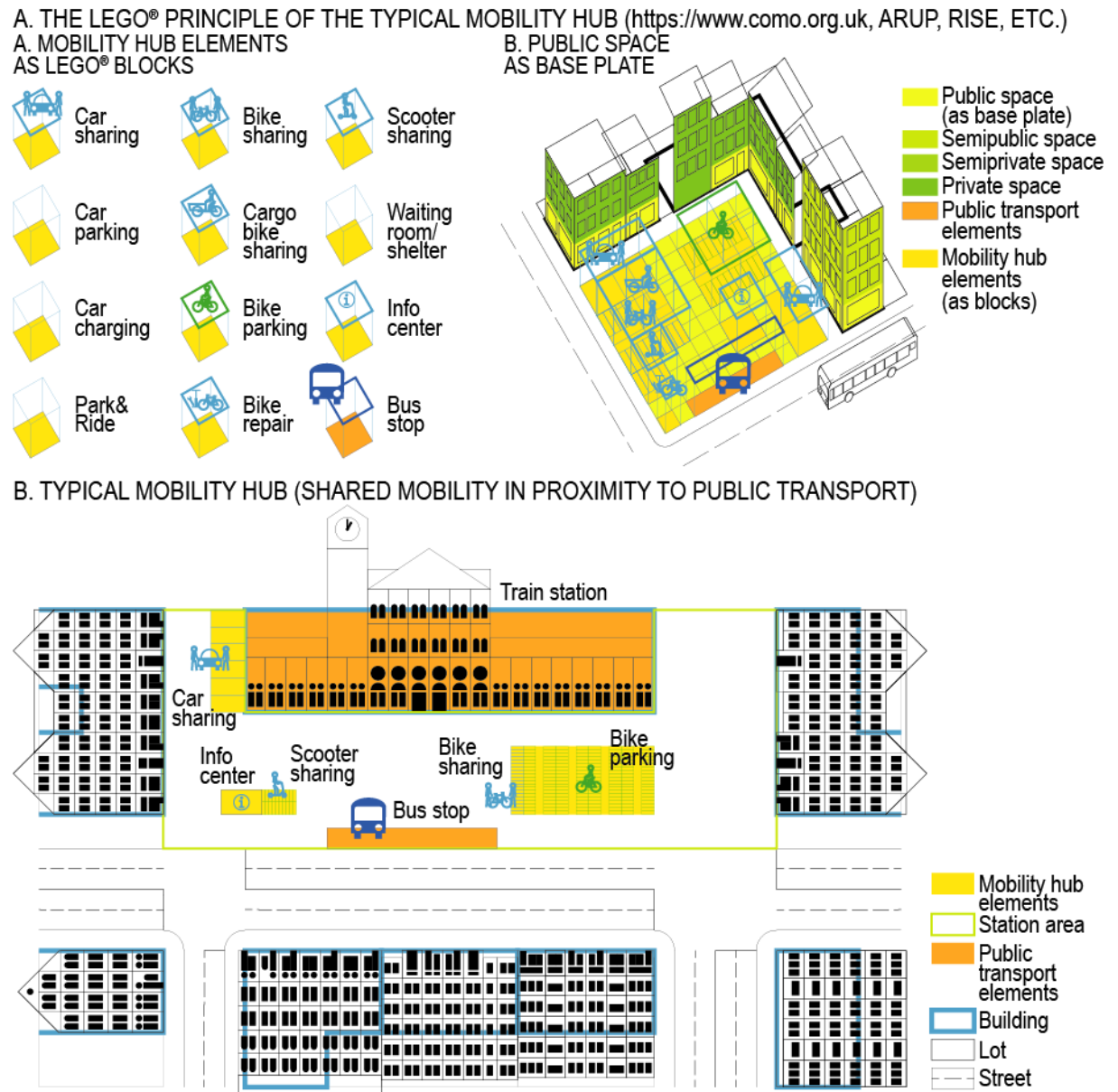
TO BE CONTINUED

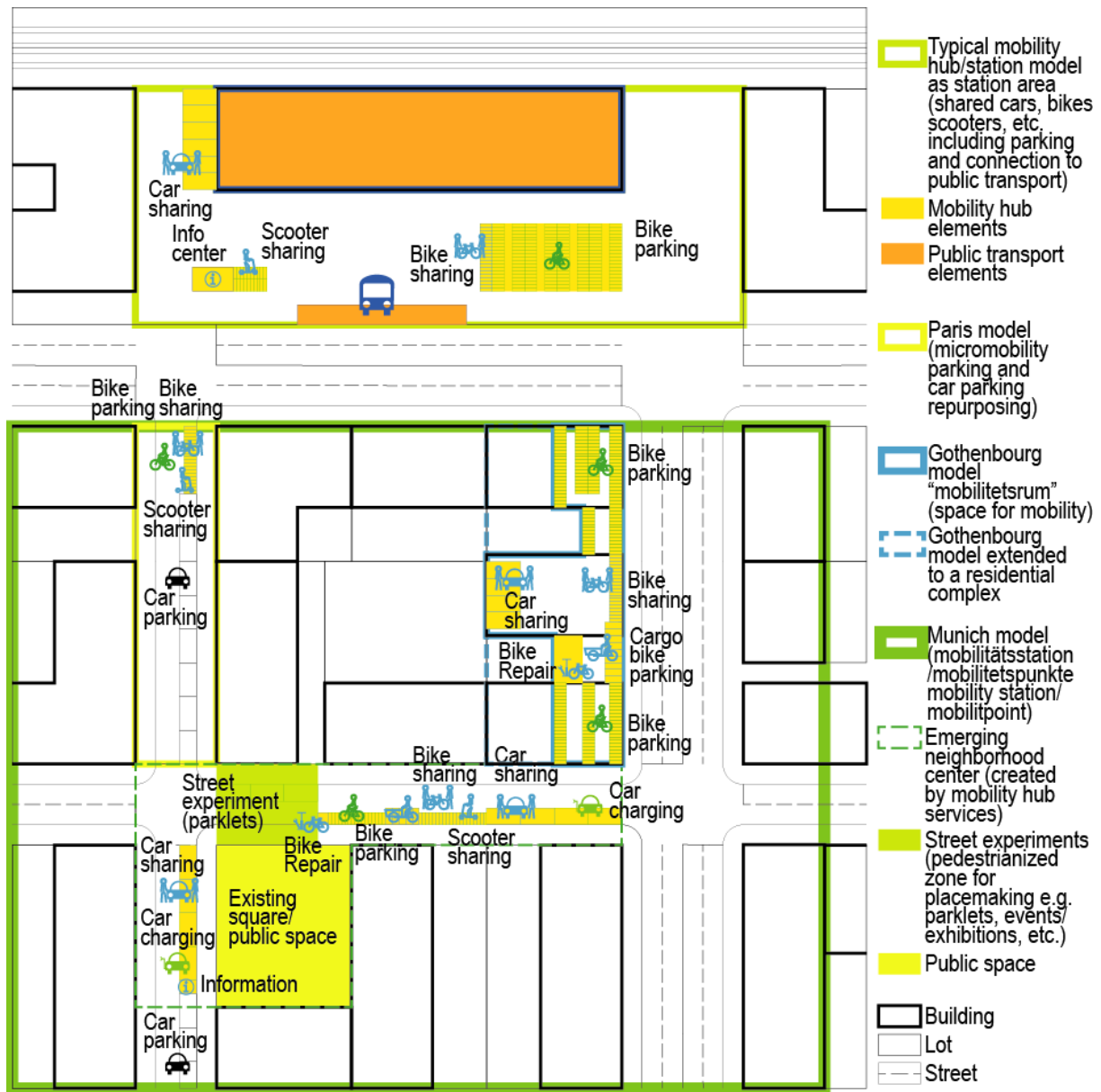
New trends (mobility hubs, sharing and automation)

Shared mobility and mobility hubs are emerging mobility culture in a process of transport morphogenesis. Mobility hubs are new shared mobility infrastructure aiming to boost accessibility (the so-called last mile) by offering on-demand mobility systems like shared bikes and electric cars at public transport stations and in surrounding neighborhoods. The mobility hubs furthermore include infrastructure for car parking and micromobility, connection to public transport, and supporting services such as bike repairs, information displays or counter, and amenities and commercial activities that boost the quality of public space. A mobility hub intersects many modes, but prioritizes sharing and boosts the visibility of shared mobility.

