

# FINE-GRAIN PARCELS AND PLOTS

INTEGRATED GUIDELINES FOR SUSTAINABLE NEIGHBOURHOOD DESIGN

Urban Morphology & Complex Systems Institute

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# TABLE OF CONTENTS

<b>INTRODUCTION</b>	<b>2</b>
<b>PLOT PATTERNS AND FINE GRAIN</b>	<b>4</b>
<b>PLOT PATTERNS AND RESILIENCE</b>	<b>7</b>
<b>DIVIDING LAND IN PARCELS AND PLOTS</b>	<b>11</b>
BENEFITS	11
DEVELOPMENT PROCESS	11
<b>REASSEMBLING LAND</b>	<b>12</b>
<b>PHASING PARCEL DEVELOPMENT</b>	<b>13</b>
<b>REFERENCES</b>	<b>32</b>

# FINE-GRAIN PARCELS AND PLOTS

## INTRODUCTION

Property lines define plot patterns. They are the fundamental component of urban land. The divisions and the 'grain' of the plot subdivision shape the form of the city. The plot divisions in most European cities were historically determined, rooted in a territory, topography and climate, based on rural subdivisions. Traditional cities comprised a variety of buildings giving rhythm to urban space. In contrast, the modern city wiped the slate clean, along with its subdivisions, to create a world of huge towers, a monotonous no man's land lacking in diversity.

Sustainable urbanism should acknowledge the fundamental importance of the plot in the spatial structure of urban fabrics. How the plot is shaped, its size and geometry, its relationship with the street and the street hierarchy, how it forms up street fronts and eventually urban blocks, how all this informs human activities and urban functions, and finally how the plot finds a correspondence with property, usage and

control, all that is fundamentally the matter of sustainable urbanism<sup>1</sup>.

'At the heart of plot-based urbanism is the understanding that streets and street fronts require diversity and adaptability to support urban life; in design terms this implies, very simply, smaller units. The modernist/place-making block is still unitary in its overall conception and execution because it is conceived as the unit. The traditional city block was smaller and made of aggregations of smaller units, the plots. Plots have a direct relation to the street, with a profound impact on diversity and character, but also to the number of entrances to the block, with impact on activity within the block. Moreover, plots are independent, with impact on the diversity of the block, and guarantee that such diversity reflects the streets on which the block sits, impacting on its responsiveness to city life.'<sup>2</sup>

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<sup>1</sup> Porta and Romice 2010.

<sup>2</sup> Porta and Romice 2010.



*Plot pattern around Lille Grand place within a circle 300-m radius. Drawing by Emile Tack. École Spéciale d'Architecture, Paris.*

Sustainable approaches distance themselves from large schemes on unitary sites (that is un-subdivided sites wiped out of their pre-existing structures). They engage with the complexity of the city itself, that is an entity with multiple scales, each scale subdivided into hundreds, or thousands of parcels. Sustainable design doesn't seek to reduce the city to the simplicity of a unitary site as a blank slate, but instead takes the city plural quality as a basis for a plural urbanism. Small parcels and plot subdivisions facilitate a greater diversity of forms and uses, as well as a more active street frontage.

Development parcels are tracts of land, usually under a single ownership, and are the basis for most new urban developments. Plots, on the other hand, are generally much smaller increments or land holdings that form the basis of most of our built heritage – giving established centres their variety and fine urban grain. For securing diversity and resilience, the grain of development should be kept fine at both levels. Subdividing large projects into construction parcels provides benefits in

speed and value of development. Careful planning is required to guarantee that the size and layout of these parcels contribute to the master plan vision and are financially viable. Design codes can help create a coherent sense of place and ensure high design standards for all parcels.

This chapter is divided into five sections

- PLOT PATTERNS AND FINE GRAIN
- PLOT PATTERNS AND RESILIENCE
- DIVIDING LAND IN PARCELS AND PLOTS
- REASSEMBLING LAND
- PHASING PARCEL DEVELOPMENT

And explores in detail three case studies

- PLOTS, PROCESS AND DESIGN IN VAUBAN AND POTSDAM
- MANHATTAN PARCEL AND PLOT EVOLUTION
- PLOT SIZES DISTRIBUTION IN MANHATTAN AND INNER PARIS

## PLOT PATTERNS AND FINE GRAIN

The variety and rhythm of the urban experience created by a fine subdivision of the blocks into many small plots is what creates interesting urban environments. For example, someone leaving the National Archives, 700 Pennsylvania Avenue, in Washington, D.C., and crossing 9<sup>th</sup> Avenue and 10<sup>th</sup> Avenue, will reach the Old Post Office, 300 metres

away, in four minutes having encountered six buildings. During a four-minute walk in Copenhagen centre, a person will go by 42 edifices. Smaller spatial dimensions, more variation, more changes in direction, and narrower blocks impact the walking experience and make it more enjoyable.



*The grey line indicates the length of the two four-minute walks, in Washington, D.C. (left) and in Copenhagen (right). They are reproduced here on plans at the same scale. (Based on Allan Jacobs, in Bosselmann 1998)*

## How fine is fine grain?

Fine grain refers to the number of distinct constructions and uses per unit of land. The higher this number the finer the grain of the urban fabric and its formal and uses diversity.



*Cadastral plan of Auteuil neighbourhood in Paris within a circle 300-m radius. Drawing by Victoria Frey. École Spéciale d'Architecture, Paris.*

For instance, Paris *intramuros* (the historical city of Paris containing 2.2 million inhabitants in 84.5 km<sup>2</sup> without the woods) is divided in 70,000 different plots. This represents an average of 8.3 plots per ha. The central districts present 25 plots per ha (3 times the average) while the urban fabrics built in the 20<sup>th</sup> century have only 2 to 3 plots per ha. Paris *intramuros* comprises 100,000 buildings, that is 12 buildings per ha on average. The most central neighbourhoods present an even finer grain with between 25 and 45 buildings per ha (between 2,500 and 4,500 buildings/km<sup>2</sup>). The traditional urban tissues were very finely grained. A radical change happened at the turn of the 20<sup>th</sup> century. Modernist types are 10 times less fine grain than pre-19<sup>th</sup> century ones. They comprise only 4 to 5 buildings per ha compared to more than 40 in the city areas built before 1800<sup>3</sup>.

<sup>3</sup> Salat et al. 2011.

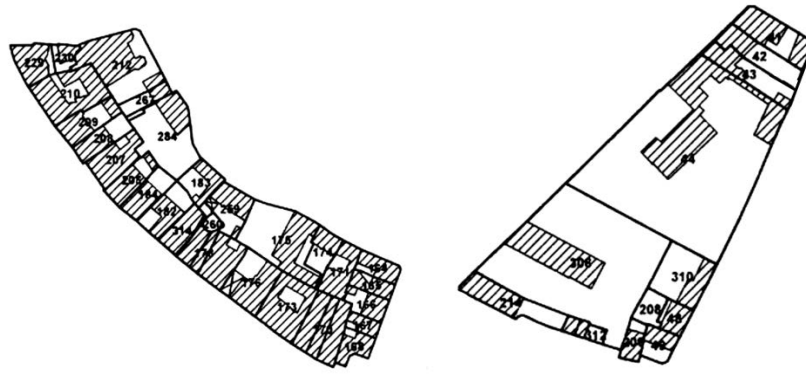


*Cadastral map around Place des Vosges in Paris within a circle 300-m radius. Drawing by Charline Roizon-Monserrat.  
École Spéciale d'Architecture, Paris.*

**Senlis, France, plot patterns**



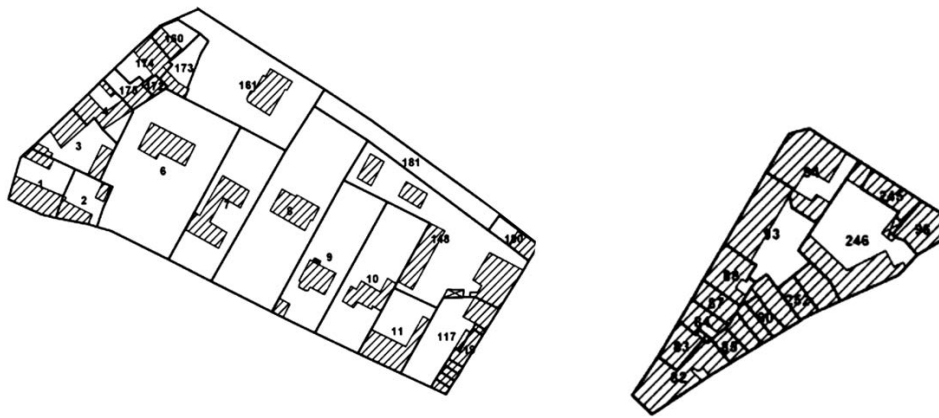




*Senlis historical core distinct plot patterns. Drawings and analysis by Ulysse Bérard. École Spéciale d'Architecture, Paris.*

*Left: The block is complex and made up of narrow and irregular rectangular plots. It comprises 34 plots, corresponding to 67.9 plots per hectare.*

*Right: The block is made up of narrow rectangular plots and large lots housing mansions and their gardens. It features 11 plots equating to 23.8 plots per hectare.*



*Senlis historical core distinct plot patterns. Drawings and analysis by Ulysse Bérard. École Spéciale d'Architecture, Paris.*

*Left: The block is made up of narrow but deep rectangular plots. It comprises 21 plots, corresponding to 17.5 plots per hectare.*

*Right: The block is made up of narrow rectangular plots and large lots in the North-East housing public buildings. It features 17 plots equating to 66.1 plots per hectare.*

## PLOT PATTERNS AND RESILIENCE

Plot patterns are the most immutable presence of a city's past, of its urban fabric enduring resilience through catastrophic destruction or gradual change. Considering lots is fundamental to understanding urban structures as they are one of the most stable elements of cities. Once established, land lots show temporal inertia and correlations over long-time scales. Rome is an example of this permanence. When an Empire falls, several simultaneous phenomena occur: the progressive disappearance of ancient habitation patterns, the reinterpretation of public statues and

buildings, especially with temples transformed into churches or broken up and dismantled, but ancient land lots inherited from the empire are still present in Medieval and modern cities.

