Corner Factory
Revisiting Urban Manufacturing

Simon Nilsson
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<u>Title</u>
Corner Factory
Revisiting Urban Manufacturing

<u>Author</u>
Simon Nilsson
www.simonnilsson.nu

<u>Supervisor</u>
Daniel Norell

<u>Examiner</u>
Jonas Lundberg

Abstract

This thesis reimagines the form, function and place of the factory. The factory of today is typically a flat, expandable and cheap 'shed', almost always placed in a monofunctional industrial zone. Manufacturing is dispersed and obscure, overlooked by a paradigm of 'mixed-use' densification.

The reasons for this separation seems dubious in a rapidly changing industrial landscape. New fabrication flows, disruptive technologies and a changing workforce looks supportive of revisiting the original factory condition: urban and compact, in close proximity to workers and resources.

Factory architecture has often been a blunt reflection of technological and societal conditions - how could a contemporary urban factory likewise reflect ongoing shifts? There is a tradition of 'spectacle' in factory architecture, where industrial workings are manifested extrovertly. In this vein, what aspects of new vertical production processes could be utilised for visual effect?

On a city-block corner in a central development area of Gothenburg, a high-rise (22x22x49m) factory is conceived. Tailored towards the high-tech sector on a hotel model and ready to accommodate 'Industry 4.0', the facility utilises a smart logistical core for handling the vertical flow problem. Promoting exposure of automated equipment, constant activity is provided to its surroundings.

Employing this proposal as critical device, the potential of industrial presence to contribute to a cityscape is investigated and further debate hopefully provoked.

Contents

Design

Aim

The aim of this thesis is to challenge the virtual absence of manufacturing in discussions regarding urban planning, and to explore what current shifts might mean for factory architecture.

Method

This is to be achieved by investigating future manufacturing space through a visionary factory proposal that provokes further discussion.

Questions

Factory architecture has often been a blunt reflection of technological and societal conditions - how could a contemporary urban factory likewise reflect ongoing shifts?

There is a tradition of 'spectacle' in factory architecture, where industrial workings are manifested extrovertly. In this vein, what aspects of new vertical production processes could be utilised for visual effect?

Themes

Factories, being pragmatic enclosures for the making of things, have perhaps faster than any other building typology adapted to new conditions. Guided by the hand of market capitalism, their architecture has closely followed changing technological, economical and societal conditions. Recurring industrial revolutions have radically transformed the form, function and place of factories over the years. This master's thesis is exploring several themes found in the growing space between the current state of factories and an ongoing transformation of manufacturing.

OPPOSITE: TAHOE-RENO INDUSTRIAL PARK (BING MAPS 2016)

'Industry, overwhelming us like a flood which rolls on towards its destined ends...'
Le Corbusier, *Toward an Architecture* (1923)

