NEW YORK: CIRCULAR DESIGN + THE SUPERTALL TOWER

by

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000 ABSTRACT

This thesis explores the design of a supertall tower in New York (through an adaptive transformation of an existing building), by employing circular design principles and design-for-disassembly strategies. The research posits that circular design, in an age of resource scarcity and depletion, affords a more sustainable, integrated and wholistic approach to considering architectural practice.

The research includes research into circular design, and builds on work experience at 3XN/GXN, to help situate circular design and its emphasis on Materials, Service Life, Standards, Connections and Deconstruction, as a method of thinking through architectural design and construction. This structure is used as a design lens for a transformation of the (slated to be torn-down and replaced) JP Morgan-Chase building on Park Avenue.

The design project explores ideas of green infrastructure, carbon neutrality, flexibility and adaptability and more fully integrated social and public spaces into a supernal tower.

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*What if we see towers as ecosystems like
the way nature functions, as closed cycles
where all the elements create value and
strengthen each other?*

001 Introduction

1.1 New York Trajectory

Circular design - already gaining attention in Europe and around the world - can be a turning point for the North America architectural industry. The potential for society to increase in prosperity while reducing primary waste and energy is possible through circular design. This thesis will explore the potentials of circular design in the design of a supertall tower in Manhattan. New York City is, after all, a global hub for innovation and is looked-to as a leader in the world in show-casing design and in particular, to demonstrate sustainability in long-term growth.¹

The world's natural resources are in short supply. The construction industry accounts for 40% of material and energy consumption on a global scale. In New York City, buildings currently account for approximately 70% of CO₂ emissions.² Although New York City has begun to reduce CO₂ emissions and has set goals to cut 80% of CO₂ by 2050, it is likely to assume that these reductions

¹ "Baruch College: Zicklin School of Business." *Zicklin School of Business Baruch College iCal*, 2020. <https://bit.ly/3kPD3Ov>

² Domonoske, Camila. "To Fight Climate Change, New York City Will Push Skyscrapers To Slash Emissions." *NPR*, NPR, 23 Apr. 2019. <https://n.pr/3gYXNBa>

Fig 01. Manhattan, New York.

will occur through linear business models.³

The shift to a circular model of design and economy is necessary, particularly with the rise of tower buildings in New York City. A circular design can indicate how 'going circular' not only conserves the value of the materials and resources reused or recycled, but in result reduces CO₂ emissions substantially from the construction industry.⁴ In time 'going circular' can serve as an important element in combating climate change.

How might we improve the buildings in New York City? In 2019, New York City introduced Local Law 97, also known as, The Climate Mobilization Act. This law is geared towards existing buildings - impacting over 57,000 of them across the city.⁵ The technology centre, NEWLAB, suggests that retrofitting buildings to current needs will be a key in reaching the benchmarks set by Local Law 97.⁶ Parallel to this context, New York City has seen an emergence of a new skyscraper type, the super-slender towers. Silvian Marcus stated in *The New Supers: Super-Slender Towers of New York* that "Super-slender towers are in many ways a perfect embodiment of global aesthetic trends and market influences."⁷ I believe this attitude can be developed further - and more positively - through circular design principles.

³ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 2

⁴ Ibid.

⁵ Code Green. "NYC Carbon Emissions Bill Passed into Law - 'Local Law 97' - What It Means for Commercial Building Owners." *Code-Green Solutions*, 16 Oct. 2019. <https://bit.ly/2CupMK2>

⁶ "Energy Efficient Building Challenge." *Newlab*, NYCEDC, 2020. <https://bit.ly/2E2TKW7>

⁷ "Baruch College: Zicklin School of Business." *Zicklin School of Business Baruch College ICal*, 2020. <https://bit.ly/3kPD3Ov>

This thesis proposes the retrofit of an existing, modernist tower into a new, supertall tower. Ultimately through speculative and critical strategies, the circular supertall tower can result as a guide to influence the generation of future supertall towers. The thesis will explore how, through a circular lens, we can enhance the well-being of society and ensure a better quality of life on a green economic status.

I

New York's growth and success is due to its creativity and problem solving

Building the Skyline

The super-tall towers transforming NYC's skyline

New York Post ⁸

⁸ Nonko, Emily. "The Super-Tall Towers Transforming NYC's Skyline." New York Post, *New York Post*, 24 Jan. 2019, <https://bit.ly/3145FMt>

NYC is about to become the largest retrofit market in the country

Urban Green Council ⁹

⁹ Mandyck, John. "\$20B Building Energy Retrofit Market." *Urban Green Council*, 31 July 2019, <https://bit.ly/2PXWYN4>

1.2 New York Annual Consumption

Figure 2 shows that New York City currently has 8.55 million people and is set to surpass 9 million by 2050.¹⁰ Furthermore, New York City is expected to increase by 9.5% by 2040.¹¹

Given that that buildings contribute to 70% of the city's carbon emissions,¹² New York City embarked on an ambitious plan to fight climate change that would require thousands of large buildings to reduce their CO₂ emissions. New York has been on a generally positive trend in this direction: energy consumption in New York City has decreased by 8% since 2010.¹³

¹⁰ "The Plan for a Strong and Just City." *#OneNYC*, onenyc.cityofnewyork.us/initiatives/new-york-city-today/.

¹¹ Bloomberg, Michael R., and Amanda M. Burden. "New York City Population Projections by Age/Sex & Borough, 2010–2040." *NYC Planning*, The City of New York, 2013. <https://on.nyc.gov/2E2Rl8q>

¹² Domonoske, Camila. "To Fight Climate Change, New York City Will Push Skyscrapers To Slash Emissions." *NPR*, NPR, 23 Apr. 2019. <https://n.pr/3gYXNBa>

¹³ Cho, Renee. "How Much Energy Does NYC Waste?" *State of the Planet*, Earth Institute Columbia University, 2015. <https://bit.ly/3arHA56>

Fig 02. NYC Annual Energy Consumption // <https://bit.ly/3kN2wbx>

Building-by-Building (kWh per m²)

- >5,000
- 2,500-5,000
- 1,750-2,500
- 1,200-1,750
- 900-1,200

1.3 The Essential

To prepare a circular Super-Slender Tower for a prospective future, it must integrate new fundamental practices. In the book *'Building a Circular Future'* 3XN Architects' green innovation team; GXN- issued key suggestions in the consideration of this future.¹⁴ They note the following as critical concerns:

I

Circular Economy

Assign business models that endorse the circular shift.

Material Passport

Install high functional information at every component level for optimal use.

Design for Disassembly

Authorize all joints to be visible, mechanical, dissolvable, and universal.

¹⁴ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 2.

Establishing these circular principles at the beginning of a design process or project can immediately generate productive gains, such as:

Flexibility Improvement

Easier adaptation for the tower's overall functions.

Faster Construction

Minimizing the construction time and optimizing workflow.

Optimized Maintenance

Through logical and simple connections and detailing information at the component level.¹⁵

¹⁵ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 22.

002 Prelude

2.1 Resource Scarcity

Figure 3 illustrates the direction of our world for the next few decades. The world's population is rapidly, and exponentially, growing. In 1950 the world's population was recorded at 3 billion people. Current projections note 9 billion people by 2050.¹⁶ In addition, this means the world's middle class will grow. In 2010 the world had 2 billion people in the middle class. By 2030 we will have 5 billion people.¹⁷

As the population continues to increase, it is possible to assume a global migration shift from country to cities. By 2050 we are expected to see 75% of our world be urbanized.¹⁸ This growth adds significant pressure on already-stressed global resources. According to the Global Footprint Network, humanity currently uses the equivalent of 1.75 planets worth of resources that it can provide.¹⁹

¹⁶ Friedman, Thomas L. *Hot, Flat, and Crowded: Why We Need a Green Revolution - and How It Can Renew America*. Allen Lane, 2008

¹⁷ Kharas, Homi. "The Unprecedented Expansion of the Global Middle Class An Update." *Brookings*, Global Economy and Development, 2017 <https://brook.gs/2PT0lzu>, 11.

¹⁸ "68% Of the World Population Projected to Live in Urban Areas by 2050, Says UN | UN DESA Department of Economic and Social Affairs." *United Nations*, United Nations, 2018 <https://bit.ly/3iGRWB5>

¹⁹ "Ecological Footprint." *Global Footprint Network*, 2020. <https://bit.ly/2PVz9FJ>

This suggests that by 2030 we will have to produce 50% more food and energy and provide access to 30% more fresh water than we currently have.²⁰ All this will have to be done while simultaneously fighting global warming and climate change. This consumption is especially stark when looking at the construction industry, which consumes 40% of the energy²¹ and 35% of the materials used in the world.²² These projected changes will lead to a higher demand in urban construction for housing, office spaces and transportation services. This year Price Waterhouse and Coopers & Lybrand, PwC, has sponsored a new report, *Global Construction 2030*, that forecasts the market growth of construction. Over the next 10 years, the demand for global construction is expected to increase by 85%, with US, China, and India accounting for 57% of the global growth.²³

²⁰ "Water, Food and Energy: UN-Water." *United Nations*, 2020. <https://bit.ly/3kRjZPU>

²¹ Abergel, Thibaut, et al. "Global Status Report 2017." *UN Environment*, Global Alliance for Buildings and Construction, 2017. <https://bit.ly/2Q2rlBX>, 14.

²² "Fashion and Waste: An Uneasy Relationship." *Common Objective*, 8 June 2018 <https://bit.ly/3kLRqU9>

²³ Robinson, Graham. "Global Construction Market to Grow \$8 Trillion by 2030: Driven by China, US and India." *ICEdevelopment*, Global Construction Perspectives and Oxford Economics, 2020. <https://bit.ly/2FkZyuu>, 11.