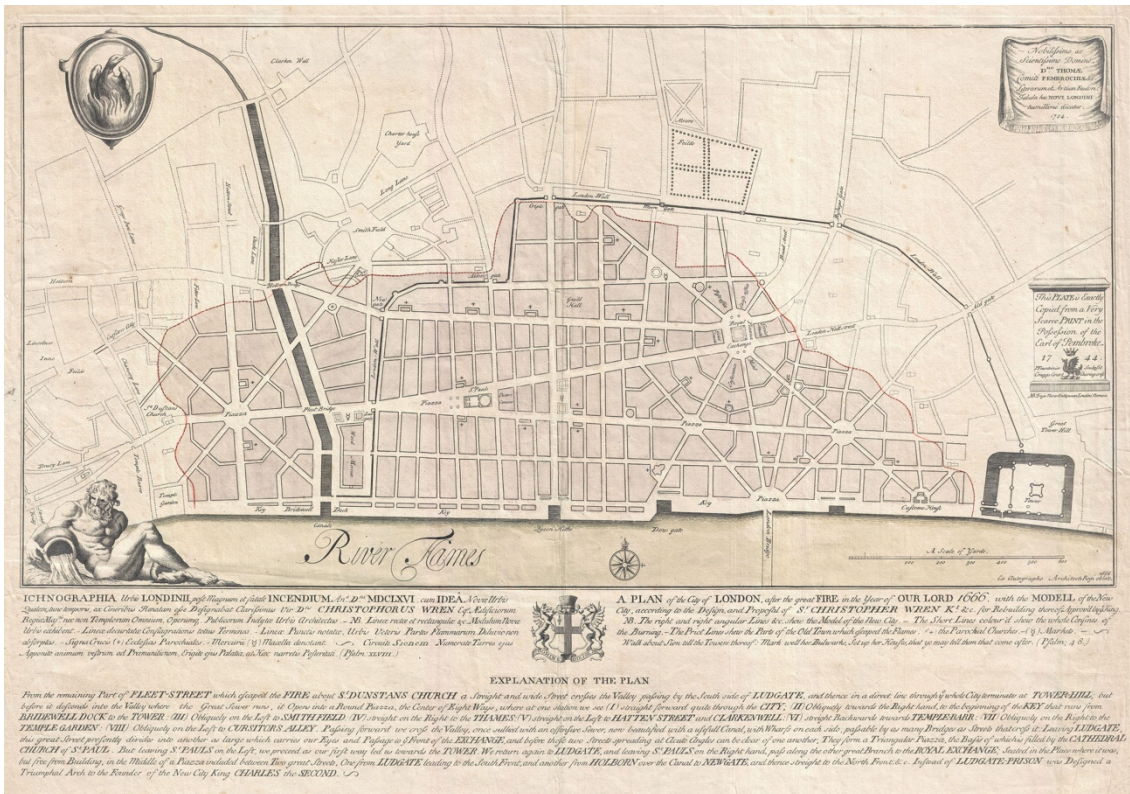
In 1666, London was reduced to ashes by the Great Fire, but the intricate pattern of narrow medieval streets and plots is still where the City traders walk today. The Great Fire of London was a major conflagration that swept through the central parts of London from Sunday, 2 September to Thursday, 6 September 1666.

The fire gutted the medieval City of London inside the old Roman city wall. The fire destroyed 13,200 houses,

87 parish churches, the Royal Exchange, Guildhall and St. Paul's Cathedral.



The Great Fire of London, depicted by an unknown painter (1675), as it would have appeared from a boat near Tower Wharf on the evening of Tuesday, 4 September 1666. To the left is London Bridge; to the right, the Tower of London. Old St Paul's Cathedral is in the distance, surrounded by the tallest flames.



Christopher Wren's rejected plan for the rebuilding of London.

Radical reconstruction schemes poured in for the gutted City and were encouraged by the King. If it had been rebuilt under some of these plans, London would

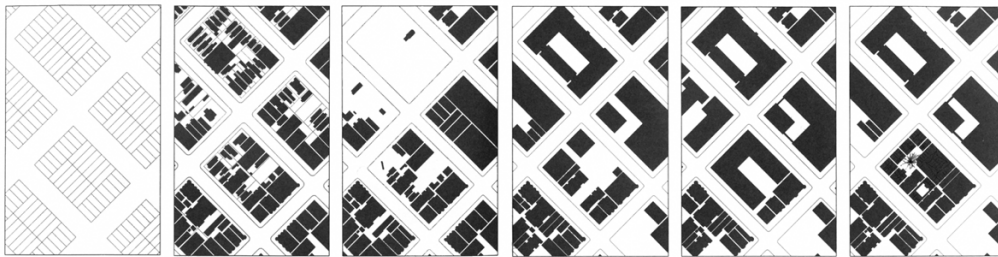
have rivalled Paris in Baroque magnificence. Wren and Evelyn, Robert Hooke, Valentine Knight, and Richard Newcourt proposed redevelopment plans. The Crown

and the City authorities attempted to negotiate compensation for the large-scale remodelling that these plans entailed, but that unrealistic idea had to be abandoned. Instead, much of the old street plan and plot pattern was recreated in the new City. Improvements in hygiene and fire safety included wider streets, open and accessible wharves along the length of the Thames, with no houses obstructing access to the river.

Paris has been almost completely rebuilt during the 19<sup>th</sup> century, but its street grid and property lines date in many parts from the Middle Ages. Were Manhattan to be entirely regenerated with new structures, its street grid and property boundaries, most dating from the early the 1811 Commissioners' Plan, would continue to shape development. The tall and narrow office buildings lining lower Broadway east of Greenwich Village reflect the precise dimensions of row houses that once occupied the site. Tokyo, the biggest city on

Earth, originally composed of tiny houses, is also such a palimpsest where property lines dating centuries ago are still the underlying geometry of the urban fabric.

The homogeneity or the tears in the urban fabric will depend on plot evolution. They may evidence complexification over time (as in Japan), moderate simplification as in the centre of Boston or New York, or brutal destruction. The continuity over time of these subdivisions cements the unity of the neighbourhood by limiting the types of buildings. Slow development permits a reasonable degree of modernization that respects the integration of scales between the different elements. Narrow plots, with dimensions close to those in the Middle Ages – ensure the unity of London and Brussels, for instance, despite the mix of epochs and architectural styles. By contrast, the destruction of plot subdivisions leads to a radical break with the past and a profound disorganization of the urban fabric.



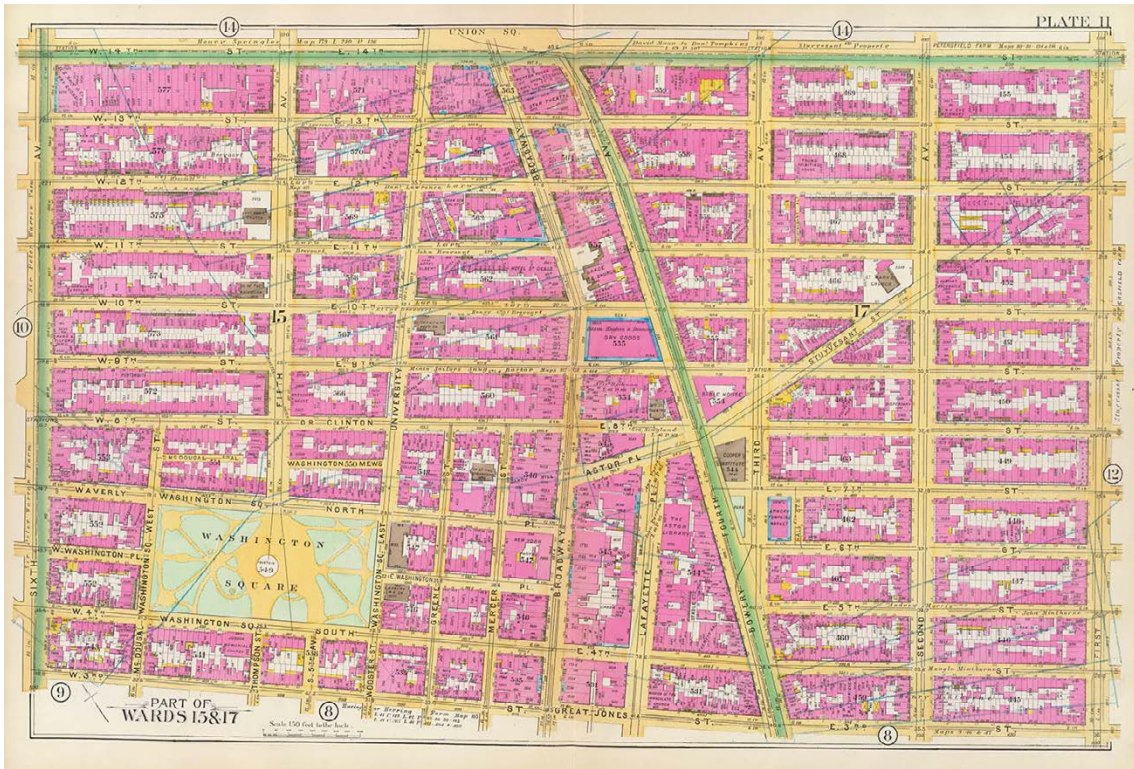
*Oakland's block morphology shows how American urban blocks have become simpler and more massive since the 19th century. Left to right: Kellersberger's platting from 1852; conditions in 1912, from a cadastre map; conditions in 1951; conditions in 2000; proposed changes in 2000; alternative development plan, not implemented. Source: Bosselmann 2008.*