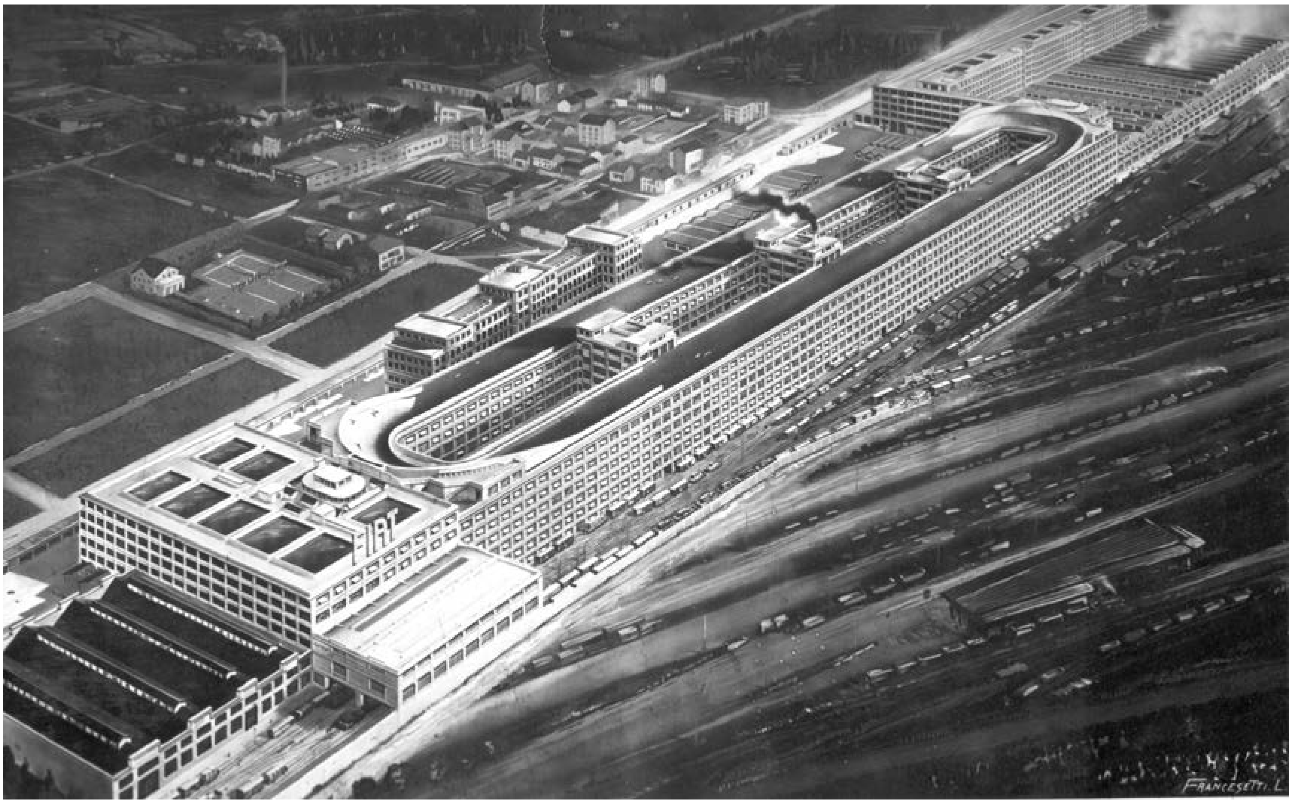
Form, place and spectacle

Manufacturing is today dispersed and global, typically located in industrial districts sorely lacking in urban qualities. Found at the outskirts of cities, no matter the country, these production zones all look similar. They are sprawling fields made up of 'sheds' - rudimentary steel halls, cheapy erected and easily expanded, the simplest possible shell for sheltering a production process. Or in effect, the very antithesis of the vertical city-factory.

Historically, multi-storey factories has often been found in dense city environments, in proximity of workers and resources. The cotton mills of Victorian England was for all their flaws as workplaces a very vital urban phenomenon, and supreme drivers of urbanisation itself. Embracing technology and rationalism, the early 20th century factory was an instrumental mover of Modernism itself, through buildings such as the AEG turbine factory (Behrens, 1910) or the Fagus Factory (Gropius & Meyer, 1913). A few years later, the *spectacular* was introduced in factory architecture by the enormous Fiat Lingotto plant in Turin (Giacomo Mattè-Trucco, 1923)