2.2 Resource Depletion

The world's natural resources are being depleted at an accelerating rate, inextricably linked to the increasing quantity of unwanted by-products due to domestic and industrial waste,²⁴ as well as carbon and toxic emissions due to industrial production. Figure 04, from The Ellen MacArthur Foundation, demonstrates our remaining resource life in years. The lightest shade covers most of the periodic table and marks only 5-50 years remaining.²⁵ In Figure 05, the lightest shade also indicates the current recycling rates of known resources.

These facts can be alarming, but these projections have been seen long ago. This realization has provoked numerous scientists and scholars to reflect on our current model of living in the world, including Walter Stahel, an architect and an economist who is recognized as one of the founding fathers of industrial sustainability.²⁶ Stahel has been credited to have coined the term 'cradle to cradle' in the late 1970s.²⁷ Throughout this thesis, Walter Stahel was an influence on my design process and my thinking around questions and ideas of architectural circularity. This thinking included aspects such as material-life extension, reconditioning activities and waste prevention.²⁸

²⁴ "Chapter I - 'Good Rather Than Less Bad': The Circular Approach." *Ellen MacArthur Foundation*, 2011. <https://bit.ly/3iO713V>

²⁵ Butterworth, Jamie, et al. "Towards the Circular Economy." *Ellen MacArthur Foundation*, World Economic Forum and McKinsey & Company, 2014. <https://bit.ly/343B6Z6>, 28.

²⁶ "Chapter I - 'Good Rather Than Less Bad': The Circular Approach." *Ellen MacArthur Foundation*, 2011. <https://bit.ly/3iO713V>

²⁷ Ibid.

²⁸ Ibid.

Fig 04. Years remaining until depletion of known resources. Reinterpretation from Ellen McArthur Foundation

Fig 05. Current recycling rates of known resources. Reinterpretation from Ellen McArthur Foundation

2.3 Area of Focus

As previously indicated, the construction industry accounts for 40% of materials produced in the world. Increasing demands for construction will result in our resources becoming even more scarce. To better focus my project, I chose to focus on existing buildings - and in this case, large office towers. The engineering behind supertall structure and load-bearing facades are acknowledged as advanced buildings currently constructed. Nearly all require large open spaces, access to daylight, a high demand for indoor environments, along with a need for a low energy consumption. In addition, the desire for large and flexible spaces requires the use of large and stronger beams, columns and joints in comparison to other types of constructions found in housing or other building categories.

Office towers are arguably the most complex to design for disassembly. I think that the methods developed for this part of the building sector could ultimately be used directly in new construction, or for adaptive re-use of other towers or less complex buildings. The high carbon footprint on buildings are caused by several systems such as electrical and mechanical systems. In order to further limit my scope, I decided to focus more on the superstructure and the envelope of the building, in large part because they account for 3/4 of the materials use in buildings. In addition, most solutions for retrofitting have focused on common and more expected adjustments towards conventional installations, window replacements and internal walls.

Why Towers?

1. They are among the most advanced buildings constructed. The ideas and strategies developed for this part of the building section can be passed down to other systems and projects

2. In New York City there are around 6,000 high-rise buildings. 274 of these are skyscrapers over 150m tall.²⁹ 27 are considered super-tall towers (+300m), and 13 new projects are under construction or on the drawing board.³⁰

²⁹ Desjardins, Jeff. "The 100 Tallest Buildings in New York City." *Visual Capitalist*, 27 Apr. 2019. <https://bit.ly/3iPZhOV>

³⁰ Plitt, Amy. "NYC's Supertall Skyscraper Boom, Mapped." *Curbed NY*, 22 Jan. 2018. <https://bit.ly/3425X8a>

3. Buildings over 5,000 square meters of floor-area represent 2% of New York City's building stock, and account for half of the built square footage in the city.³¹

³¹ Mesa, Nilda, and Bill de Blasio. "One City Built to Last: Technical Working Group." *New York City, The City of New York*, 2019. <https://on.nyc.gov/2E4pv0P>

4. Buildings over 10,000 square meters of floor-area account for half of New York City's energy use.³²

³² "Mapping Greenhouse Gas Emissions in NYC: Jill Hubley." *Mapping Greenhouse Gas Emissions in NYC | Jill Hubley*, 17 Jan. 2016. <https://bit.ly/30Y-dpPJ>

Fig 06: Image overlooking mid-town east Manhattan.

Reconstruct, Reuse, Revitalize

In New York City, more than 66% of the building stock that will exist in the year 2050 is already built.³³ In order to propose a circular design process, a circular economy to the built environment is required. This must include feasible strategies for working with existing buildings. These strategies towards renovations need to focus on both material economy and social value.³⁴

33 "WHY THE BUILDING SECTOR?" *Architecture* 2030. <https://bit.ly/2FtUioA>

34 Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 7.

The City generally lacks examples of comprehensive retrofits that could be implemented across its diverse building stock to achieve dramatic reductions³⁵

New York City 80 x 50 Buildings Technical Working Group

*Is the risk of climate change being adequately considered?
Are developers exploring the potential for reductions in greenhouse gas emission when they reposition or build new skyscrapers?*

Unkown

*Is the risk of climate change being adequately considered?
Are developers exploring the potential for reductions in greenhouse gas emission when they reposition or build new skyscrapers?*

Unkown

35 Mesa, Nilda, and Bill de Blasio. "One City Built to Last: Technical Working Group." *New York City*, The City of New York, 2019. <https://on.nyc.gov/2E4pv0P>

003 What is a Circular Economy?

3.1 Circular Business Models

Linear Economy

As noted in the previous chapter, the building industry is globally responsible for enormous material consumption and energy use. This is an intense burden on the industry because materials in buildings require large amounts of manufactured resources. This production of re is hardly recycled in neither a biological nor technical cycle. Cement production, for instance, is highly energy-intensive: it accounts for about 2% of global energy consumption, and 5% of total global industrial energy consumption.³⁶

For a long time, our building processes - and our material flows - have followed a linear economy, commonly seen as the “take-make-waste approach”. The current system mines resources, then uses them in the manufacturing of a product (building components for example) which are later disposed when these valuable materials are at the end of their (perceived) use.³⁷ This results being that building “waste” is downcycled to landfills or slated for incineration. As a result, a large amount of resource value is lost if not recovered.³⁸ It is estimated that 1/5 of the raw materials extracted worldwide ends up as waste.³⁹

³⁶ Worrell, Ernst, et al. “Carbon Dioxide Emissions From The Global Cement Industry.” *Annual Reviews*, 2001. <https://bit.ly/344xN3G>

³⁷ Halim, Shakera. “The Circular Economy Concept, Explained.” *Government Europa*, 1 Oct. 2019. <https://bit.ly/3fXoyot>

³⁸ Ibid.

³⁹ Material Resources, Productivity, and the Environment.” *OECD, Green Growth*. 2018. <https://bit.ly/30YhQtR>, 10.

Fig 07. Linear Economy business concept.

Linear Concept

Take -----> Make -----> Waste

+1 Resource Extraction

+3 Consumption

+5 Energy from Finite Sources

+2 Production + Distribution

+4 End of Life

Circular Economy

The notion of the circular economy stems from various system design concepts. A few influences on this concept include the functional service economy of Walter Stahel, the cradle to cradle design philosophy of William McDonough and Michael Braungart, biomimicry as articulated by Janine Benyus, the industrial ecology of Reid Lifset and Thomas Graedel, and the blue economy systems approach described by Gunter Pauli.⁴⁰

A circular economy is a system that is restorative or regenerative by intention and design.⁴¹ It replaces the end-of-life concept with a restorative one and moves towards the use of renewable energy. This eliminates the use of toxic chemicals which impair reuse (and safe returns to the biosphere) and aims for the elimination of waste through the design of materials, systems and business models.⁴²

Much of this thinking was derived from the field of industrial ecology which calls for an imitation of natural ecosystems and its circular cycles as models for the industry.⁴³ Our planet naturally follows a circular system in which nothing expands. Plant growth and 'waste' is used as food for other species and contribute to production

⁴⁰ "What Is a Circular Economy?" *Ellen MacArthur Foundation*, 2017. <https://bit.ly/3g-0S0Kb>

⁴¹ "Towards the Circular Economy: Accelerating the Scale-up across Global Supply Chains." *World Economic Forum*, Ellen MacArthur Foundation and McKinsey & Company, Jan. 2014. <https://bit.ly/3auP5lz>

⁴² Ibid.

⁴³ Reisch, Lucia A., and John Thøgersen. *Handbook of Research on Sustainable Consumption*. Edward Elgar Publishing, 2017, 34.

of new soil and oxygen through photosynthesis.⁴⁴ This translates into the need for products to be infinitely re-used and powers the system with renewable energy.

⁴⁴ Braungart, Michael, and William McDonough. *Cradle to Cradle: Remaking the Way We Make Things*. Vintage, 2019, 80.

A circular economy aims to reshape the productive cycle of consumer products through a transition in the industrial system that benefits the ecology, as well as the well-being of humans.⁴⁵ It aims to redefine growth and focuses on positive society-wide benefits.⁴⁶ It is based on three principles:

⁴⁵ Michael Lieder, and Amir Rashid. "Towards Circular Economy Implementation: A Comprehensive Review in Context of Manufacturing Industry." *Journal of Cleaner Production*, Volume 115, 2016. <https://bit.ly/3ilxAY8>, 36.

⁴⁶ "What Is a Circular Economy?" *Ellen MacArthur Foundation*, 2017. <https://bit.ly/3g-OS0Kb>

1. Design out waste and pollution
2. Keep products and materials in use
3. Regenerate natural systems

Fig 08. Circular Economy business concept.