*Unlike the American plot, the Japanese plot is subdivided and becomes more complex over time, creating a 'fractal' city where the land use testifies to a complex society. Comparison of plot structure between the mid 19th-century Edo period (left) and the same site at present (right). Source: Firley and Stahl 2009.*

Fine grain ensures adaptive resilience of cities to ever-changing economic conditions with bottom-up

processes constantly increasing the diversity and complexity of neighbourhoods.



Greenwich Village, Bromley insurance map, 1891.



Washington Square in 1916 (left) and today (right).

Manhattan provides a good example of such an approach. Originally, its land plots were sold in units of 200 square metres. Such small plots fostered an active land market with great potential of future mixed use. Over time many plots of land in Manhattan have assembled, but 40% of all land still remains the initial size set two centuries ago. Few plots occupy whole urban blocks. We see a striking difference between land markets when comparing New York and current Chinese superblocks. The number of initial lots in

Manhattan is about 165,000; and the number of 500 m side non-subdivided superblocks in a similar 66km<sup>2</sup> area in a typical Chinese new development is only 250! That huge difference in the number of the ‘building bricks’ explains why a diverse and resilient land market cannot emerge from a superblock pattern. It emerges only from traditional small lots when planning instruments are flexible and market responsive enough.

## DIVIDING LAND IN PARCELS AND PLOTS

A city or a development with all identical large plots of development is unbalanced. To ensure diversity of development, sustainable projects divide land into development plots. In Malmö for example, each plot has been given to one of thirty-four different architect-developer teams for detailed design. While each team

of architect developers had to follow urban design guidelines for height, density, green spaces, they were free to develop their architectural responses to site conditions. The result is a high variety of the block inner spaces with random, angled paths and small squares that contrast in scale, material and form.

### BENEFITS

The benefits of dividing a large scheme into discrete development projects include<sup>4</sup>:

#### Development benefits

- **Speed** – construction can proceed on several fronts simultaneously.
- **Flexibility** – it can give time for acquiring additional land.
- **Risk reduction** – the master plan is implemented through a series of deals. Contractual agreements can evolve according to performance on the preceding land parcels.
- **Value engineering** – the promoter can engineer a business model benefitting of higher land values in later phases of the project when the value of the place has been established.

### DEVELOPMENT PROCESS

- **Find a balance between design and development considerations.**

- **Mixed-use** – specialist developers can be brought in to undertake different elements of the scheme, such as retail or leisure facilities.

#### Urban design benefits

- **Variety** – different designers can work on separate parts of the project.
- **Diversity** – smaller land parcels enable a large project to be opened up to smaller developers and architectural practices.
- **Innovation** – small parcels can encourage innovative approaches to the layout and design.
- **Visual interest** – character areas will make the site interesting to move around and can enhance legibility.

Developers often prefer large plots and minimal variety in construction methods and components for reasons of efficiency, ease, certainty and

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<sup>4</sup> English Partnerships and Housing Corporation 2007.

management. However, encouraging creative design fosters diversity and establishes interesting, unique and identifiable places.

- **Divide land into effective parcels.**

The key design decisions are parcel size and location. Parcels should be sized according to their position in the street hierarchy. Large areas should be allocated to low-order streets and small parcels to prominent locations for finer grain. Where requiring a fine architectural grain, the number of design parcels defining a public space may be proportional to its importance in the spatial hierarchy.

- **Keep the parcel grain fine and involve a wide array of developers and architects.**

When planning large areas as a whole, it is sometimes possible to subdivide the development parcels and divide them among different developers, such as in Hammarby Sjöstad. Allowing a range of developers to participate is desirable to generate a richer mix of building types, tenure and uses. As an indication, parcels of 1 to 2 hectares avoid any 'monoculture'. This grain should be finer towards the neighbourhood centre.

- **Keep the plots small and narrow.**

Subdivision of development parcels into plots, as small and narrow as possible, promotes diversity of forms, uses and tenures and allows the creation of various buildings. This also

- Generates a more active frontage.
- Encourages 'human scale' and fine pedestrian grain.
- Enables higher density (large plots often generate detached buildings flanked by parking).
- Provides a flexible basis for further consolidation into larger plots if necessary and allows diversified incremental growth.
- Minimizes costly and wasteful leftover spaces.

Small, regular, and narrow elongated plots of 5 m by 20 m, accommodate different buildings and optimize the use of land. Larger plots are often needed for commercial, industrial or civic buildings. Subdivisions 15 to 20 m wide and 30 to 40 m deep provide flexible land increments for these areas. Wrapping these with smaller plots ensures that rear elevations and servicing are not exposed to the street while maintaining the fine grain of the neighbourhood.

## REASSEMBLING LAND

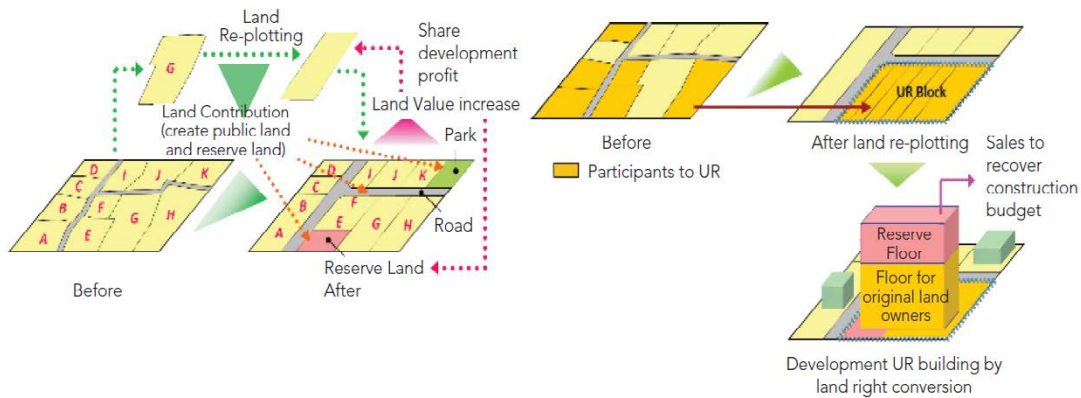
Land readjustment is a very useful tool in neighbourhood regeneration projects involving private land and fragmented land ownership. Land readjustment

- Enables the public and private sector to carry out necessary development projects to serve public interests through provision of infrastructure and service delivery.
- Can be done through land rights conversion method or whole purchase method.

This approach is commonly employed in East Asian countries, such as Japan and Korea. The government

gathers or assembles the various privately-owned parcels in an area. It develops a land-use plan for the entire area, including the designation of zones for infrastructure and land use, public services such as roads and open spaces. It then implements the plan and provides the necessary network infrastructure. At the end of the process, the government gives each owner a parcel of land proportional to the original parcel but smaller (for example, 50 to 60% of the initial parcel). The new parcel has a higher value because it belongs to a sustainably developed urban land. The government retains selected strategic parcels of land that it sells at auction or at market prices to recover the costs of its investments in infrastructure and service delivery.

## Land Readjustment Schemes in Japan



*Left: Land readjustment projects. Right: Urban redevelopment projects.*

Land readjustment is the major instrument of urban development in Japan

- 1/3 of all urban area in Japan (1/4 of area in Tokyo's Wards developed through land readjustment).
- 1/2 of all principal residential parks in Japan (parks amount to 14,000 ha).
- 1/4 of roads designated in City Plans (roads amount to 11,000 km).
- 1/3 of station plazas at major train stations in Japan (about 900 station plazas).

## PHASING PARCEL DEVELOPMENT

Development parcels may coincide with architectural parcels, or a single development parcel may be divided into several architectural parcels. If the same construction technique is used in different architectural parcels (perhaps for construction economies), it should be specified initially in the briefing for the architectural commissions.

To minimize disruption to residents during construction, design or development parcels may be subdivided along the rear of the parcel or as seams in public areas

- Along the back of the parcel to facilitate construction in the less busy streets.
- Within the public realm at key locations requiring diversity.

To ensure coherence, one person or entity should supervise the public domain.