Figure 49: THE TYPICAL MOBILITY HUB AT TRANSIT STATIONS AND THE LEGO PRINCIPLE TO (→)

Based on ongoing transport morphogenesis and experiments worldwide as niche transport modes of shared mobility, **the TOD2 handbook describes a typology of mobility hubs that can be used by urban planners and designers.** The typology starts with the typical mobility hub that applies LEGO® blocks-like principle for designing mobility hubs crafted by advocacy groups and consultancies such as CoMoUK, WSP, ARUP, RISE, etc. The typical mobility hub includes mobility modules (typically with shared transport modes) and supporting elements. The typology is classified by morphological scales, the German “mobilitätsstation/punkte” (mobility station/point)





as Munich neighborhood model; the Paris micromobility parking model at a street scale, the Swedish "mobilitetsrum" (space for mobility) at a building scape and the robotaxi San Francisco model at a city scale. The characteristic of the **German "mobilitätsstation/punkte" (mobility station/point) model** that it is driven by private businesses (as branding, service and ownership of the vehicles) often in coordination with municipalities. **The mobilitätspunkte of Munich** offers micromobility parking for bikes, shared bikes, cargo bikes and scooters and shared cars, while pursuing street experiments and establishing pedestrian zones. Even though it keeps the LEGO® block-like pattern, the core idea is to create neighborhood centers around shared mobility by optimizing parking on streets and street remake.

Figure 50: MOBILITY HUB MODELS (->)

The Paris model is a response to the chaos caused by dispersal of e-scooters and e-bikes, in combination with a micromobility revolution . Unlike the mobility hubs in Munich that are neighborhood centered and they tend to be a creative LEGO® block-like patterns of clusters of shared vehicles organized rather chaotically on streets and in public spaces, **the Paris model standardizes mobility hubs and a micromobility parking**, located typically on side streets and offers parking for bikes (velo), motorcycles (moto) and scooters. The parking for micromobility would be typically located next to a corner café or bakery.

In contrast to the typical mobility hub, the models of Munich and Paris that center on the street and the neighborhood, **the Swedish "mobilitetsrum" (space for mobility)** highlights the building and its

off-street parking. Many Swedish apartment complexes and condominiums have shared facilities such as rooms with washing mashing (tvätstuga, literally washing cottage), for cycling storage (cykelrum) and for community gathering and parties (festrum) that should be conjoined to create mobility space.

Figure 51: MOBILITY HUB MODELS AT MORPHOLOGICAL SCALES AND POTENTIAL FOR TRANSIT-ORIENTED DEVELOPMENT (TOD) (→)