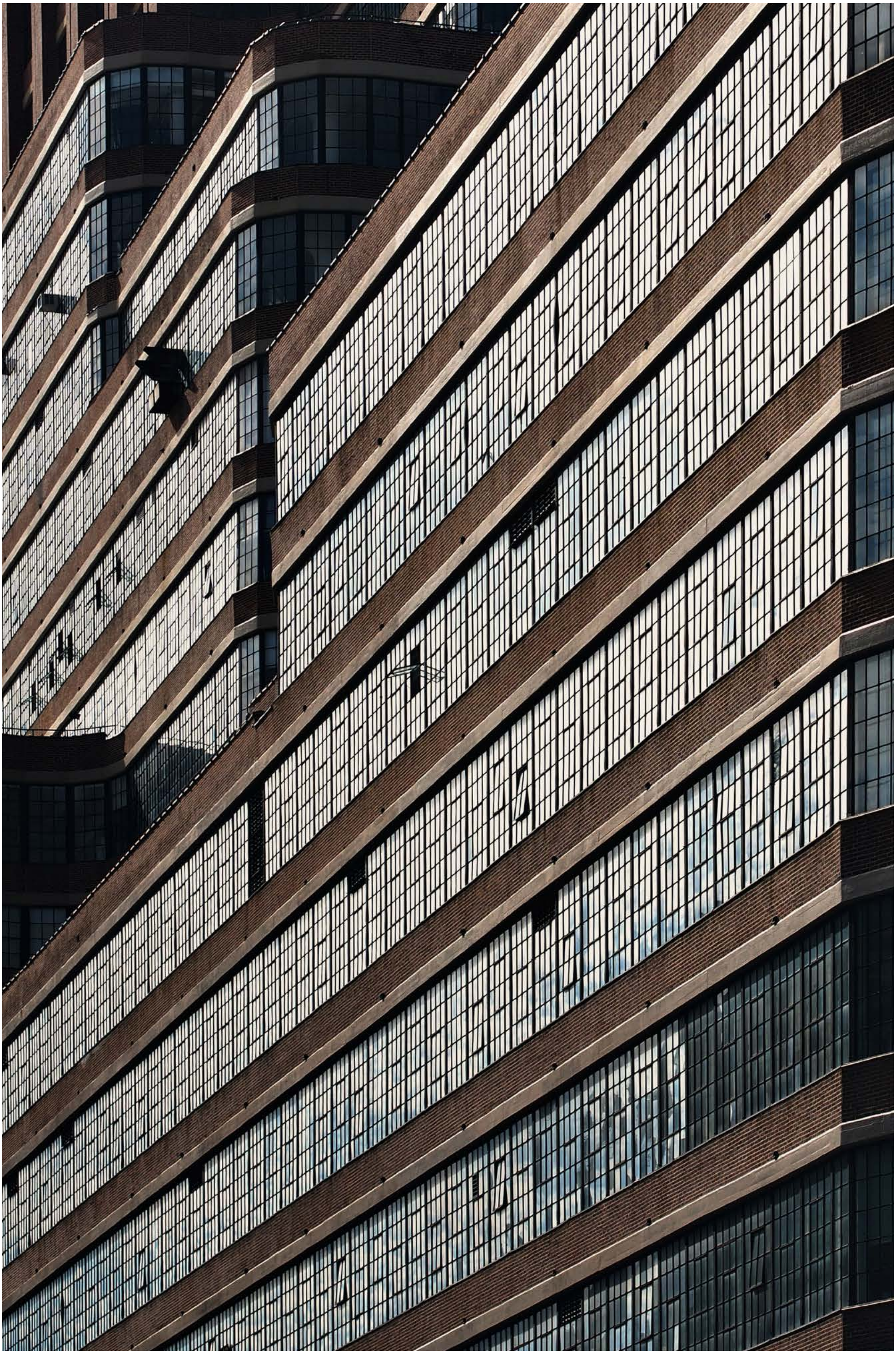
With its crowning rooftop test track, signifying a new age through the symbolism of the car. At the time of its opening, it was something radically new, and was hailed by Filippo Tommaso Marinetti as the 'first Futurist constructive invention'[1] and by Le Corbusier as 'one of the most impressive sights in industry' and 'a guideline for town planning'.

Apart from this incredible gimmick, the Lingotto plant is modelled on the Ford Highland Park factory (Albert Kahn, 1910). In this facility, Ford was testing out his theories of utilising gravity through chutes and slides along the vertical production line winding across four floors. In the end, Highland Park was abandoned as Lingotto opened. The pragmatic Ford had simply faced up to the supremacy of horizontal flows for mass production[2]. The cotton mills had been compact and multi-storey for reasons of mechanical



LINGOTTO PLANT IN 1928 (DGTMEDIA - SIMONE. CC 3.0)
OPPOSITE: VAN NELLE FABRIEK (ARJANDB. CC-BY-SA-3.0-NL DESATURATED BY AUTHOR)

1. MARINETTI, SOMENZI, MAZZONI. (1934) FUTURIST MANIFESTO OF AERIAL ARCHITECTURE
2. BRUNNSTRÖM, L. (1990) THE RATIONAL FACTORY : ON THE ROOTS OF FUNCTIONALIST ARCHITECTURE (SWEDISH EDITION)



force transfer, and electrification initially did little to alter factory typology. But the advantages of laying out a spacious production line on a single floor soon became obvious. Opening a virtually self-sufficent car-making mini-city at River Rouge, a new template for large-scale manufacturing was established.