Ensuring that infrastructure and public domain construction is consistent with design intent (and subsequent adoption) can be difficult when land is subdivided into different development parcels. Problems can be exacerbated where planning parcels join. Three options minimize potential disruption and ensure continuity<sup>5</sup>

- Attaching detailed specifications for the infrastructure to the sale of the land and follow by rigorous on-site inspections.
- The promoter's team (urban design, engineering, landscape) is seconded to each developer.

The promoter builds infrastructure in advance, including streets, and provides serviced land.

<sup>5</sup> English Partnerships and Housing Corporation 2007.

## CASE STUDY: PLOTS, PROCESS AND DESIGN IN VAUBAN AND POTSDAM

### Vauban in Freiburg, Germany

An example of subdividing the land in plots is the scheme of Vauban in Freiburg. The city followed a small-scale approach in terms of cadastral division and did not hand over the whole site to a single developer. Historically, the land had been under single ownership since 1936. The city devised a scheme where *Baugemeinschaften* (building communities) or *Baugruppen* (building groups) bought separate plots. These are associations of private individuals created for a particular project construction, generally for the stakeholders' housing needs. Legally flexible and adjustable to the future occupier's competence and desired degree of involvement, they now comprise an increasingly important part of the residential market throughout Germany. *Baugruppen* schemes represent a shift from a top-down planning process, in which the customer has to choose from a conventional, often very limited supply, towards a far more complex market.

The multitude of participating interests has led to a diversity of architectural solutions within a rather neutral urban design scheme. East-west oriented slabs allow the majority of dwellings to have an optimum exposure to natural light. The residential part – mainly four and occasionally five stories tall – offers a large variety of designs and density. They comprise conventional apartments, one-family terraced houses, and small-scale apartment buildings, with two or three separate units – often stacked duplex dwellings – partly accessible from exterior staircases.

### Design guidelines in Potsdam Kirchteigfeld

After acquiring the 58.7 ha site, the private developer Groth + Graalfs organized a charrette aimed at formulating a vision with six invited architects and members of Potsdam's planning services. After three months and several sessions, the office of Rob Krier and Christoph Kohl (KK Architects) was invited to continue with the detailed urban plan. All other charrette members were subsequently asked to contribute in the future master plan plot design. Several other architectural practices completed the participants of the workshop. Each of them received, for every building plot, design guidelines established by Krier and Kohl practice.

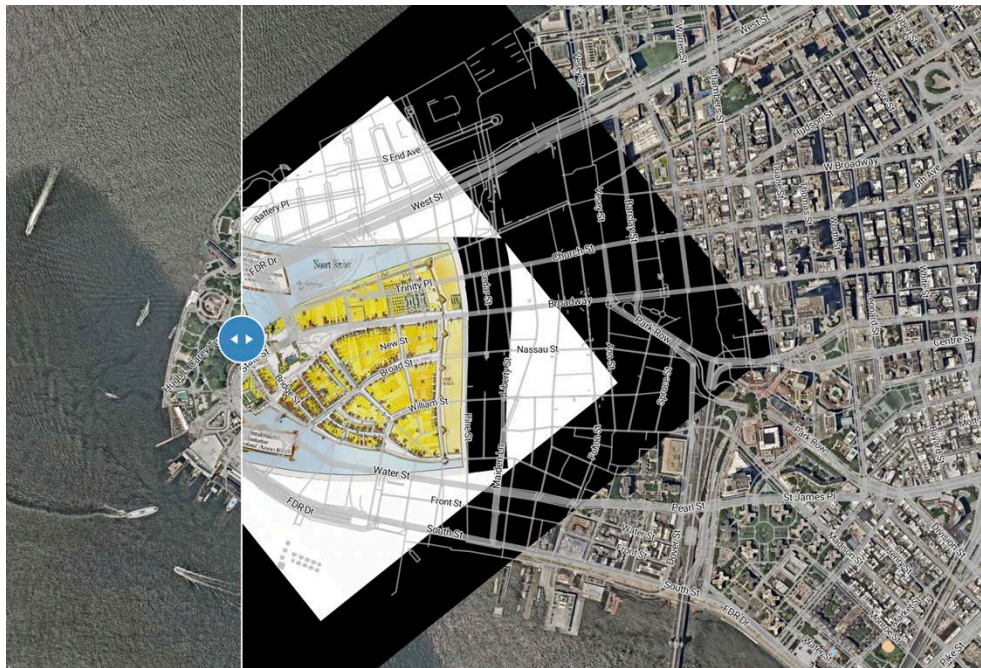


*Parcel Structure of a block with the distribution to different architects.*

Twenty-four parties participated in this process, representing many architectural styles. Of major importance for the project urban coherence, and crucial to the perimeter block design concept, was the decision to subdivide blocks into plots designed by separate architects. Looking at the plans, we are reminded of Camillo Sitte book, *City Planning According to Artistic Principles* (1889). He pioneered applying the shape of traditional urban spaces – evolved over a long period of time – to the design of contemporary neighbourhoods.



CASE STUDY: FROM MANNAHATTA TO MANHATTAN, ADAPTIVE RESILIENCE OF A PLOT PATTERN



Overlay of Manhattan in 1665 and today.



Picture of the City of Amsterdam in New Netherland. The Castello Plan. Jacques Cortelyou<sup>6</sup>/Anonymous, ca. 1665.

The Lenape, Manhattan's original inhabitants, called the island Manahatta, which means 'hilly island.' Rich with natural resources, Manahatta had an abundance of fruits, nuts, birds, and animals. Europeans Giovanni da Verrazzano in 1524

<sup>6</sup> Jacques Cortelyou (ca.1625 – 1693) arrived in New Netherland from Utrecht in 1652 and was commissioned by the provisional government as the surveyor general in 1657. Cortelyou's original survey is now lost but sometime around 1665 a 18 x 25" ink and watercolour manuscript map was prepared from it by an anonymous draftsman. The manuscript ended up with the cartographer Johannes Blaeu (of *Atlas Major*) who bound it into an atlas and sold it to Cosimo de' Medici, Grand Duke of Tuscany. The map was rediscovered in the de' Medici's Villa di Castello near Florence in 1900, hence its Italian name – the Castello Plan. It is now in the Biblioteca Medicea-Laurenziana.

and Henry Hudson in 1609 sailed into the Manahatta harbor. In 1624, as the Dutch settled in what is now Lower Manhattan, the Lenape of Manahatta began to lose their homeland. Mannahatta became the Dutch trading post of New Amsterdam. To safeguard Dutch interests in New Netherland, Willem Verhulst, the second Director-General of the Dutch West India Company (WIC), built Fort Amsterdam in 1625. It was on the southern tip of Manhattan Island at the juncture of the East and Hudson rivers. The fort served as a military outpost and an administrative and commercial centre. After the third WIC director Peter Minuit famously 'purchased' in 1626 Manhattan Island from the Lenape for 60 guilders (about US\$24 at that time) worth of trade goods<sup>7</sup>, the company began relocating settlers to the area around the citadel forming the town of New Amsterdam.

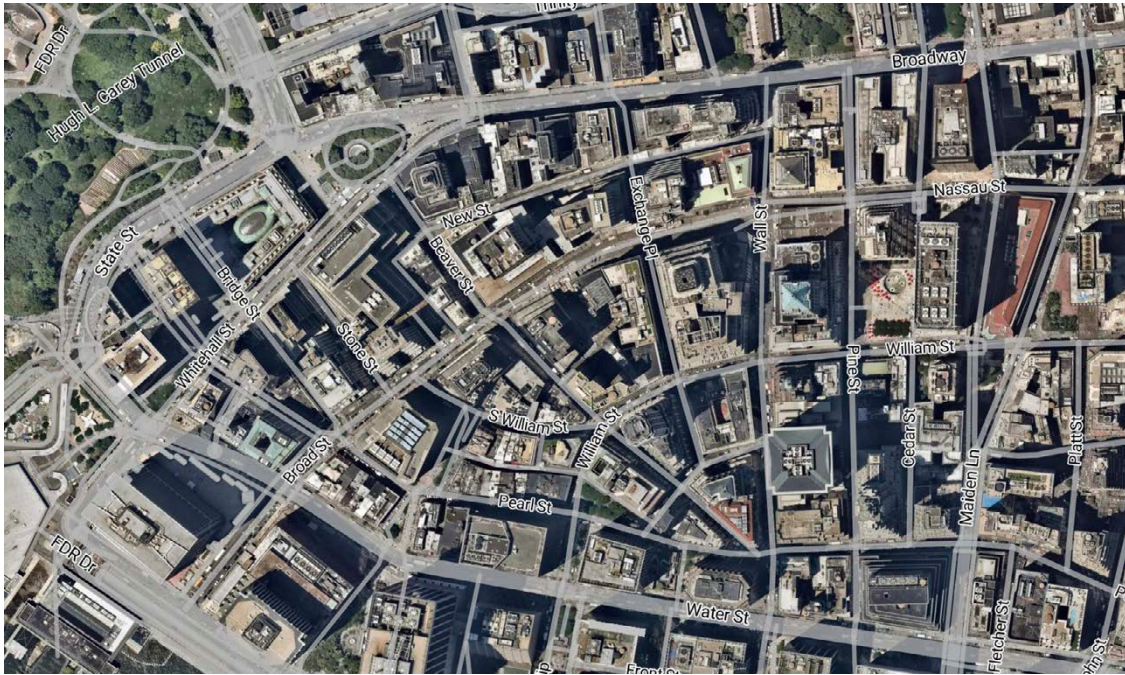
The town slowly grew with a mixture of not only Dutch settlers but Walloon, Huguenot, Frisian and English, and later African slaves and Ashkenazic and Sephardic Jews. The population was 270 in 1630, perhaps 400 in 1638 and nearly 700 by the time Peter Stuyvesant, the seventh and last director, arrived in 1648. Stuyvesant, among other things, set out to turn New Amsterdam into a proper Dutch town. He widened and lengthened streets, transformed the refuse stream into a *gracht* (canal), built a pier and in 1653 constructed a 'high stockade and small breastwork across the northern frontier' [now Wall Street]<sup>8</sup>.