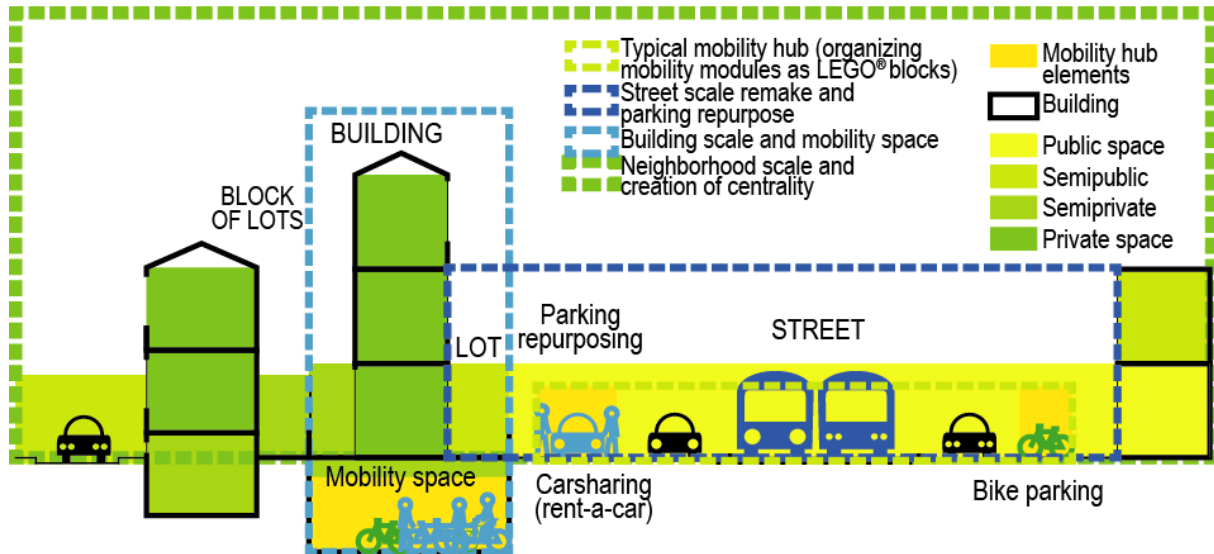
Unlike the other mobility hub types that are shared mobility at a scale of a building (Gothenburg model), on a street (Paris model), in a neighborhood (Munich model), the **robotaxi model of San Francisco** is initially without mobility hubs (curb based), but robotaxis can use all the mobility hubs models to pick up passengers and reload, creating a driver-free alternative to taxi, and rent-a-car and ride hailing.

The neighborhood model of Munich can be applied as intermediary step to developing TODs.

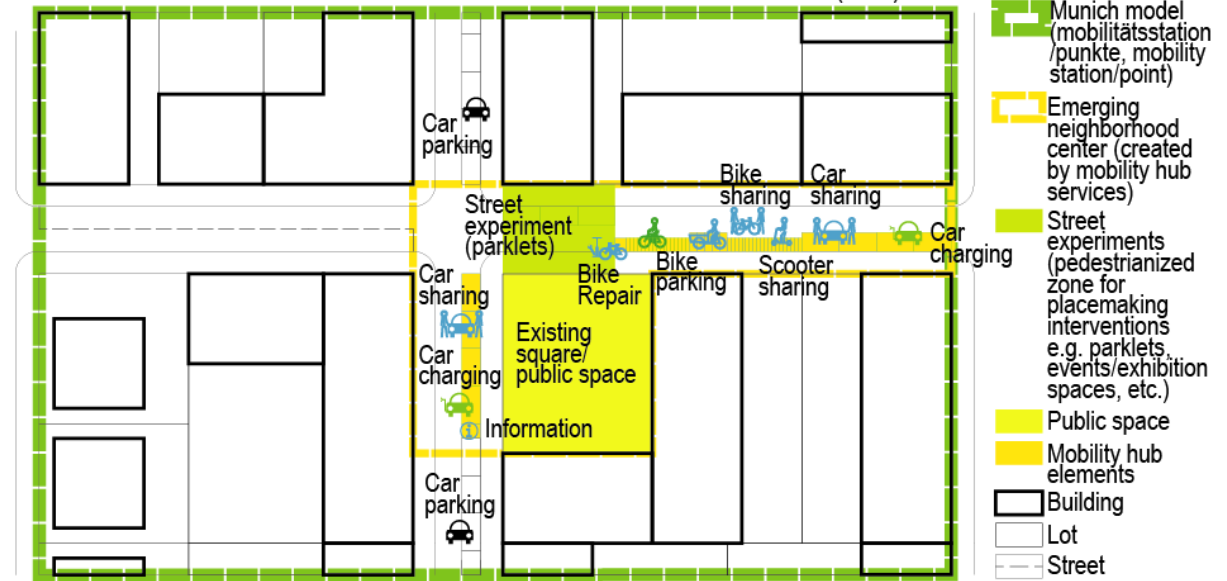
An intermediate step from car-friendly suburb to TOD can be introduction of new mobility hubs that work as multifunctional public spaces. Furthermore, the mobility hubs can be served by robotaxis, and they can create a new futuristic taxi system in combination with all models that can be alternative to the privately owned car and public transport. The mobility hubs will then have a central role in structuring nodes and public spaces for picking up passengers. It is however questionable if any (robo)taxi model is more sustainable than the private automobile model. Taxis typically do detours to pick up passengers and they need additional journeys.