'The most beautiful spectacle of the modern age', again according to Le Corbusier, is the Van Nelle Fabriek (Brinkman & Van der Vlugt, 1931). Designated a world heritage in 2014, it brandishes the world's first pre-fabricated curtain wall. Through this the factory's contents was exposed like never before, and the machine aestethic truly came into its own through the constructivist bridges transporting goods into a logistics terminal.

This super-transparency has a modern counterpart in the Gläserne Manufaktur of Volkswagen in Dresden (Günther Henn, 2002), which is meant to represent the company's values (rather ironical in light of the 2015 emissions scandal). While a practical, operational facility and not a showroom, this factory is still the public 'face' of VW production, being both building and ongoing PR campaign. This communications strategy is common among premium car manufacturers, with the BMW plant in Leipzig being especially noteworthy. Through a central section designed by Zaha Hadid, car chassis are conveyed through the management and administration facilities, blurring the division of labor in a celebration of speed and movement reminiscent of Lingotto.

With super-block structures such as the Starett-Lehigh building on Manhattan (Cory & Cory, 1931) urban manufacturing reached an all-time high of density and urbanity. However, during the postwar economic boom, factories started leaving cities according to the economical logic of that era. Cheap energy, transportation and labor pushed industry to similarly cheap locations.

Today, as manufacturing conditions are rapidly changing, so are the fundaments of the location and form of certain facilities. Complementing the fields of sprawling sheds at our city outskirts, could an urban return of factories be plausible? The exuberant wonder of the first machine age have faded, but technology is marching on. What could these recent advances and following socioeconomic shifts imply for factory architecture?

And what could a contemporary spectacle consist of?

TESLA FREMONT FACILITY (CHRISHMT0423 CC 2.0)
OPPOSITE: STARETT-LEHIGH BLDG (AUTHOR 2014)

Typological evolution

OPPOSITE: STARETT-LEHIGH BLDG (AUTHOR 2014)