*1660 Map of New Amsterdam (Today known as New York City), in the colony of New Netherland. Redraft of the Castillo Plan in 1916 by the historian I. N. Phelps Stokes and the artist John Wolcott Adams.*

<sup>7</sup> However, the Lenape didn't see the transaction as the official handing-over of one thing for another. They saw it as a chance to share the land with the Dutch. Minuit, however, saw the transaction as a sale, and assumed the Dutch had become the owners.

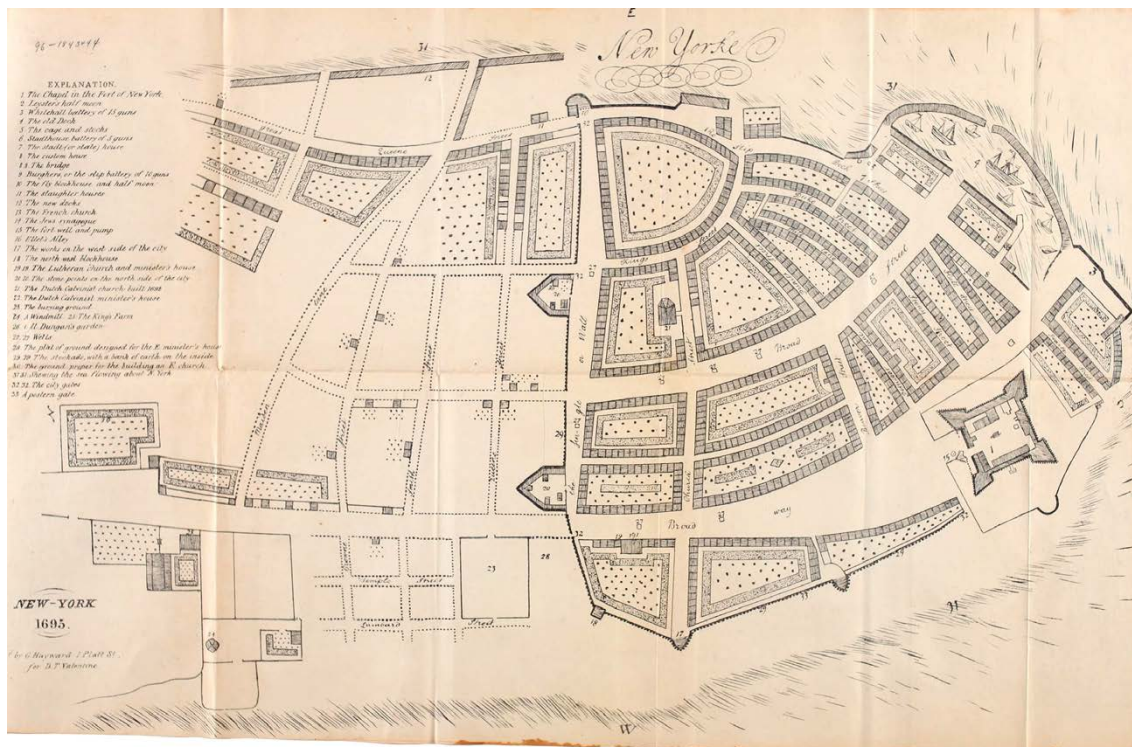
<sup>8</sup> NYC 99. <http://www.nyc99.org/1600/castillo.html>



Resilience of block and street patterns. Above: map of New Amsterdam in 1660. Bottom: aerial view of Lower Manhattan today with Wall Street occupying the site of the original Dutch City wall. The street next to the 12-ft earthen rampart was named de Waal Straat. English surveyors laid out a new road along the original outline of the rampart.



The Castello Plan recreated in 2008 by Peter Ekamper, a senior researcher at the Netherlands Interdisciplinary Demographic Institute.

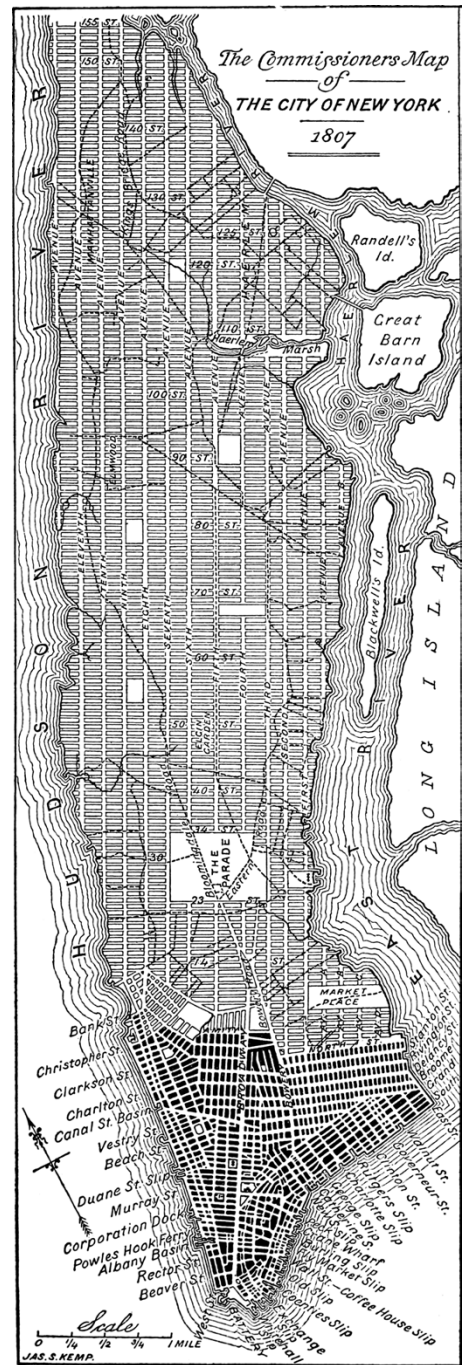


*The Miller Plan. New Yorke. John Miller, 1695.*

In 1664, New Amsterdam became the English settlement of New York. Initially New York was indistinguishable from New Amsterdam. By the 1670s, however, the English governors began to make their improvements to the city. In the 1675 the canal (Heere Gracht) was filled. As trade grew so too did the population: from some 3,000 in 1680 to nearly 5,000 by 1700. To accommodate this increase, 'water lots' on the East River shore were offered to those who would fill them in and construct houses. New streets were laid out in 1691, 1694 and 1700. Finally, in 1694 the wall was torn down due to the 'Incroachment of Buildings.' Despite the removal of the wall virtually the entire city – now some 750 buildings – were still tightly clustered south of present-day Fulton Street<sup>9</sup>.

Before the grid, New York City grew organically. Concentrated at the Southern tip of the island, it was a knot of short streets, some dating to the Dutch settlement of New Amsterdam, shaped by local conditions and lacking a unifying order. Along the way, Mannahatta original landscape of marshes, woodlands and hills has been transformed into a Cartesian grid.

<sup>9</sup> As Sarah Kemble Knight wrote in 1704: 'The Cittie of New York is a pleasant, well compacted place, situated on a Commodius River wich is a fine harbour for shipping. The Buildings Brick Generaly, very stately and high, though not altogether like ours in Boston. The Bricks in some of the Houses are of divers Coullers [diverse colours] and laid in Checkers, being glazed look very agreeable.'



Left: The Mannahatta map. Eric Sanderson, 2009. Using a geolocated version of the 1782 British Headquarters Map, historical records, even rock and soil samples, Sanderson and his team spent five years creating a digital terrain model of early Manhattan. Being an ecologist Sanderson reconstructed the forensic ecology of the island, identifying 55 different ecological communities and populating it with as many as 1000 different species. Finally, by connecting these diverse relationships in a network Sanderson created the likely habitats of these species. The 2009 Mannahatta Map is, as Sanderson writes, 'a view of Manhattan a few hours before Hudson arrived that sunny afternoon four hundred years ago'.

Right: The Commissioners' Map of the City of New York, 1807 (modern redrawing in James S. Kemp, June 1893. 'The Evolution of New York: Second Part.' Harper's New Monthly Magazine 87 – 542 – : 23.

Most of the island was a patchwork of farms and meadows, ponds and marshes, laced with meandering country roads and providing ample ground for expansion. The Common lands were vacant land first granted by Dutch provincial authority to the government of New Amsterdam in 1658. After the Independence War, the city was bankrupt. To

facilitate the Common lands sale, Casimir Goerck prepared in 1797 a subdivision plan<sup>10</sup> with three long and parallel streets, which would eventually become 4th, 5th and 6th avenues.