*In nature, there is no such thing as "waste"- the waste of
one system becomes food for another-*

William McDonough
architect, designer, author

A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems

William McDonough
architect, designer, author

Circular Economy Breakdown

Figure 9 - the butterfly diagram - is from the Ellen MacArthur Foundation and it outlines and organizes the circular economy into a few principles. The top must preserve and enhance natural capital. This can be achieved by controlling finite stocks and balancing renewable resource flows.⁴⁷ The middle optimizes resource yields by circulating products, components and materials at their best utility, continuously, and in both biological and technical cycles.⁴⁸ As a result the bottom will foster system effectiveness by revealing and designing out negative externalities.⁴⁹

The principles of a circular economy drive numerous sources of value creation that are essential to the building industry. For instance, the inner circles in the diagram refers to a minimization of material usage in contrast to a linear system. The tighter the circle, the more valuable the strategy becomes in reuse of the materials and energy used in producing the materials.⁵⁰ A longer circling refers to maximizing the number of consecutive circles.⁵¹ This can mean reusing the materials a number of times to extend its life.

⁴⁷ "Towards the Circular Economy: Business Rationale For An Accelerated Transition." *Ellen MacArthur Foundation*, Ellen MacArthur Foundation, Nov. 2015. <https://bit.ly/3avbIMN>, 5.

⁴⁸ "Circular Economy System Diagram." *Ellen MacArthur Foundation*, Ellen MacArthur Foundation. <https://bit.ly/2Ft3tWm>

⁴⁹ "Towards the Circular Economy: Business Rationale For An Accelerated Transition." *Ellen MacArthur Foundation*, Ellen MacArthur Foundation, Nov. 2015. <https://bit.ly/3h1MM1Z>, 7.

⁵⁰ *Ibid.*, 8.

⁵¹ *Ibid.*

Within the cycle, reuse occurs in cascades. Cascading refers to diversifying reuse across the value chain.⁵² In other words, it means 'using (part of) a product or component for another application. For example, steel in our building industry can be often cascaded in the metal industry due to its economic value. Simultaneously wood can be commonly used as a biofuel in combustion power plants.

⁵² "How Do Materials Circulate in a Circular Economy? - Kenniskaarten - Het Groene Brein." *Kenniskaarten*, 2020. <https://bit.ly/31Qcnok>

Fig 09. Economic and Technical model in the building industry life cycle. Reinterpretation of Ellen MacArthur Foundation diagram.

Fig 10. Image of lost valuable materials post demolition.

3.2 Additional Methods & Strategies

To prepare a circular design, key methods must be established. In order to prepare materials for the circular economy they must be properly fit for their reverse cycles. A few circular activities are presented below.

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Upcycling, Recycling and Downcycling

The most common practices in waste management are the 3R's; reduce, reuse and recycle. This practice is considered to be the basis of environmental awareness and a way of promoting ecological balance through conscious behavior and choices.⁵³ Recycling is the process of recovering materials and converting into something of roughly the same value as it was originally.

However, within the broad term recycling, a distinction must be made between two strategies; upcycling and downcycling. Upcycling converts a material into something of greater value than its original state.⁵⁴ In *Cradle to Cradle: Remaking the Way We Make Things*, William McDonough and Michael Braungart state that the goal of upcycling is to prevent wasting potentially useful materials⁵⁵ by converting them into something useful and

⁵³ "The Difference between Recycling, Upcycling and Downcycling." *Theupcyclingfashionista.wordpress.com*, 8 Nov. 2013. <https://bit.ly/2E3qcro>

⁵⁴ Silveira, Rafael. "Recycling – Upcycling, Repurpose or Downcycling." *TU Delft Open-Research.net*, TU Delft, 2015. <https://bit.ly/3kLPoTX>

⁵⁵ Braungart, Michael, and William McDonough. *Cradle to Cradle: Remaking the Way We Make Things*. Vintage, 2019

hopefully, beautiful. Downcycling converts a material into low-valuable raw materials.⁵⁶ This often creates a lower-grade product and prevents it from retaining its former durability once repurposed. Consequently, the opportunity is lost, and the material is not re-inserted back into its original cycle.

⁵⁶ "The Difference between Recycling, Upcycling and Downcycling." *Theupcyclingfashionista.wordpress.com*, 8 Nov. 2013. <https://bit.ly/2E3qcro>

Refurbishment and Re-manufacturing

Refurbishment is an update and change to the aesthetic maintenance of a product.⁵⁷ It returns the product or design to a condition comparable to that of a new product. As defined by the Ellen MacArthur Foundation, refurbishment it returns a product or design to a good working condition by replacing or repairing major components that are at fault or failure.⁵⁸ Re-manufacturing focuses on the disassembly of discarded components and reassesses their functioning parts.⁵⁹ Reusable components are detached from one use and assembled into a new one.

Reuse and Redistribute

Creating another life for the product means introducing the component into another market. The component can often be serviced for the same purpose or used differently than its original intent.

■

⁵⁷ " Migliore, Marco. *Strategies for Circular Economy and Cross-Sectoral Exchanges for Sustainable Building Products*. Springer International Publishing, 2020, 86.

⁵⁸ Tonelli, Marcello, and Cristoni Nicolò. *Strategic Management and the Circular Economy*. Routledge, 2018, 7.

⁵⁹ Migliore, Marco. *Strategies for Circular Economy and Cross-Sectoral Exchanges for Sustainable Building Products*. Springer International Publishing, 2020, 88.

⁵⁹ Tonelli, Marcello, and Cristoni Nicolò. *Strategic Management and the Circular Economy*. Routledge, 2018, 71.

Author's Note

The Ellen MacArthur Foundation paved the way for various companies to adopt and advocate circular economy principles. I was able to experience these new methods in the building and design industry at 3XN/GXN. 3XN Architects, along with its green think tank, GXN Innovations, produced a book, *'Building a Circular Future,'* that maps out five key aspects and corresponding principles and strategies to consider when applying a circular economy, design for disassembly and a material passport. These principles will be mentioned within the coming chapters.

3.3 The Five Principles

New Businesses

To accomplish the circle in the circular economy, new businesses need to emerge.

Facilitate

New means are crucial to manage, handle and certify building materials and elements.

Incentive

Each corporation in the supply chain will have to establish economic benefits.

Business

The benefits for a business must be evident in the implementation of a circular economy.

New Models

Rather than generating products, businesses need to provide the user with a service.

Access over Ownership

Receive the service of the product in lieu of the product itself.

Partnerships

The union of partnerships and collaborations are fundamental in order to run the circular economy together.

Interdisciplinary

Collaboration between different professions are critical to cover all aspects of the circulation.

Circulation

The value of the materials in the technical and biological cycle require to be maintained as long as possible.

Redistribute

Products in good condition can be used numerous times.

Financing

New opportunities for business investors will provoke the circular economy.

Consultants

Intermediary consultants can unify various parties together.

Society

The benefits for society must be evident in the implementation of a circular economy.

Environment

The practice of the circular economy model creates a positive impact on the environment.

Leasing

Establish a performance policy where the user returns the product after a defined period of use.

Reclaim

Facilitate companies to recall products at the end-of-life.

Knowledge Sharing

Clear communication and sharing information across industries is necessary for high quality and better results.

Prosperity

All partners participating must benefit from the collaboration for the circular economy to work.

Repair

Restore parts that are in need and sustain the product to work for as long as possible.

Recycle

Materials recovered after a products end-of-life will replace the use of raw materials.

3.4 Circular Economy in Architecture

The circular economy is increasing in popularity and has already been applied (and is currently in use) in a number of European cities and in a number of architectural projects. The following are listed in the next few pages.

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Fig 11. Image of Green House Solution.

Image: the water around the building is being reused continuously in a closed cycle and also acts as a 'living machine' which cleans the water before entering the building.

Green House Solution

Location	Ronne, Denmark
Year	2015
Client	Green Solution House
Architect	3XN Architects + Steenberg
Size	4,500m ²

Information:

The design along with its site shows an operative holistic approach to sustainable design. The structure prioritizes regenerative solutions through renewable energy sources, active materials and recyclability. Inspired by cradle-to-cradle principles, all materials implemented are either completely recyclable or biodegradable.⁶¹ As a result, the design aims to eliminate the concept of waste. Additionally, the design follows a 'Design for Disassembly' strategy that supports the eventual recycling and reuse of building components.⁶²

⁶¹ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019., 188.

⁶² "Green Solution House." *One Planet Network*, 3 Dec. 2018. <https://bit.ly/31Yy8ll>

Fig 12. Image of B/S/H Headquarters.

Image: A full height four-story sustainable atrium with a living green wall and a Building Integrated Photovoltaic (BIPV) roof that maximizes energy and day lighting.

B/S/H Headquarters

Location	Hoofddorp, Holland
Year	2011
Client	Bosch Siemens Home (B/S/H)
Architect	William McDonough + Partners
Size	8,670m ²

Information:

The BSH headquarters is perceived as Netherlands's first development to display a design and construction technique that follows a cradle-to-cradle process.⁶³ The use of Cradle to Cradle certified materials including, curtain wall system and atria roof are design for easy installation and disassembly.⁶⁴ This creates the opportunity to convert and adapt spaces when needed. Lastly its materials serve as a material bank⁶⁵ for the next generation of circular buildings.