(1) 1400'S, VENICE ARSENALE: CANAL PRODUCTION LINES IN FIRST FACTORY

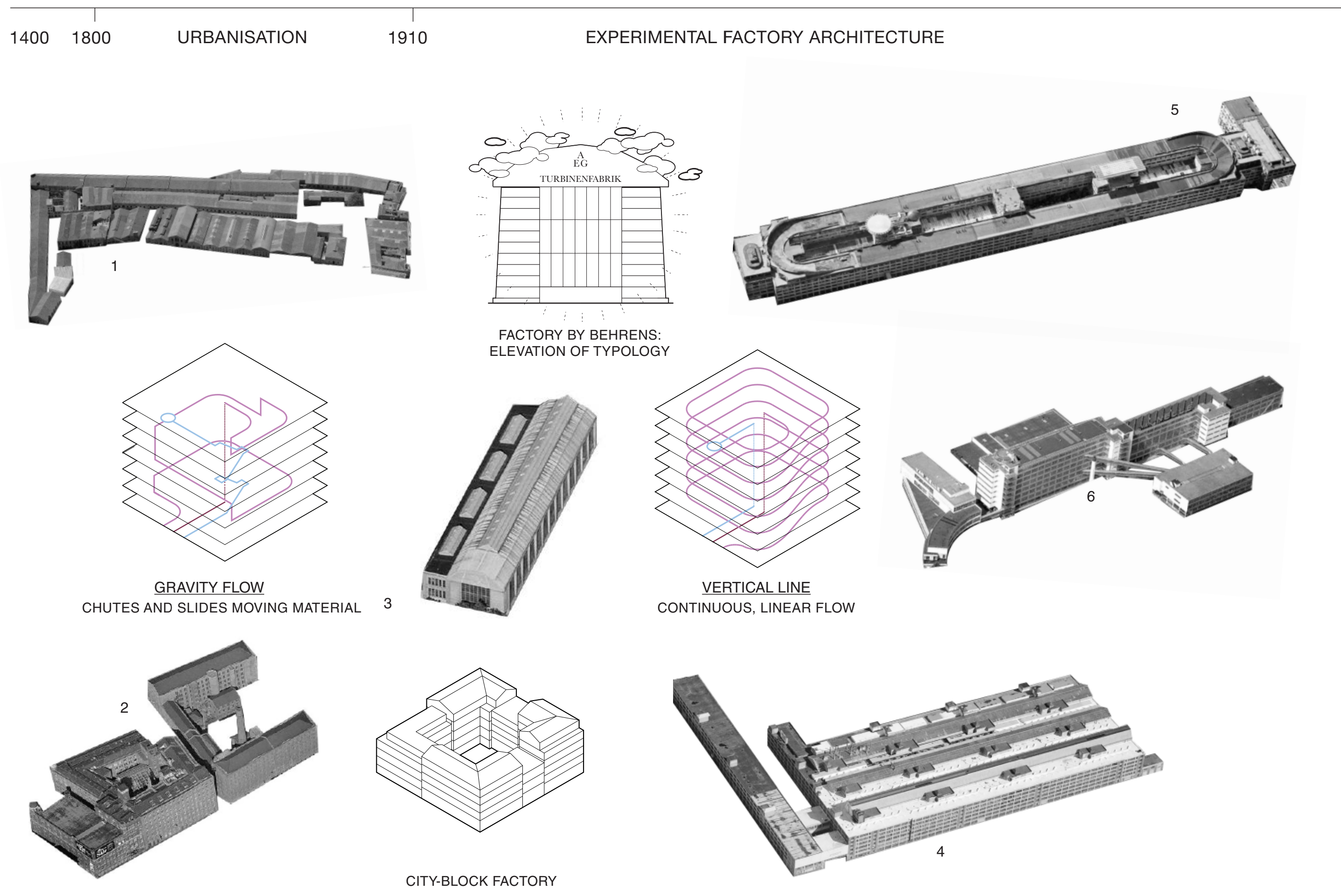
(2) 1797, MURRAY'S MILLS: URBAN AND COMPACT

(3) 1910, AEG TURBINENFABRIK: THE FACTORY RECOGNIZED AS ARCHITECTURE

(4) 1910, HIGHLAND PARK: GRAVITATION FLOW EXPERIMENTS BY HENRY FORD

(5) 1923, FIAT LINGOTTO: FUTURISTIC TEST TRACK MANIFESTING NEW VALUES

(6) 1931, VAN NELLE FABRIEK: SUBLIME MACHINE AESTETHIC



MODIFIED IMAGE SOURCES: BING MAPS 2016

(11) 2003, VW: CLEAN HIGH-TECH IN TRANSPARENT SHELL

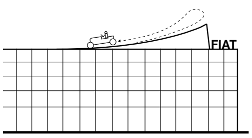
(8) 1933, STARETT-LEHIGH BLDG: INTEGRATED LOGISTIC TERMINAL

(9) 1934, BRICKEN BLDG: TALL MANUFACTURING LOFTS

(7) 1933, RIVER ROUGE: FORD MOVES ON TO THE SHED MORPHOLOGY

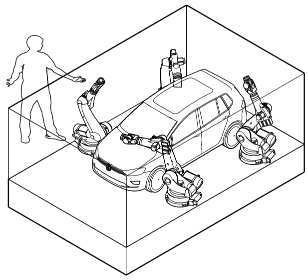
(10) 1980, FANUC MT FUJI: FULLY AUTOMATED PRODUCTION

1940 AGE OF SHEDS 2000 NEAR FUTURE

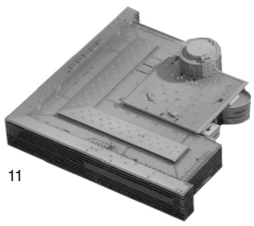


CELEBRATING PRODUCT & PROCESS

9



THE BRANDING PR FACTORY



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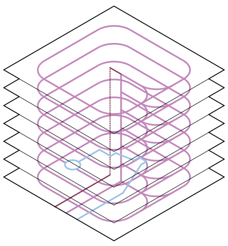
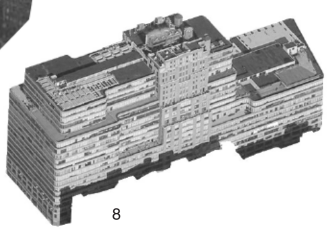