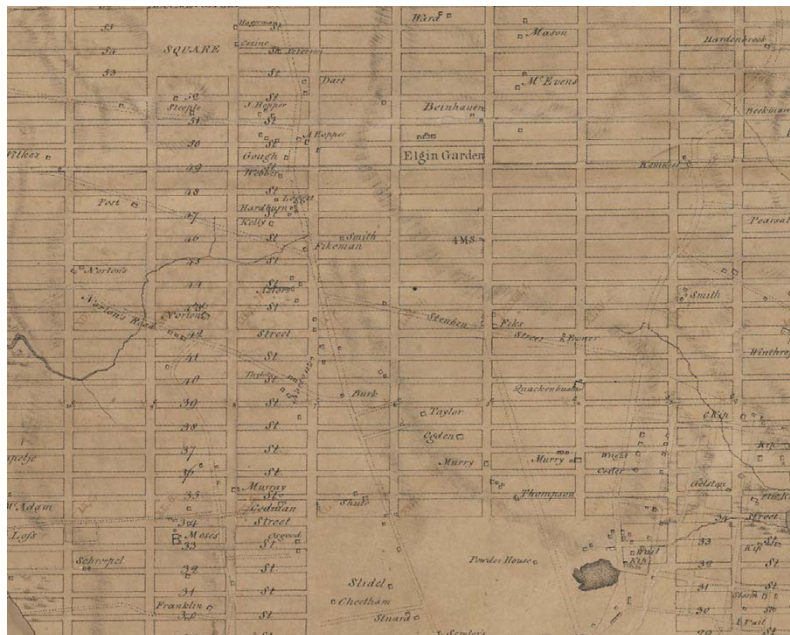
*The Mangin-Goerck Plan. In 1797 the city council commissioned the architect Joseph-François Mangin and the surveyor Casimir Goerck to prepare a survey of the existing streets. It took Mangin four years to complete his Plan and Regulation of the City of New York. The map included not only the existing streets but his own proposed grid. As he said it was not 'the plan of the city such as it is, but such as it is to be'.*

In 1807, the city council undertook to establish a comprehensive street plan for Manhattan. Or more specifically to '[lay] out Streets ... in such a manner as to unite regularity and order with the public convenience and benefit and in particular to promote the health of the City...' The Commission completed their plan by early spring 1811. Randel prepared a monster size – 2.54m × 0.76m – pen and ink map which was accepted by Mayor Dewitt Clinton on 4 May. The Commissioners' map overlaid the final grid of rectangles over the island. This plan started the rise of New York real estate market and land values ascent.

<sup>10</sup> By 1794, hoping for increased sales of Common Lands, the Common Council hired Goerck to add roads to the east and west of his original middle road – these would become Fourth and Sixth Avenues when the Commissioners' Plan came out. He was also to lay out east-west streets connecting the three north-south roads, which would later become the numbered streets of the 1811 plan. The Common Lands were now divided into 212 numbered blocks of a size close to 2.0 ha.



*This detail from John Randel's original pen-and-ink map of the Commissioners 1811 street survey shows the 'intersection' of the existing New York street plan – Greenwich Village, left – with the proposed grid – starting with 1st Street in the Lower East Village. It is a glance of both the past and the future of New York City.*



*Detail of Manhattan 1811 Commissioners' map. Present-day Times Square.*

The Manhattan grid was foremost a format to facilitate the sale of terrain and land development. The grid emptied the actual island of any local or topographical feature. It became a pure, abstract surface. The hills were erased in an irresistible drive to develop the avenues northwards.

The grid transformed the island into a pure concept: that of an infinitely versatile, combinatorial land market, open to endless speculation, ceaselessly recreating itself, with constantly rising land and property values. In 1807, the assessed value of the New York City real estate was \$25 million. In 1887, it was \$2 billion, an 80-fold increase.

This apparently uniform and isotropic grid, erased all topographical variations. It would give rise to an incredible diversity of structures: neighbourhoods with identities as distinct as the Washington Square of Henry James, Soho, Tribeca, the Upper East Side, or Woody Allen's Brooklyn. How could this diversity and scaling properties emerge from a grid? Thanks to subtle differentiation, to the breaking of symmetry, as in physics, establishing emerging structures

that would then continue to become more complex. Firstly, the grid of Manhattan contains two metric patterns that generate variety. The street width is one of these: 30 metres for avenues running north-south, 20 metres for standard transversal streets, with 15 major transversal streets, 30 metres wide at irregular intervals. The second pattern results from the diversity of dimensions in the city blocks. All the blocks are 60 metres wide from north to south, but their length from east to west varies, diminishing from the centre towards the coast. From 3rd to 6th Avenue, the blocks are 280 metres long. Towards the east they shrink to 189, 198 or 195 metres long. Towards the west they contract uniformly to 244 metres long.

The grid also contains a hierarchy in the topological properties of the streets. The theory of graphs specifies the continuity of a street as the number of street segments between the intersections. It defines the connectivity of a street as the number of other streets to which it is connected. As the avenues in Manhattan are connected to 155 streets, while the streets are only connected to about 13 avenues, this establishes an important variation of topological scale between the avenues and the streets.

This initial breaking of symmetry was enough to lead to enormous growth in complexity, initiating a subtle and complex form of order, capable of both stability and development, creating new structures and adapting to constantly changing conditions<sup>11</sup>.

Manhattan construction comprised four phases<sup>12</sup>.

#### Phase 1: Street layout



*The Bridges map. As early as May 1811 William Bridges, architect and city surveyor, was offering an engraved map that was an identical – and uncredited – copy of Randel's survey.*

In 1811, the streets were laid out. The Commissioners' plan consisted of 12 lettered or named north-south streets running parallel to the island and 155 numbered east-west cross streets in a perfectly orthogonal grid – a life-size Cartesian coordinate system.

The topography was abrupt and it took a long time to regrade the slopes and lay out the basic lines of the general plan.

<sup>11</sup> Salat 2015.

<sup>12</sup> This description of Manhattan construction phases draws on UN-Habitat 2015.



## Phase 2: Street construction



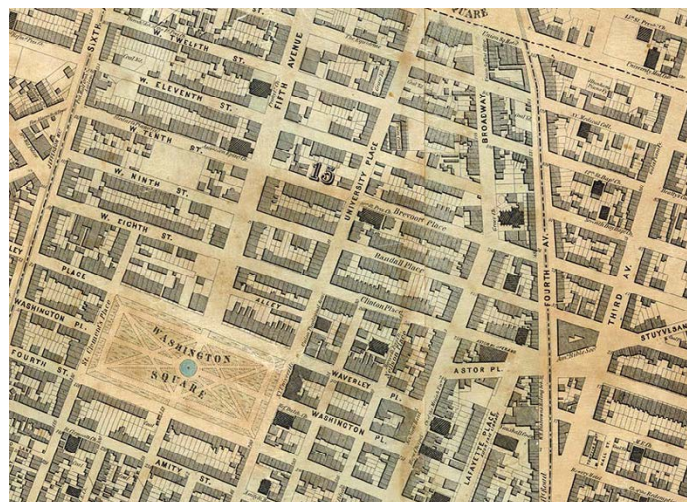
*The Viele map. This map from 1865 by the civil engineer Egbert Ludovicus Viele shows not only the current grid but a pre-development view of Manhattan's topography and hydrology.*

Soon after the Commissioners' Plan was adopted construction of the street grid began. It proceeded with remarkably few major alterations. This was a multiple-step process managed by the Street Commission. In the first step, the city would acquire or trade the lands required for street openings. The 1807 state legislature act defined the street opening system. It enabled the city to trade land destined for streets or other public areas and to compensate the owners financially. Proprietors often contested this system and refused to cede land to the city. This resulted in a subsequent law, passed in 1836, which reinforced the position of the city council. The second step assessed the value of the properties next to the new streets. It calculated how much the streets would soar the land value of these properties. The land owners were then charged proportionally to the increase in land value and this surplus was dedicated to the construction of the streets. Only after 1869 was the city permitted to fund half the cost of the street with tax revenue. The last step was the development of the streets. It comprised the regrading of the surface and street paving.

As the city's population grew – it doubled every 20 years throughout the 19th century– the grid expanded north. First Avenue was opened in 1813, 21st Street in Chelsea in 1834 and 57th Street in Midtown in 1844.

## Phase 3: Plot division

The 1811 Plan did not dictate plot sizes but the block yielded a modular system – a block was divisible into modules 20–25 ft wide and 100 ft long, which were the standard proportions of townhouse plots. The resulting standard plot dimension was 5–7.5m x 30m. In 1835 single plots dominated but many properties combined two, three, four and six plots and some even retained a full block.