⁶³ "B/S/H/ Office: The Inspiration House at Park 20: 20." *William McDonough + Partners*, 2020. <https://bit.ly/3112jto>

⁶⁴ "BSH." *Delta*, 2020. <https://bit.ly/3h4eDi0>

⁶⁵ "B/S/H/ Inspiration House, Park 20: 20 in Hoofddorp, The Netherlands by William McDonough + Partners." *Arch-Showcase*, 28 Aug. 2015. <https://bit.ly/2PTIFdJ>

Fig 13. Image of Brummen Town Hall.

Image: The timber structure focuses on developing business models, which close the loops for reuse, repair, refurbish, re-invent or recycle. This way components and materials remain available for future products.

Brummen Town Hall

Location	Brummen, Holland
Year	2013
Client	Brummen Municipality
Architect	RAU Architects
Size	3,000m ²

Information:

The municipality of Brummen commissioned a building for a 20-year service life. The outcome to the proposal was design made for disassembly with reusable and renewable premium materials. Approximately, 90 percent of all materials added to the design can be dismantled and reused.⁶⁶ The design not only enabled disassembly, but it allowed a significant reduction in construction time.⁶⁷ Furthermore the building received the first materials passport transforming into a raw materials depot. This means the details of every piece are known, including the previous use and owners.⁶⁸

⁶⁶ "Modular Building: Brummen Town Hall." *Circular Economy Club (CEC)*, 2019. <https://bit.ly/31Y71ay>

⁶⁷ Hutton, John, et al. "Circularity In The Built Environment: Case Studies." *Ellen MacArthur Foundation, CE100 Network*, Apr. 2016. <https://bit.ly/3aqHgDN>, 23.

⁶⁸ "Modular Building: Brummen Town Hall." *Circular Economy Club (CEC)*, 2019. <https://bit.ly/31Y71ay>

004 What is Design for Disassembly?

4.1 Overview

As the green building industry continues to grow, firms and clients are becoming increasingly conscious of the environmental impact of buildings. However, we currently design our buildings as if they are never going to leave. Design for Disassembly (DfD) is a concept to intentionally design buildings and products for material recovery, value retention, and meaningful next use.⁶⁹

DfD (in architecture) is a method to design a building or building component in a particular way that facilitates future change and the eventual dismantlement of building/ components and reuse/recycling of its parts or materials.⁷⁰ This application of design is a fundamental basis for the circular economy. The goals for DfD are to design enduring buildings and projects, create value for owners and clients, and ultimately eliminate waste with closed loops. As a result, this will create flexibility and convertibility on buildings that are easy to repair, refurbish or reconfigure.⁷¹ It is likely to assume that numerous buildings are removed from sites due to redevelopment and their inability to remain useful for an alternative land use.

⁶⁹ "What Is Design for Disassembly?" *Cradle to Cradle Products Innovation Institute*, Cradle to Cradle Certified, 10 Oct. 2017. <https://bit.ly/2Fo-11jH>

⁷⁰ Thormark, Catarina. "Motives for Design for Disassembly in Building Construction." *Fraunhofer IRB*. <https://bit.ly/2PYiwsV>

⁷¹ "What Is Design for Disassembly?" *Cradle to Cradle Products Innovation Institute*, Cradle to Cradle Certified, 10 Oct. 2017. <https://bit.ly/2Fo-11jH>

As a substitute, DfD, offers a strategy to reduce the risk of obsolesce. Furthermore, it is an essential action to succeed in reducing both energy and resources as well as the production of waste.⁷²

The lack of flexibility and adaptability (disassembly) of buildings results, often, in wholesale demolition. In the US, the United States Environmental Protection Agency (USEPA) calculated that 136 million tons of building-related waste are dispatched to landfills from project sites and further estimates that 92% of this comes from renovations and demolitions.⁷³ It is essential to introduce DfD strategies and reuse existing buildings to minimize the impact. Studies have shown that the existing building stock has the greatest potential to lower the environmental load of the built environment over the next 20-30 years,⁷⁴ particularly as a result of performance upgrading on existing buildings. DfD can make use of the existing bearing structures of buildings and recover materials to prevent large sources of waste for the next generation.

⁷² Thormark, Catarina. "Motives for Design for Disassembly in Building Construction." *Fraunhofer IRB*. <https://bit.ly/2PYiwsV>, 1.

⁷³ Frisman, Paul. "Building Deconstruction." *Connecticut General Assembly, Office of Legislative Research*, 13 Dec. 2004. <https://bit.ly/3h2QQ1V>

⁷⁴ Rovers, Ronald. "Existing Buildings, A Hidden Resource, Ready for Mining." *Oecd.org*, OECD, Jan. 2004. <https://bit.ly/2PV5AnV>, 43.

Page 62 shows five principles on how to work in the built environment with design for disassembly.

Design for Disassembly, is an important measure to achieve circular design. It requires a different approach to the design of buildings and their components. In return it creates buildings that are the building stocks of future buildings. Buildings, in effect, become material and component pantries for future projects. The motives for DfD as well as the benefits from DfD are both environmental and economical for builders, owners and community.

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Building art is a synthesis of life in materialized form. We should try to bring it under the same hat, not a splintered way of thinking, but all in harmony together

Alvar Aalto
architect

4.2 Motives & Benefits

There are many motives, both environmental, economic and social, for DfD in the building construction industry.⁷⁵ Many of these hold benefits that will either come into immediate effect or be realized over the course of time. All in all, these benefits will affect the longevity of the planet as a whole. These motives and benefits can be summarized below:

- A quick and transparent construction can result in a more effortless process to remove, upgrade, replace or repair components. In turn, the substituted components can be upcycled to new products.
- The demand for new raw materials will be reduced in response to a reduction in waste production.
- Optimized construction operations and maintenance of buildings means quicker assembly times (quicker occupancy and use) as well as smoother repair and maintenance.
- Optimized upcycling, recycling and reuse allows for efficient processes and loops in both economic and environmental ways.
- Materials become a consistent value to the market and buildings are seen as investments

⁷⁵ Thormark, Catarina. "Motives for Design for Disassembly in Building Construction." *Fraunhofer IRB* <https://bit.ly/3h-4geo0>, 2.

Fig 14. Image of planning and strategizing at 3XN in Copenhagen.

4.3 The Five Principles

Five principles to consider for a design for disassembly.⁷⁶

Materials

Select materials with properties that ensure they can be reused.

Quality

Use materials of a high quality that can handle several life cycles.

Service Life

Design the building with the whole lifetime of the building in mind.

Layers

Make the long-lasting building elements allow for flexibility, so other elements are easily changed.

Standards

Design a simple building that fits into a 'larger context' system.

Modularity

Use modular systems where elements easily can be replaced.

Connections

Choose reversible connections that can tolerate repeated assembly and disassembly.

Accessible

Make the connection accessible in order to minimize assembly and disassembly time.

Deconstruction

As well as creating a plan for construction, design the building for deconstruction.

Strategy

Create a simple plan for deconstruction, to ensure a quick and easy disassembly process.

Healthy

Use non-toxic materials to provide a healthy environment- now and in the future.

Pure

Use as pure materials as possible which can be recycled with ease.

Flexibility

Make a flexible building design that allows functions to adapt and change in the future.

Interim

Look at the building as a temporary composition of materials and design with the preservation of material value in mind.

Prefabrication

Use prefabricated elements for a quicker and more secure assembly and disassembly.

Components

Create a component when the composition of elements becomes too complex to handle.

Mechanical

Use mechanical joints for easy assembly and disassembly without damaging the materials.

Dissolvable

Avoid binders, but if necessary, use binders that are dissolvable.

Stability

Make sure that stability in the building is maintained during deconstruction.

Environment

Ensure the deconstruction plan is respectful to nearby buildings, people, nature and the social spaces around them.

75 Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 39.

4.4 How to Design

The lifecycle of building must always be considered when designing, which means considering renovation, rebuilding, or demolition, while designing.

Rebuilding occurs when the use of the building is changed or a particular building is no longer needed. This is completely normal in life. A building's use can change over time due to new trends, expansion or reduction in users, or a new owner. It is in our nature as humans to adapt and evolve when we experience change. Imagine if a building could do the same.

Stewart Brand, an American writer, presents an idea of how buildings are adaptable and able to evolve. Figure 15, explains this idea through Brand's adaptation of Frank Duffy's concept of "Shearing Layers." In design for disassembly, this concept is also referred to as pace-layering, and can be translated into an architectural design principle.⁷⁷ This strategy of arranging layers allow for maximum adaptability within the elements.

⁷⁷ Brand, Stewart. "Pace Layering: How Complex Systems Learn and Keep Learning." *Journal of Design and Science*. *Journal of Design and Science*, PubPub, 18 Jan. 2018, <https://bit.ly/3iL9ImJ>

Fig 15. Shearing Layers Concept. Reinterpretation of Stewart Brand's *How Buildings Learn: What Happens After They're Built*

This concept allows buildings to be viewed as a set of components that evolve in different time frames. In *How Buildings Learn*, we read that "Our basic argument is that there isn't any such thing as a building. A building properly conceived is several layers of longevity of built components".⁷⁸ Brand's book summarizes this concept into five elements and their corresponding durations of longevity.⁷⁹

⁷⁸ Brand, Stewart. *How Buildings Learn: *What Happens after They're Built*. Viking, 1994. 32.

⁷⁹ Ibid., 35.

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Site (100+ years)

Given the nature of the foundation, it becomes difficult to access. This is acceptable because the element has a long life that can endure several buildings.

Structure (50+ years)

The structure is the backbone of the building, it is acceptable that the connections are the least accessible. The lifetime of this element is longer than most buildings. In result it's important that it can be removed and reused in another building.

Facade (30+ years)

A facade will undergo many changes and renovations over time due to its exposure to many weather patterns. Therefore it is important that these actions for change can be made easily.