FLOOR LOOPS
PROCESSES SEPARATED ACROSS FLOORS



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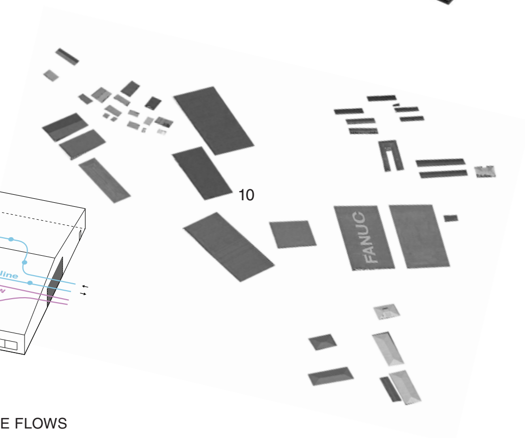

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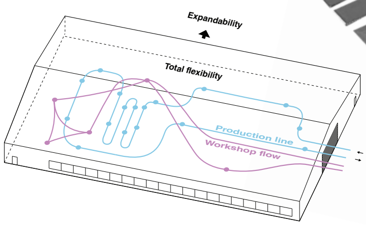
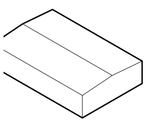


HORIZONTAL LINE
FLAT, FLEXIBLE AND EXPANDABLE FLOWS



THE 'SHED' APPEARS

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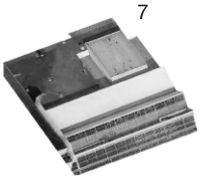


'...we are witnessing the end of the machine age - at least on the level of the collective imaginary.'
Vittorio Gregotti, *Architecture - Means and Ends* (2010)

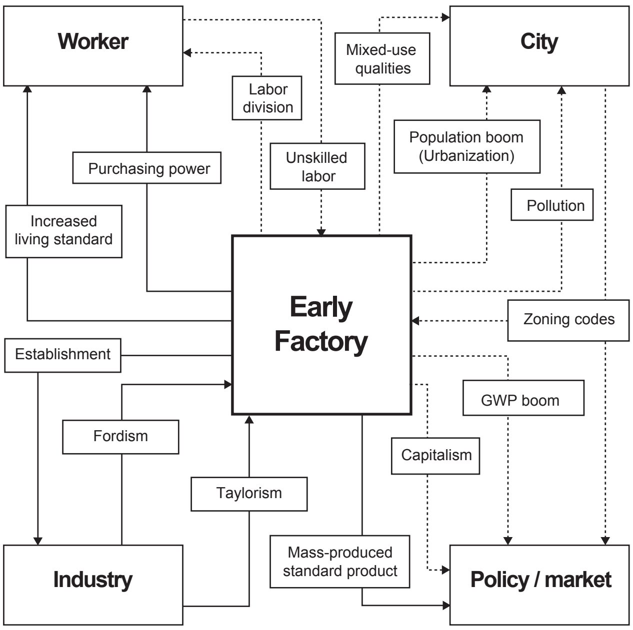
Discriminating paradigms

There seems to exist a paradigm stating that the cities of tomorrow needs to be denser, and urban areas more mixed in program, or *diverse*.[3] In effect, this 'diversity' typically means combining residential, commercial and 'public' space at the scale of the block or building. With 'public' usually translating to consumtion of goods, services or culture, and offices producing information and ideas - always immaterial - a question might arise: why not consider including industry into this paradigm?