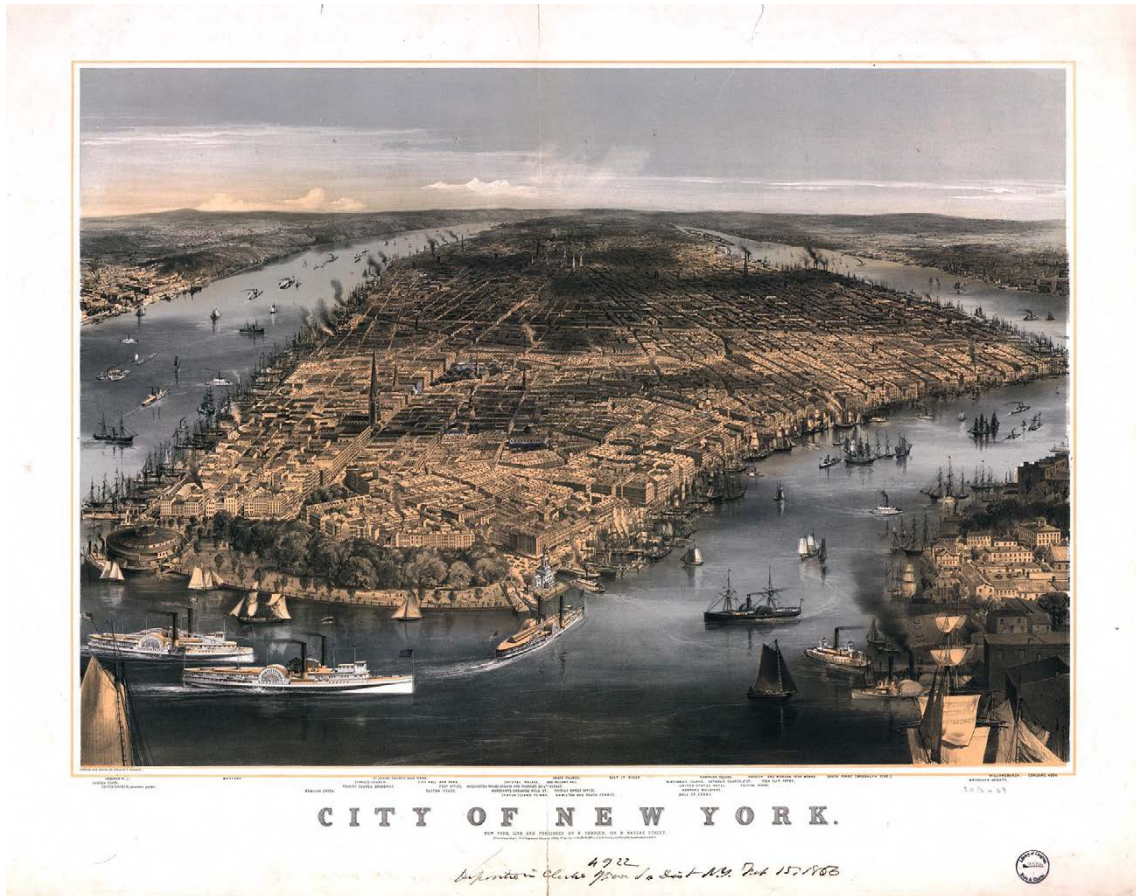
*Detail of Manhattan grid and plots, the 15th and 17th wards, Greenwich Village, ca. 1852.*



This map prepared by John F. Harrison was published by Matthew Dripps in 1852. In addition to the grid overlay, the Dripps map is the first to show individual lots and buildings. It shows an amazing detail of mid-19th century Manhattan.

#### Phase 4: Buildings

Fine-grain plots within the grid have ensured for two centuries the city adaptation to economic, social and market changes. They have led to a variety of neighbourhoods with a distinctive identity. The grid was above all an easy format for the subdivision and development of land. The grid system stripped the land of topographical markers and specificity, and repackaged it as standardized building lots.



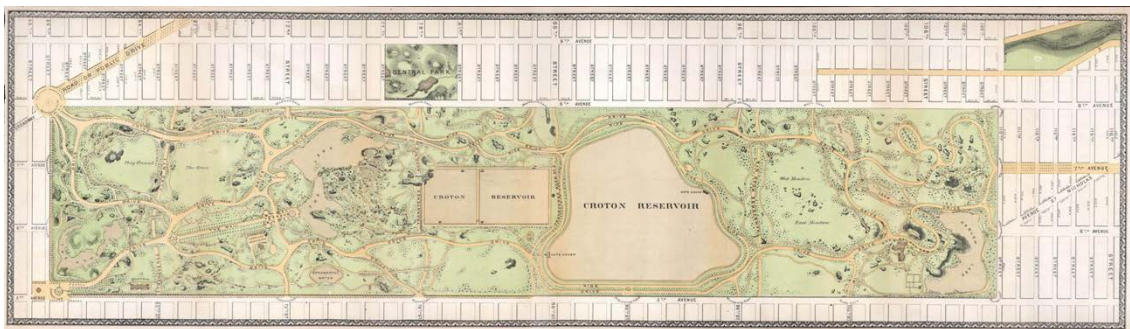
*Three-dimensional view of New York. Charles Parsons/Nathaniel Currier, 1856.*



*The Bollman Map, 1962.*

Blocks were subdivided for land sale into identical plots of 205m<sup>2</sup> area. Under the influence of market forces, they started to consolidate. This created a differentiated platting ordered by combinations of the same basic module very early in the process. The Plan established an overarching order in Manhattan Island. This order was far from being uniform. The fine-grain land division in about 165,000 small plots opened a space for endless variation and assembly.

It included the possibility for larger schemes such as Central Park or the Rockefeller Center.



*Vaux and Olmstead map for Central Park.*

Central Park comprised hundreds of small land plots in the 1850s. Olmsted and Vaux's design for a single large rectangle of open green space required the acquisition and combination of these plots.

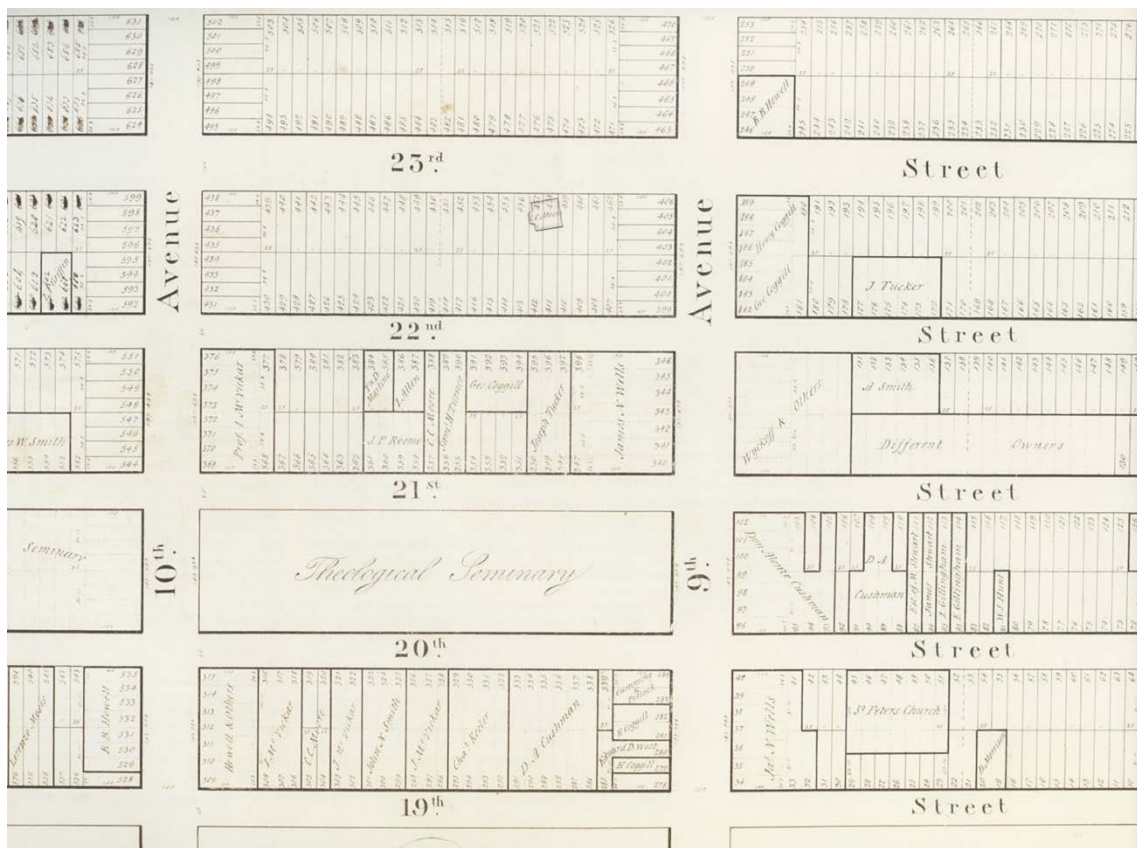
The Rockefeller Center site has not always been unitary. Its developers purchased and aggregated over 100 plots to provide its site in midtown Manhattan.



*Rockefeller Center in Midtown Manhattan. Drawing by Nawrass Kamour. École Spéciale d'Architecture, Paris.*

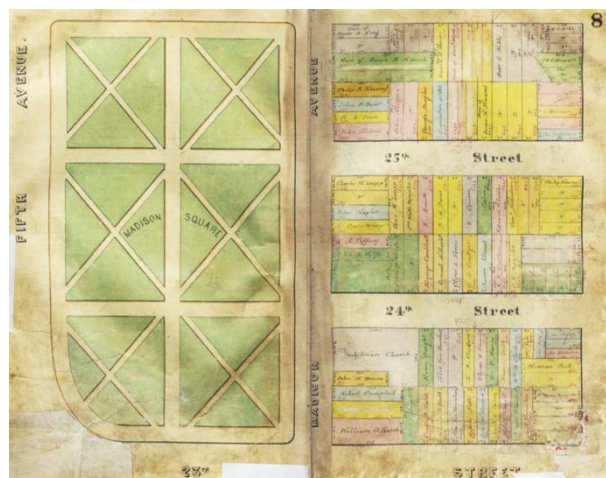
The 165,000 plots within the Manhattan grid plan have created a vibrant land market and land value increase has been captured for the city growth. This fine-grain land market has ensured a high diversity of development types and a resilient and adaptive urban form. Forty percent of original plots, dating two centuries ago, still exist in Manhattan along streets lined with 19<sup>th</sup>-century brownstone houses. Other plots have consolidated in a high diversity of sizes<sup>13</sup> and uses from medium-scale buildings to skyscrapers, with a wide variation in the intensity of land development.