Partitions and Systems (10+ years)

A building must be able to adapt to the changing needs of its occupants, and create flexibility. This can be achieved through the partition walls and technical systems.

Stuff (1+ years)

The stuff are pieces that generally have a short life cycle inside buildings, such as the furniture. These pieces need to be carefully thought out in regard to the overall use of the building to avoid any interference with the flexibility and reuse of the resources.

4.5 Disassembly in Architecture

Design for disassembly has already been applied (and is currently in use) in a number of European cities and in a number of architectural projects. The following are listed in the next few pages.

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Fig 16. Image facade of ICE House.

Image: The facade panels are modular and are designed to reconfigure to optimize daylight.

ICE House

Location	Davos, Switzerland
Year	2016
Client	SABIC
Architect	William McDonough + Partners
Size	100m ²

Information:

McDonough states ICEhouse is a structure designed for disassembly and reconstruction.⁸⁰ The ICEhouse is primarily made of four materials that are formed in ways that allow them to be easily disassembled and reused for other locations. The design reflects the positive design framework described in Cradle to Cradle, and the sustainable development goals of the United Nations, and the reuse of resources implicit in the circular economy.⁸¹

⁸⁰ McDonough, William. "ICE-house™." *William McDonough + Partners*, 5 Jan. 2018, mcdonoughpartners.com/projects/icehouse/.

⁸¹ Ibid.

Fig 17. Image of frames added to the Aquatics Centre.

Image: The building's flexibility accommodated an additional 2,500 spectators. The roof components are 50% recyclable and the ceiling is fitted with sustainable timber.

London 2012 Olympics

Location	London, England
Year	2012
Client	Olympic Delivery Authority
Architect	Zaha Hadid Architects
Size	21,897 m ² and 15,950 m ²

Information:

The Aquatics Centre was designed before the Olympics, meaning the spectator wings were not part of the original design. They were later added as a temporary structure to fit the larger audience and accommodate the London Games.⁸² The temporary add-ons were only possible because of a very flexible design of the permanent structure. The added wing frames were later removed, unbolted and sold. Other building parts that were no longer needed were recycled.⁸³

⁸² "London 2012 - Aquatics Centre." *Detail.de*, <https://bit.ly/3h5UQik>

⁸³ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 48.

Fig 18. Image of Bullitt Center.

Image: Expresses the separation of different systems. The Skin is a high performance envelope that is estimated to last 50 years. While the roof is an active solar control photovoltaic that lasts for 25 years.

Bullitt Center

Location	Seattle, USA
Year	2012
Client	Bullitt Foundation
Architect	Miller Hull Partnership
Size	800m ²

Information:

The Bullitt Center uses 100% onsite renewable energy, waste and water management globally marks it as one of the greenest commercial buildings. The structure comprises three main materials: timber, concrete, and steel. These materials are carefully used and separated in the structure according to their specific load-bearing characteristics. In addition, the team focused on minimizing its carbon emissions during the construction phase and limited the use of concrete by solely applying it to the foundation in order to carry the loads.⁸⁴

⁸⁴ Hull, Robert, and David Miller. "Miller Hull - Bullitt Center." - *Bullitt Center*, 2012, millerhull.com/project/bullitt-center/.

4.6 Deconstruction Strategies

The general principle for designing for disassembly is to use reversible connections that can be disassembled multiple times without damaging the material or component. This will ultimately prepare the design for change in its lifetime.

Using common screws, nuts and bolts are simple ways of practicing design for disassembly and for safely allowing materials to be reused. Implementing similar fasteners can maximize freedom and assembly. This can also lead to a reduction in specific or highly specialized tools required for deconstruction.

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Fig 19. Detail challenge 1:
Wall section of a traditional col-
umn-beam assembly.

Fig 20. Detail solution 1:
Wall section of column-
beam mandrel assembly.

Fig 21. Detail challenge 2:
Wall section of a traditional
wall-deck assembly.

Fig 22. Detail solution 2:
Wall section of wall-deck de-
signed for disassembly.

Concrete Prototype

In 2015 Martin Ravnsbæk and Hans Nicolai Søndergaard, developed a new concrete building element that focused on the three objectives:⁸⁵

- Flexible concrete walls and columns that underlies direct reuse and design for disassembly.
- Create a system to use mechanical connections over casting between the elements.
- A system that saves time by prioritizing safety and optimizing the construction and dismantling process.

The desire with this prototype was to show that a circular economy is possible in the world of concrete materials. This new element can potentially create a new second hand market for stakeholders in the industry.⁸⁶

The prototype also demonstrated a typical connection between two precast concrete elements. The connections are built with accessible load transferring bolts that are set in anchor boxes inside a recessed precast concrete. This makes it easy to dismantle or fasten for future needs.

Fig 23. Image of recessed pre-cast concrete.

Fig 24. Image of load transferring bolts.

⁸⁵ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 92.

⁸⁶ Ibid.

Fig 25. Image of a circular concrete connection.

Image: Using mechanical connections instead of casting them together allows for disassembly and reuse.

Steel Prototype

In 2015, Jimmi Jensen and Milad Ahmad Tokhi, developed a new steel building element that focused on three objectives:⁸⁷

- High quality steel product that highlights a higher reuse and follows design for disassembly.
- A modular system of typical columns and beams that provides high flexibility.
- A system that saves time by prioritizing safety and optimizing the construction and dismantling process.

We can design and consider our buildings as material banks. The use of high quality steel structures that are flexible and high reusable can ultimately provide a significant economic advantage for future stakeholders.⁸⁸ Steel today is used in a constant downcycling of quality. Therefore this steel prototype influences the circular design tower to assure it maintains a high quality steel and is used in an upcycling manner.

Fig 26. Image of steel connection with split.

Fig 27. Image of split with washers.

⁸⁷ Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 86.

⁸⁸ Ibid.

Fig 28. Image of a circular steel connection.

Image: The disassembly method is optimized faster in result of a simpler action. Connections are joined by a mandrel with two splits and stabilizing washers, which can be undone at any time.

004 What is a Material Passport?

5.1 The Concept

A material passport is to ensure all the material data of a building is recorded. This can lead to materials being tracked, traced, recovered and reused during a renovation or demolition. It helps prevent the chances that demolished materials will be dumped or incinerated.⁸⁹ As noted in chapter 4.4, the lifecycle of building must always be considered when designing a building. The design of a building must be ready for any change in its lifetime, becoming storage for useful materials. The passport helps with this process through diligent and consistent recording and tracking.

In addition to preventing loss of materials value, a material passport holds relevant and useful information for the next consumer or stakeholder, which can include the following:⁹⁰

⁸⁹ "The Material Passport as next Step in Circular Economy." *MaterialDistrict*, 25 Aug. 2017, <https://bit.ly/3h62Z6o>

⁹⁰ Kaminski, Isabella. "Material Passports: Finding Value in Rubble." *Architects Journal*, 2019, <https://bit.ly/3g1aESb>

- Chemical and technical specifications
- Description of quality assurance and relevant certificates
- Environmental impact during production and lifetime
- Instructions for assembly/disassembly, maintenance and reuse.
- An individual code to identify its location in the building or construction.

5.2 The Five Principles

Five principles to consider for a material passport.⁹¹

Documentation

Documentation is critical for maintaining the material's value and quality.

All Around

The documentation will provide all relevant materials and resources.

Identification

It is critical for the individual elements to contain a physical identification for finding correct information.

ID Code

Each individual material should require a unique tag for easy identification.

Maintenance

Proper maintenance is crucial to secure the value of the materials.

Physical

A hardcopy of guidelines for the material's maintenance must be accessible.

Safety

Safety measures in all phases must be provided in the administration of a building's life.

Construction

Document all safety measures for the construction process.

Interim

Throughout the interim period, all necessary information on how to handle materials must be provided.

Ownership

The company responsible for the materials and components in this phase must be documented.

Accessibility

The information must be accessible for all collaborators.

Liability

The ownership, accessibility and liability should be evident in the information.

Database

The materials should be stored in a database that contains all relevant materials.

Link

The ID code must be associated with the database.

Digital

The digital passport must be frequently updated on any modifications or renovations.

Restoration

Following a disassembly, a proper guideline of restoring the material's value must be accessible.

Operation

Document all safety measures for the operation and maintenance of a building.

Deconstruction

Document all safety measures for the deconstruction process.

Transition

In order to minimize storage, a direct transition of materials between buildings is preferred.

Storage

If storage is required, then documentation on how materials should be handled and stored is needed.

91 Guldager Jensen, Kasper, and John Sommer. *Building a Circular Future*. 3rd ed., Arkitektens Forlag, 2019, 127.

006 New York: A Circular Tower

6.1 270 Park Avenue

The research on circular design in the previous chapter has allowed me to focus on environmental elements towards a current supertall proposal on 270 Park Avenue in midtown Manhattan. The following chapter investigates an alternative proposal to 270 Park Avenue.

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Fig 29. Visual of existing 270 Park Avenue from midtown east.

6.2 Introduction

270 Park Avenue holds a prominent position in midtown Manhattan with exceptional views to the Empire State Building and lower Manhattan to the south, the Chrysler Building and East River to the east, Central Park to the north and Midtown and Hudson Yards to the west. The tower stands out as a highly visible landmark in New York's skyline that can be seen from all over the city.