TO BE CONTINUED

A. MOBILITY HUB MODELS IN A MORPHOLOGICAL STRUCTURE OF PUBLIC-PRIVATE SPACES



B. MUNICH MODEL AS POTENTIAL TRANSIT-ORIENTED DEVELOPMENT (TOD) EMBRYO



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Acknowledgements

This handbook is under continuous reiteration and version v0.2 is a second draft printed for the upcoming TOD2 conference in Copenhagen being part of two international projects:

<https://jpi-urbaneurope.eu/project/tod2/>

<https://www.vinnova.se/en/p/transit-oriented-development-tod-mobility-hubs-and-shared-autonomous-vehicles-savs/>

The research on TOD2 and mobility hubs is sponsored by the Swedish Innovation Agency Vinnova (grant number 2023-01114) and through JPI Urban Europe, by the Swedish Energy Agency (Energimyndigheten) (grant number P2023-00026). Much of the research and diagrams is produced during previous project supported by Riksbyggen's Den Goda Staden scholarship, grants from Vinnova (2015-03483) and Energimyndigheten (P44455-1 and P44455-2) and a Fredrik Bachmans Minnesfond scholarship.

The Public Transport (PuT) part is largely influenced by the work with Karl Kottenhoff on the course at KTH Royal Institute of Technology and Kalle's compendiums for students. A handbook on TOD and VRT was published in 2013.

Stojanovski T. och Kottenhoff K., (2013), Transit-Oriented Development (TOD) och Bus Rapid Transit (BRT): Stadsplanering för effektiv kollektivtrafik, Stockholm: Kungliga tekniska högskolan.

The handbook is printed as academic advocacy booklet without references and endnotes, just by naming the handbook bibliography.

Starting with Sweden (v0.2, a handbook under continuous reiteration)

Year 2023 marked the 30th anniversary of the book The Next American Metropolis that promoted Transit-Oriented Development (TOD) as Urban Design (UD) policy to prioritize Public Transport (PuT). The TOD2 handbook is written for laymen. It defines key terms and presents PuT hacks and UD tips to develop TOD visions seeking to inspire retrofit of car-dependent suburbs. TOD2 forwards mobility hubs as potential TOD embryos. Mobility hubs are stations for shared vehicles and there are new developments with Shared Autonomous Vehicles (SAVs). In practice it is often difficult to implement TOD, because many suburbs have high social status and there is strong resistance for redevelopment. With TOD2 and mob hubs as public spaces and stations for shared vehicles, SAVs, podcars and robotaxis, the TOD pearls can change in size and access. A mobility hub on a street can potentially transform neighborhood into a future TOD.

TOD2 highlights a set of objectives:

1. Emphasize human scale and travel experience in a “whole journey” perspective with focus on urban morphology, public spaces and commercialization for improving walking, waiting and onboard transit experience
2. Enriching the “string of pearls” TOD1 approach with highlighting design of PuT at various scale (“pearls”, corridors, networks) combining UD manuals and transit handbooks
3. Highlighting carbon neutrality and transport energy efficiency with morphological indicators and digitalization
4. Advocating for mobility hubs with new shared mobilities (robotaxis, podcars, etc.) as intermediary step for retrofitting suburbs
5. Developing green TOD visions with integrating ecological design and urban agriculture
6. Promoting public mobility as post-car culture of mobile communities (including passengers, drivers, conductors, transit vehicles, etc.).