<sup>13</sup> Plot sizes in Manhattan follow an inverse power law linking the frequency of plots to their size. There are only a few large plots, an average number of medium scale plots, and a 'long tail' of small plots. This distribution follows a mathematical regularity (a power law of exponent 0.6 in the Manhattan grid, and of 0.5 in Lower Manhattan. The latter is identical to that of medieval Paris, 19<sup>th</sup>-century Haussmann Paris, and Hong Kong, showing that market forces create a diversity of development organized as a complex system following mathematical regularities characteristic of complex adaptive evolving systems.



Map of property belonging to C.C. Moore at Chelsea. New York, 1835, detail.

An example of the strategies that made New York success is the construction by Charles Moore of his estate, which eventually became the vibrant Chelsea neighbourhood. Dating as early as 1835, the map of his estate illustrates his process. Clement Clarke Moore developed his estate into Chelsea Village. He centred it around Chelsea Square, which he had donated in 1819 to the Episcopal Church. The break of symmetry created by the square, the church and the public garden initiated a cascade of differentiation. The size and value of the plots varied with their location near or far from Chelsea Church. In 1820, Moore had evaluated his estate at \$17,000. His wealth was estimated at \$350,000 in 1845 and \$600,000 in 1855, that is a multiplication by 35 in 35 years. Differentiation and asymmetry in land prices occurred very quickly in the seemingly uniform Manhattan grid.



Assessment map of Madison Square from 18<sup>th</sup> Ward, Volume I, 1853–1879. New York City, Municipal Archives.

Another example is the development around Madison Square. Property taxes were a crucial component of the city's finance. Until the 1820s, the municipal corporation filled its treasury by renting property, including its common land

and wharves, and by collecting licence and franchise fees. Property taxes were originally low, but increased as land prices rose. The city's growing reliance on real estate taxes motivated officials to improve property values by opening streets and parks for collecting more money for the municipality. In 1830, property tax revenue amounted to roughly \$200,000, but seven years later, they totalled \$1.1 million.

Land values were much higher and homes were more luxurious facing Madison Square than along Fourth Avenue. In 1860, real estate along Fourth Avenue ranged from \$3,500 to \$8,000, while lots along Madison Avenue were valued between \$18,000 and \$55,000 at proximity of Madison Square.

This process of open-ended development has continued until now and is facilitated by mechanisms such as the transfer of development rights<sup>14</sup> (TDR). Over the last 50 years, New York City has pioneered the use of Transferable Development Rights (TDRs) to achieve planning and urban design goals. These mechanisms unlock floor area, generate revenue for public benefits, or achieve other planning objectives. Transferring Development Rights between landowners creates above all a significant freedom for development in the third dimension.

New York plot pattern is thus like a chessboard on which the movement of pieces allows developers to perform a large number of games. Who are the players? They are the human beings. They interact daily with the physical forms of the city. They endlessly reconfigure their dynamics, exchange and transform money, symbolic signs, matter and energy. This ceaselessly increases the quantity of algorithmic information in the city system. Simple calculations show that the size of the elementary squares on the chessboard of New York or Barcelona – the land lots – is 3,000 times smaller than the super blocks of the Le Corbusier's *Ville Radieuse*. This figure leads to vertiginous differences in connectivity and variety in the urban structure, i.e. in potential for interaction and in localization diversity<sup>15</sup>.

Connectivity, diversity and variety, under the effect of combinatorial mathematics, increase almost endlessly when the urban mesh becomes very fine. This is due to the factorials expressing the possible positions and connections between the pieces on the chessboard squares<sup>16</sup>.

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<sup>14</sup> For each plot in the city, New York's zoning code (known as the 'Zoning Resolution') specifies the maximum number of square metres of floor area that can be built per square metre of plot area. This ratio (known as the 'Floor Area Ratio' or 'FAR') depends on the location of the plot (e.g. the zoning district in which it is located and, in some cases, whether it faces a wide or narrow street), the use to which the building would be put (e.g. residential, commercial, community facilities, or manufacturing), and whether or not the developer includes certain amenities or land uses (e.g. a public plaza or affordable housing). Currently, the Zoning Resolution offers three types of mechanisms for transferring these development rights

- *Zoning Lot Mergers*. Through a process known as a 'zoning lot merger', owners of adjacent land in the same zoning district, or in some cases, different zoning districts, can agree to link their properties together and have them treated as one lot for zoning purposes.
- *Special Purpose District*. In some cases, the Zoning Resolution permits more distant transfers that depart from the underlying zoning structure in order to serve specific planning goals.
- *Landmark Transfers*. Finally, to support preservation of the city's historic buildings, the Zoning Resolution (Sections 74–79) provides a special transfer process to some of the landmarks designated by the city's Landmarks Preservation Commission.

For more information, see:

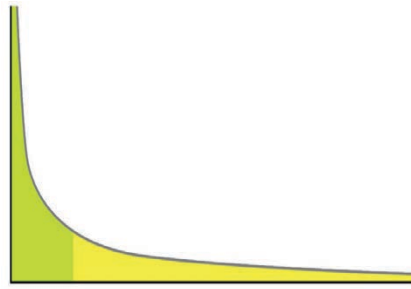
<https://www1.nyc.gov/site/planning/plans/transferable-development-rights/transferable-development-rights.page>

<sup>15</sup> Salat 2015.

<sup>16</sup> Salat 2015.

## CASE STUDY: PLOT SIZES DISTRIBUTION IN MANHATTAN AND INNER PARIS

The development of inner-city Paris (84.5 km<sup>2</sup> without the woods) and the grid of the Commissioners' Plan of Manhattan (66 km<sup>2</sup>) were recorded on different ages scales: two millennia for Paris and two centuries for Manhattan<sup>17</sup>. Despite being very different in appearance, with competing feudal powers in a compartmentalised society and competing markets in an open society, land lot distributions marked by scaling hierarchies<sup>18</sup> have emerged that are surprisingly similar, as if there were a form of universality at work. These universal mathematical regularities comprise a few large plots, a few medium scale plots, and a 'long tail' of small plots. This ensures a high variety and order in the size of buildings. A few large buildings stand out among a high variety of medium and small-scale buildings.



$$freq_i = \frac{A}{l_i^\epsilon}$$

Assembling small plots into larger ones – under market forces or design decisions – produces over time emerging patterns. A spike of a few large plots is combined to many small size plots ('a long tail'). The distribution follows a mathematical regularity which is universal in cities as diverse as Manhattan, medieval and 19<sup>th</sup> century Paris, or Hong Kong<sup>19</sup>. As this pattern in the distribution of plot sizing is the result of adaptive evolution, it is a good rule to follow in new developments. As a rule of thumb, developments made only of big or small identical plots without mechanisms to divide or reassemble them overtime will prove non-adaptive and non-resilient.

A city like Paris comprises in the inner districts 25 plots of land per ha.

<sup>17</sup> Salat 2015.

<sup>18</sup> These scaling hierarchies are the 'signature' of urban structures fractal complexity (Salat et al. 2011). In urban systems, averages have hardly any sense as values show few peaks in intensity and long tails of low values. For instance, 1 square mile (2.56 km<sup>2</sup>) in the City of London produces 14% of Greater London (1,569 km<sup>2</sup>) GDP. The landscape of urban values is a very uneven one. In cities like New York, Tokyo, London and Paris, research finds an unequal distribution in the values of land prices, components and linkages sizes, centralities in networks (Salat and Ollivier 2017, Salat 2017). Fractal structures and their classes of universality describe the mathematical regularities of these unequal systems. The essential notion is a form of symmetry: scale invariance. It is the result of the structural complexity fostered by the evolution of urban systems adapting to external constraints (Salat et al. 2011). This symmetry can be observed in countless natural phenomena.

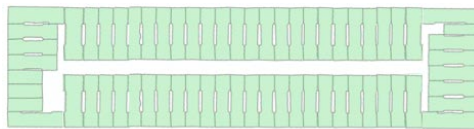
<sup>19</sup> Salat 2017.





*Paris plot patterns. Left: Rue Mouffetard. Right: Avenue des Champs Élysées.*

A city fabric like Manhattan comprises today 130,000 plots on 66 km<sup>2</sup>. This represents 19 plots/ha. The original 1811 Commissioner's Plan comprised about 165,000 original 200 m<sup>2</sup> plots of that is about 25 plots/ha.



*Original Platting of Manhattan blocks.*



*Left. Manhattan plot patterns around Madison Square today. Right. New York City plot patterns in Brooklyn today.*

Plot size distribution function is an inverse power law of exponent  $-0.5$  in urban fabrics as diverse as Medieval and late 19<sup>th</sup>-century Paris, Lower Manhattan and Hong Kong. These complex urban fabrics have evolved through time and under market forces and they present universal sizes distribution.

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