Brief History

270 Park Avenue, also known as the JP Morgan Chase Tower, and formerly the Union Carbide Building, is a 1960 mid-century icon that stands 216 m tall with 139,354 m² of interior space. In 2019, the city and JP Morgan-Chase announced plans to demolish and replace the modernist tower by a new taller skyscraper.⁹² This demolition will be the tallest voluntarily demolished building in the world. This has sparked large environmental concerns and criticism, particularly since JP Morgan completed a renovation of 270 Park Avenue in 2011 which achieved a LEED Platinum status.⁹³ The new 403 m (a 187 meters taller than the existing building) skyscraper is set to yield around 222,967m² of newly built space - almost doubling its original height and area.⁹⁴

⁹² Brenzel, Kathryn. "270 Park Avenue: Midtown East Rezoning: NYC Demolition." *The Real Deal New York*, 3 June 2019, <https://bit.ly/3iQsuxx>

⁹³ Kim, Elizabeth. "270 Park Avenue, A Quintessential Modernist Skyscraper, Is Being Slowly Destroyed By Chase Bank." *Gothamist, Gothamist*, 8 Jan. 2020, <https://bit.ly/3g90M9b>

⁹⁴ Young, Michael. "First Look at JPMorgan Chase's Future Supertall Headquarters at 270 Park Avenue, in Midtown East." *New York YIMBY*, 15 Oct. 2019, <https://bit.ly/3arZqFb>

Many wonder if the new tower will plan to salvage any materials. It is still unknown given that the company has not released any official documents addressing any reuse.

This thesis proposes an alternative project that will address environmental issues and client needs through a circular framework that proposes a new strategy for using the existing building. As indicated in chapter 1, these strategies will focus on both material economy, social and environmental values.

This design proposal explores the possibility of a circular tower typology in the high density urban environment of Manhattan. As the population and demand for development continues to grow in the coming years, existing urban plots in the city proper may not be enough for building city parks or gardens since the common conventional point tower typologies leave little at grade for the public. This project explores a substantive integration of public space into the tower. The revival of 270 Park Avenue through a circular design approach, that integrates both private and public amenities, as well as incorporating stronger natural and green elements - by embracing the vertical nature of the supertall tower.

Global Press Response

"This feels rather wasteful. A perfectly-good, recently LEED Platinum certified, 52 storey office tower at 270 Park Ave in NYC is being dismantled to be replaced with a new 70 storey office tower. I don't know what the carbon budget is on this, but it can't be good #climate-crisis"

Jason Thorne

Head of Department of Planning & Economic Development

"By no logic-design,environmental planning,zoning, landfill capacity-does demolition of 270 Park make sense, especially when at least some in the architectural community are trying to advance sustainable design...is any of it being recycled? this is a clear environmental issue."

Roberta Gratz

Journalist, New York Review of Books

"Without a better understanding of how it will be dismantled and what is going to replace it, demolishing such a recently renovated green building, particularly one as prominent as 270 Park Avenue, implies that sustainable design is a low priority."

American Institute of Architects

Fig 30. Typical vs new typology.

Typical Typology

New Typology

6.3 Site Analysis

270 Park Avenue

Fig 31. Aerial image of 270 Park Avenue.

Area of Interest

Fig 32. Site analysis map 1.

Key Landmarks

- 1 Central Park 1100 m away from site.
- 2 Chrysler Building 482 m away south on Lexington Avenue in midtown east.
- 3 Grand Central 321 m south of site on E 42nd St.
- 4 Time Square 804 m west of site towards 7th Avenue.
- 5 Empire State Building 1200 m south of site on W 34th St.

Fig 33. Site analysis map 2.

Fig 34. Existing tower facts.

Nearby Supertalls + Height

- 1 Chrysler building 319 m.
- 2 One Vanderbilt 427 m
- 3 350 Park Avenue 442 m.

Certified as LEED Platinum 2011

98% Occupancy

Current Condition

Fig 35. Image of north elevation overlooking Park Avenue.

Fig 36. Image of east elevation.

Current Condition

Fig 37. Image of main entrance from Park Avenue.

Fig 38 Image of east elevation.

6.4 Design Approach

The design for the new 270 Park Avenue tower is founded on four main principles that will emphasize circular design - and further illustrated in the following chapters.

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- Creating an efficient, flexible and adaptable building
- Designing healthy spaces, which inspire creative work and engage people in social behavior
- Designing a low carbon building that celebrates sustainability through circularity
- Creating a publicly accessible icon

Fig 39. Design approach scheme.

Creating an efficient, flexible and adaptable building

The project begins with the circular design principles and strategies of re-use and adaptability, based on a modular and flexible plan. The proposal also deploys best practices in design - stacked elevators and design for disassembly, in order to allow for variety in design and layout and future transformability. All additions to the existing structure will be made by standardized elements designed for disassembly - meaning that floors can easily be added or removed.

Designing healthy spaces, which inspire creative work and engage people in social behavior

The design aims to create transparency, flexibility and social environments that can easily be adapted. In addition to office spaces, additional floor areas can be re-configured and are used to create an interior core/vertical park which holds communal spaces, creates visual interaction across floors and gardens, and becomes a core for inspiring, and creating healthy and engaging areas to the existing workplaces and interior spaces.

Designing a low carbon building that celebrates sustainability

This proposal implements ambitious circular economy strategies involving reuse, environmental performance, upcycling and on-site energy production. The gardens within the vertical park will act as 'green lungs' of the building, cleaning and passively preheating the air before it enters the work areas, reducing the need for heating the air as well as giving the building a distinctive appearance.

The aim is to reuse as much as possible of the original building. Accounting for the existing structure, the design ensures that 85% of columns, beams, and slabs, as well as 95% of structural walls were reused in the redesign of the tower. This ensures that 50% of the resources required for the new tower are to be directly reused from the existing building. The savings in material costs and time means significant reductions in CO₂ emissions. A total of 6,500 tons of CO₂ is saved by reusing materials.

Creating a publicly accessible icon

The idea that architecture shapes behavior can influence change and inspire a new practice of tower design. The regenerated tower aims to be a good neighbor, bringing value and a new environmental models to the surrounding cityscape. Similar to New York being a hub, the new design will make the building a part of the public realm by connecting the surrounding corridor of trees in Park avenue to a green podium at grade, allowing the public and other users to enjoy and explore the vertical park and its amenities. A public restaurant in the "summit" or crown of the tower will afford visitors breathtaking views of the entire city.

Fig 40. Image of new 270 Park Avenue overlooking midtown Manhattan.

6.5 Future Flexibility

Deconstruction + Construction Strategy

Creating an Efficient and Adaptable Building

The existing structure is based on a grid that informs the new tower as well. The grid creates a flexible and efficient system for flexible and potential reuse in the future. To achieve the vertical park, new floor slabs are demountable floor slabs, which makes it possible to add or remove spaces, see figure 42. The proposed design, with the vertical park, will meet the square footage requirement in the JP Morgan Design brief, of 222,967 m². Flexibility, however, is ensured by accounting for contingencies. In the event the building changes program or the tenant requires more area, the void spaces can be reconfigured at any level of the tower. The design of these floors utilise design for disassembly principles to ensure a clear assembly without disrupting the on going use of the building.

The overall structure is organized by a rational structural grid which simplifies the overall superstructure throughout. The structure takes the form of a system of blocks that cantilever from one another. The contrast in cantilever allows the structure to balance itself similar to the concept of Jenga. The thick slabs at the start of a new block are used as transfer floors to provide stability.

The atrium floors are made in standardized steel profiles incorporating mechanical joints and connections. All floor components are scaled to fit within the tower's service elevators to avoid and minimize any scaffolding or construction pollution. In addition, the reconfiguration of floor plans or entire sections of the tower results in a greater reduction in construction time.

Figure 41, indicates area differences with the internal configurations of the building.

Area Difference

Fig 41. Area differences with the internal configurations of the building.

Module Framework

Fig 42. Various module options.

New Park Module Options

Workspace Flexibility

Fig 43. Adaptive workspace combined for different needs.

Deconstruction + Construction

A deconstruction manual permits resources and materials to be harvested in a way that preserves the value of the materials and parts of the tower. This permits design for disassembly methods to be used, allowing the building to adapt and change over time.

Fig 44. Proposed deconstruction manual.

Fig 45. Circular design considerations.

Fig 46. Circular concrete prototypes.

Fig 47. Upcycled concrete with aggregates of reused concrete.

Fig 48. Concrete elements are joined by bolted steel connections, all reversible reusable in the future.

Material Transparency

The elements and materials for 270 Park Avenue will contain detailed information of their content, environmental footprint and material value. This will allow the reuse and recycling possible for the future.

Fig 49. Phases of Material Passport.

Disassembly Protocol

Fig 50. Existing 270 Park Avenue in its context. Southview from midtown east.

Fig 51. Existing 270 Park Avenue isolate from context.

Fig 52. Part 1. Deconstruction and recovery of materials and components.

Fig 53. Part 2. Deconstruction and recovery of materials and components.

Fig 54. Building stripped down to its structural elements.

Fig 55. Construction of new 270 Park Avenue. Existing columns and slabs are reclaimed and reinforced where necessary.

Fig 56. 270 Park Avenue top out. Facade and other recovered materials are added.

Fig 57. New 270 Park Avenue isolated from its context.

6.5 Concept Approach

Fig 58. Concept mass.

Fig 59. Inviting the public realm.

Fig 60. Social hubs on each block.

Fig 61. Vertical park linking all blocks.

Fig 62. Programs added to the vertical park.

Fig 63. New 270 Park Avenue. Buildings in the foreground are hidden.

Fig 64. New 270 Park Avenue with its context. Southview from midtown east.

6.6 Green Infrastructure

The shift from gray to green infrastructure is becoming more apparent in our industry. Green infrastructure is a cost effective, resilient approach to managing wet weather impacts that provide many community benefits. Conventional gray infrastructure is based solely on a single-purpose system designed to move urban stormwater away from the built environment.⁹⁵ Green infrastructure reduces and treats stormwater at its source while providing environmental, social and economic benefits. A list of interesting facts and benefits are listed below that 270 Park Avenue aims to achieve.

⁹⁵ "What Is Green Infrastructure?" *EPA*, Environmental Protection Agency, 4 Dec. 2019, <https://bit.ly/344ropl>

Environmental Benefits

- Improve air quality and reduce urban temperatures locally
- Water management and climate change mitigation
- Support for biodiversity and pollination

Social Benefits

- Improve beauty and liveability of life
- Fewer incidences of pollution and heat-related illnesses
- Increase opportunity for recreation and interactions with nature, and associated psychological and restorative benefits

Economic Benefits

- Improve marketability of building
- Energy cost savings
- Infrastructure cost savings
- Increase workplace productivity

Urban citizens are 20% more at risk of developing anxiety disorders and 40% more likely to develop mood disorders.⁹⁶

Research has shown that people who work in buildings who can see green space take almost a quarter less time off work than those who cannot.⁹⁷

⁹⁶ Adli , Mazda. "Urban Stress and Mental Health." *LSE Cities*, Nov. 2011, www.lse.ac.uk/cities, 2.

⁹⁷ Armour, Tom, and Chris Luebke. "Cities Alive: Rethinking Green Infrastructure." *ARUP*, 2014, <https://bit.ly/345tHHH>, 52.

Several studies have demonstrated that vegetated features in buildings, such as green roofs, green walls and landscaping, can increase the property value up to 20%.⁹⁸

98 Tomalty, R.; Komorowski, B.; Doiron, D. The Monetary Value of the Soft Benefits of Green Roofs—Final Report; Smart Cities Research Services: Montreal, QC, Canada, 2010., 5.

Green Strategy

The vertical park integrates a series of landscape typologies from around the USA. Natural biomes are mapped out and integrated to enhance the functions of the building. Inspired by landscapes from around the United States, the vertical garden incorporates a series of conceptual terrains into the experience of the building. In figure 71, it illustrates the desert at the bottom of the podium to create a retail/commercial experience. The tropics create restorative oases and the great plains and forest creates a social amenity garden. The landscape typologies are strategically placed where their special traits provide the most value. The mountain biotope is naturally found in a tall and wind-like climate like towers. The green walls and plants help clean and heat the air. The vertical park concept creates a unique experience for social interaction and allows the possibility to interconnect floors with suspended bridges.

Fig 65. Tucson Mountain Park in Arizona.

Fig 66. Everglades National Park in Florida.

Fig 67. Badlands National Park in South Dakota.

Fig 68. Allegheny National Forest in Pennsylvania.

Fig 69. Rocky Mountain National Park in Colorado.

Fig 71. Interior park view of green strategy.

Nature All Year Round

The vertical park strategy is a long-term solution, where all four seasons and natural growing cycles are linked, to provide an engaging natural environment, with low maintenance, self-sustaining biodiversity and appealing natural processes that can be used all year round. Empirical evidence shows that positive emotions, mental restoration and other benefits can occur in as little as five to twenty minutes of immersion in nature.⁹⁹

⁹⁹ Tsunetsugu, Yuko, and Yoshifumi Miyazaki. "Measurement of Absolute Hemoglobin Concentrations of Pre-frontal Region by Near-Infrared Time-Resolved Spectroscopy: Examples of Experiments and Prospects." *Journal of PHYSIOLOGICAL ANTHROPOLOGY and Applied Human Science*, vol. 24, no. 4, 2005, pp. 469–472., doi:10.2114/jpa.24.469.

Fig 72. Spring in Central Park, New York.

Fig 73. Summer in Ralph Bunche Park, New York.

Fig 74. Autumn in Central Park, New York.

Fig 75. Winter in Adirondack, New York.

Sprouting Spring

Beginning in the spring, users can grow their favourite vegetables, herbs, and leafy greens in the park. The area stimulates all senses, creating an environment that is educating, inspiring and encourages a dynamic recreational lifestyle. See figure 76.

Fig 76. Spring garden detail.
See the corresponding icon below.

Relaxing Summer

The park allows users to meet and socialize in an informal manner. Evaporative cooling from trees and grass reduces the urban heat island effect, creating a comfortable microclimate for relaxing and socializing outdoors. While easily accessible from the surrounding spaces, the park still feels separate and unique. see figure 77.

Fig 77. Summer garden detail.
See the corresponding icon below.

The park creates educational experiences

Optimized microclimate on roof gardens

Active Autumn

Natural elements are used to provide shelter from high altitude winds, while pockets are created to capture the sun. These are spaces that feel safe, providing a sense of retreat and withdrawal – for work, protection, rest or healing. These refuge conditions are important for restoration experiences and stress reduction, which can lead to a lowered blood pressure and heart rate.⁹⁹ See figure 78.

⁹⁹ Browning, William, et al. "14 Patterns of Biophilic Design." *Terrapin Home - Terrapin Bright Green*, 12 Sept. 2014, <https://bit.ly/30Zz4au>, 12.

Fig 78. Autumn garden detail. See the corresponding icon below.

Visible Winter

When selecting plants for the park, the long term survivability has a significant impact on maintenance cost. Therefore the plants will be selected due to their natural adaptation to the winter conditions. This will provide plants to still create a sense of environment. These plants can still be used as part of a green home that is designed to provide habitat for birds and insects. See figure 79.

Fig 79. Winter garden detail. See the corresponding icon below.

Natural shelters are extending the season

The plant strategy support survivability and easy maintenance

Life Inside

Fig 80. Life inside the park view diagram.

6.7 Ground floor and Public Realm

Site Plan

Fig 81. Public domain site plan.

The Podium

The lower floors of 270 Park Avenue tower works as an extension of the plaza and serves as the start of the vertical park. The overlapping voids are connected by a playful ramp that stimulate a curious environment to explore and to socialize in. The green spaces will stretch over several voids, offering dining and hang out space for various retail components. Several studies show that integrating greenery as part of commercial environments make people stay longer, creating a more robust and interesting atmosphere.

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Fig 82. Accessible atrium ramp made from recycled copper.

Fig 83. Existing ground floor.

Fig 84. Proposed ground floor- the social lobby + desert park.

Fig 85. Floor 002- The market place.

Fig 86. Floor 003- The universal workspace.

Fig 87. Floor 004- Conference center.

Fig 88. Floor 005- The tropical park.

Fig 89. Visual of desert atrium from ground level

6.8 Skybridge Park

Fig 90. Aerial visual view of the skybridge park.

The Skybridge

The design of the skybridge provides a place for place-making, experience and engagement. It provides a sense of urban identity and specific iconicity to the park as well as a sense of excitement. It draws interest from the street and its public programming encourages continuous use.

The skybridge is an outdoor and indoor community center offering seasonal multi-purpose programs such as weekend street markets, a fitness center, public concerts & events and a winter ice skating rink. Visitors and users are able to stroll and experience the skybridge at any time and day of the year. The skybridge park includes a number of designed experiences.

Fig 91. Floor 048- The sky-bridge park.

0 m 50 m

Floor 48/ Area Program

- +1 Event Breakout
- +2 Restaurant/Cafe
- +3 Mixed Retail
- +4 Open Air Gym
- +5 Herb Garden/ Ice Skating Rink
- +6 Sensual Garden/ Public Concert and Events
- +7 Production Garden/ Weekend Street Market
- +8 Activity Center

Sensual Garden

Bees, butterflies and songbirds are attracted to the local plants and fragrant herbs in order to create a immersive fragrant and tactile garden. See figure 92.

Production Garden

A small scale urban farm on the skybridge can be a profitable business as well as a social attractor and high-quality amenity that serves the cafe and restaurant which locally grown foods in an informal setting. See figure 93.

Fig 92. The sensual garden.

Fig 93. The production garden.

Herb Garden

On the skybridge, herbs can be picked from hedges, and casual encounters and open air meetings take place with a view over the city. See figure 94.

Open Air Gym

The walkway that circulates through the landscape becomes a running track for a morning run and acts as a space for exercise from a busy work day. See figure 95.

Fig 94. The herb garden.

Fig 95. Open air gym.

6.9 The Top of Manhattan

Fig 96. Visual of rooftop overlooking the city.

270 Park Avenue offers a series of public spaces in the top. It is accessible for the users of the building and the community. Visitors can enjoy a full panorama view of the city from a continuous green space.

Urban Farm Rooftop

The green space at the crown of the tower could be used for urban farming, supplying a restaurant where people would dine among the crops in direct table to plate style. Furthermore, the rooftop includes an innovative 'agrivoltaic' technology to produce both food and renewable energy from the same area. The outcome in organic food production will create a sense of community while reducing the environmental footprint for food consumption.

Fig 97. Urban Farm Rooftop terrace diagram.

6.10 The Workplace

6.10 The Workplace

The spaces of our workplaces are rapidly changing, made even more apparent under the COVID-19 pandemic. They need to reflect employee desire for more varied and engaged collaborative environments, as well as private spaces for security. Simultaneously, businesses are increasingly asked to plan for uncertainty to scale, contract or flex with scant warning.

Workplace destinations are the future of work. 270 Park Avenue does not only deliver amenities but creates a workplace destination for all visitors and users. For the users of 270 Park Avenue, the office floors are based on a modular approach with flexible and efficient spaces that contain a variety of spatial work areas such as informal and collaborative areas.

Fig 93. The workplace floor tactics. +S: The floors are connected with the park atrium and stairs

Fig 98. The workplace models.

Flexible Work Areas

Fig 99. Work area options.

Spatial Office Diversity

Fig 100. Office diversity plans.

6.11 Designing A Circular Tower

Designing a Green Icon

The aim of the thesis is to propose a design that maximises existing resources, structure and materials to help ensure a high quality build, while balancing spaces of production, leisure, public and private.

Carbon Neutrality

Carbon neutrality, or even positivity, as a concept and strategy that can be defined and deployed in various ways. This research addresses the issue through two approaches:

The aim of the thesis is to propose a design that maximises existing resources, structure and materials to help ensure a high quality build, while balancing spaces of production, leisure, public and private.

1: Energy consumption in use

The building is designed to passively minimize energy consumption. This is done by the recycled shading vertical louvers, which ensures minimal heat gain into the interior spaces. In the interior gardens the glazed area is maximized to utilize passive heat gain to preheat air. To actively supply renewable energy, the design proposes to implement photovoltaic cells on walls and south facing louver sides.

2: Embodied carbon – a full circle perspective

Reusing the existing structure is already a significant carbon reduction strategy. The aim here is to reuse as much as possible of the original building. Calculated through a Life Cycle Analysis (LCA), the design ensures 85% of columns, beams and slabs, as well as 95% of structural walls are retained and reused in the redesign of the tower. The estimated savings totals 6,500 tons of CO₂ emission. The additional building parts are defined by high quality modular steel and concrete construction. Furthermore the design aims to utilize material upcycling and design for disassembly to further reduce embodied carbon and life cycle carbon footprint.

Water Cycle Design

Greenery, water and biological systems are not simply considered for their resource value or aesthetics, but also for their functional and productive value. By rethinking water systems in a circular perspective, the planty and greenery is seen as interconnected and looped to the other systems of the building. Water is treated in a closed loop and air is recycled rather than dispensed, helping to keep energy losses to a minimum.

Grey Water Reuse

Grey water used for toilets can be used advantageously for reducing fresh-water intake and costs. Grey water can further be used for sub-surface irrigation and is filtered biologically by plant beds before mechanical filtration for reuse.

Fig 101. Grey water reuse.

Transpiration Through Green Roofs

The green roofs are highly effective at thermal balancing, using natural transpiration in summer to cool the roof areas that are most exposed to direct radiation, while the biological activity in the soil preserves warmth in the winter.

Fig 102. Transpiration through green roofs.

Air Recycling through Green Lung

A large-format air recycler coupled to a ventilated green-wall capitalizes on residual CO_2 from return air. The green walls in the vertical park produce oxygen and capture NO_2 , VOCs, and free radicals at an effectiveness 100 times that of a standard green wall, due to this coupling.

Rain Collection & Reuse

Biological filtration of rainwater using the terraces can be used for both irrigation and heat rejection. The water in storage may act as a heat-sink for conditioning and be evaporated in mechanical systems with minimal post treatment.

Fig 104. Rain collection & Re-use.

Biofiltration

The green roof with granulate under-layer helps filter rainwater for storage and reuse. These rely on microbial bacteria in the root systems of plants to absorb contaminants and condition the water using aerobic digestion.

Fig 105. Biofiltration. The water is cleaned using a biological process called a 'living machine'.

Waste Management

Fig 106. Waste management strategy.

Waste is food: By integrating strategies for waste separation in the process, as well as implementing innovative technology for clean energy production, 270 Park Avenue will be able optimize the handling of daily waste.

Facade

The new louver facade system uses a combination of the existing metal facade and upcycled metals. The metal louvers are angled to shade for the sun, and highlights the vertically of each floor.

Fig 107. Metal louvers with sun direction.

Fig 108. View from E 47th St.

Upcycling Strategy

The design investigates the potential of reusing secondary raw materials from the transformation as new materials in the rejuvenate 270 Park Avenue. This includes the reuse of steel from the facade for new louvres, glass for either insulation, glass bricks as elements in glass partitions or internal facades in the gardens.

Fig 109. Upcycling tower approach.

Fig 110. Facade breakdown.

Life Cycle Assessment and Design

Ensuring that 50% of the resources required for the new tower are already in place allows the design to reduce a significant amount of CO₂ emissions. In order to receive a better estimate of the environmental impact of design for disassembly, and of the reuse of the superstructure elements, a life cycle assessment was performed as part of the thesis research. The calculations were done through an LCA database assuming a lifespan of 100 years for 270 Park Avenue. This evaluation excludes energy consumption and only focuses on the embedded environmental impacts related to building materials.

Figure 111: Illustrates a comparison of total CO₂ emissions saved for 270 Park Avenue between no reuse to three reuse cycles.

Figure 112: Illustrates a closer breakdown of total CO₂ emission saved between the building components.

■

Fig 111. LCA diagram 1.

Fig 112. LCA diagram 2.

Fig 113. Life Cycle Design.

Designing for Disassembly

It is likely to assume the demands for commercial buildings will change constantly; constructing and building in a robust and adaptable manner is critical to design. The LCA studies show that elements such as inner walls and installations are regularly changed, for example, in relation to new tenants moving in or expanding. This continuous retrofitting constitutes a significant carbon footprint over time. Therefore, by applying design for disassembly principles will ensure materials and components to stay in the loop and maintain their inherent value over time. The diagram illustrates an estimate on how often the elements should be replaced.

Air Quality and Health

The chemicals and off gassing from materials can have a significant impact on productivity and well being in office environments. Therefore the building will include carefully looked healthy materials using non-toxic surfaces and use products certified with social and environmental performance. This will ensure a work environment with the highest air quality standard. The diagram illustrates what building elements have the most impact on air quality.

Fig 115. LCA air quality and health.

Primary Energy and CO₂ Footprint

The LCA results allowed the design to focus on building components that have the greatest impact on CO₂ footprint. Carefully focusing on these elements allows the building to achieve a high degree of sustainability. The diagram illustrates what building elements hold the most energy towards global warming potential.

Fig 117. Visual of construction

Fig 118. Section of 270 Park Avenue 1

Fig 119. Section of 270 Park Avenue 2

6.12 Conclusion: Expanding the Value of Circular Design

6.12 Conclusion: Expanding the value of Circular Design

This proposal for 270 Park Avenue has shown the potential for significant environmental impact savings when applying circular design principles and design-for-disassembly strategies. The current model of the supertall is not predicated on a technological progress that allows us to build higher buildings, but is a model based on the concentrations of wealth. This thesis suggests a counter model, an alternative mode of thinking and designing the supertall- one that is much more inclusive, open, and broadly accessible - not just to billionaires.

The project emphasises programmatic, experiential and adaptable flexibility and circularity - not just material circularity. This proposal for 270 Park Avenue is designed to be readily and easily changeable: programs can be adjusted, added and removed so that the stasis of the building does not prefigure its own future demise. The building can, and should, be able to change and flex as urban and social needs require.

Adopting a circular economy and circular design principles is an urgent issue for architecture. Preserving raw and manufacturing materials that can be reused can help drastically reduce our construction consumption and material waste pollution. Designing buildings that can have a second life and implement deconstruction practices in line with sustainability standards can be a significant force to combat climate change. The fight against global warming, against wealth, living and urban inequity is a responsibility shared by all of us. 270 Park Avenue does more than upcycle an existing tower: it also frames a new design outlook for future generations. This thesis hopes to expand modes of architectural practice and to inspire other designers in an age of environmental and sustainable transformation.

Fig 120. West facade view over sunrise.

Fig 121. Civilian on Madison Avenue.

Fig 122. Existing main entrance of 270 Park Avenue.

Fig 123. New main entrance of
270 Park Avenue.

000 GLOSSARY

Building Stock

Used to describe the total number of buildings in an area.

Cradle to Cradle

A sustainable business strategy that mimics the regenerative cycle of nature in which waste is reused.

Living Machine

Ecological wastewater treatment system that relies on biological systems, such as microorganisms, and plants to purify wastewater

Material Bank

A repository or stockpile of valuable materials that might be recovered from other building sources.

LEED Plantinum Status

LEED, which stands for Leadership in Energy and Environmental Design, is a green building rating program. The highest certification is LEED platinum awarded to buildings that attain 80 or more points.

Green Lungs

An area of a natural parkland within an urban region, supposed to replenish the air with oxygen.

LCA (Life Cycle Assessment)

is a multi-step procedure for calculating the lifetime environmental impact of a building, product or service.

000 IMAGE INDEX

Fig 10. Image of lost valueable materials post demolition

Accessed November 10,2019. <https://bit.ly/3iSLCGR>

Fig 11. Image of Green House Solution. Accessed No-

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Fig 12. Image of B/S/H Headquarters. Accessed Novem-

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Fig 16. Image facade of ICE House. Accessed November

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Fig 23 Image of recessed precast concrete. Accessed

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Fig 25. Image of a circular concrete connection. Accessed June 20, 2019. <https://bit.ly/318B28F>

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Fig 35. Image of north elevation overlooking Park Avenue. Accessed May 18, 2020. <https://bit.ly/2YaB5yK>

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Fig 69. Rocky Mountain National Park in Colorado. Accessed July 18, 2020. <https://bit.ly/3l397Pk>

Fig 72. Spring in Central Park, New York. Accessed July 22, 2020. <https://bit.ly/318NncZ>

Fig 73. Summer in Ralph Bunche Park, New York. Accessed July 25, 2020. <https://bit.ly/324uAhU>

Fig 74. Autumn in Central Park, New York. Accessed July 25, 2020. <https://bit.ly/3aBJjor>

Fig 75. Winter in Adirondack, New York. Accessed July 22, 2020. <https://bit.ly/2Y7Pagr>

Fig 120. Existing main entrance of 270 Park Avenue. Accessed May 18, 2020. <https://bit.ly/2E4ps5B>

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Thank You.