Classic 'more is more' notions of urban diversity, such as the 'ubiquitous principle' forwarded by Jane Jacobs, seems supportive of this.[4] In later works, Jacobs argues that urban heterogeneity ultimately is the source of economic productivity.[5] Along these lines, urban studies theorist Richard Florida also argues that "diversity and creativity work together to power innovation and economic growth".[6]

As shown by Nina Rappaport in examples from New York[7], urban clustering of production can allow for industrial symbiosis through sharing of resources, recycling of goods and energy. While the claims[8] to an 'industrial renaissance' in the west seems overblown[9,10], the locally manufactured is enjoying an increasing attractiveness. Certain smaller businesses employing skilled city-dwellers have no viable alternative habitat other than the city, where the flow of people and ideas are at its most intense.

The potential of an diverse cityscape for both economical and sensory stimulation is well established, but the potential of manufacturing to contribute to this appears



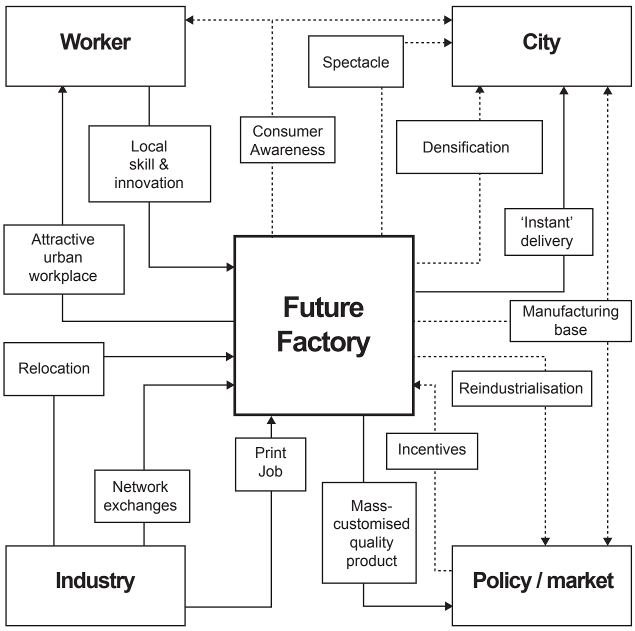
EXCHANGES, EARLY FACTORY

3. PISKORZ, W., GOULET, R. CITIES OF TOMORROW: CHALLENGES, VISIONS, WAYS FORWARD. BRUSSELS: EC
4. JACOBS, J (1961) DEATH AND LIFE OF GREAT AMERICAN CITIES
5. FAINSTEIN, S. (2005) CITIES AND DIVERSITY. COLUMBIA UNIVERSITY
6. FLORIDA (2002) THE RISE OF THE CREATIVE CLASS-REVISITED: REVISED AND EXPANDED
7. RAPAPORT, N. VERTICAL URBAN FACTORY
8.SIRKIN ET AL. (2011) MADE IN AMERICA, AGAIN: WHY MANUFACTURING WILL RETURN TO THE U.S.
9. NAGER, A, AND ATKINSON, R. (2015) THE MYTH OF AMERICA'S MANUFACTURING RENAISSANCE: THE REAL STATE OF U.S. MANUFACTURING.
10. HEYMANN, R., VETTER, S. (2013) EUROPE'S RE-INDUSTRIALISATION: THE GULF BETWEEN ASPIRATION AND REALITY.

largely unexplored.

There are of course many causes of the current spatial organisation of industry. Part of the reasons for the absence of manufacturing in discussions on densification is likely to be the connotations carried by the word 'industry', evoking images of heavy transport, loud and emissive machinery, if not belching chimneys. While this was once often the case, manufacturing has become cleaner, quieter and more compact. Final assembly of the Volkswagen Phaeton is carried out on wooden floors in what is basically museum spaces. Certain small-scale manufacturing can be carried out in what is essentially office spaces, completely inoffensive as neighbours.

Whether or not urban industry is brandishing its otherness, this thesis argues that the mere addition of another sector to our urban spaces is beneficial through its diversifying effect, primarily social and visual. Bringing the factory worker out of the anemic industrial district and into the central city would certainly serve to widen the cross-section of people using those urban spaces. Perhaps more interestingly, introducing a prominent factory on the corner of a shopping street, in a restaurant area or a central business district could provide an unexpected and intriguing break in an all too familiar and predictable rhythm. In regard to 'diversity', it is this potential for visual spectacle that this thesis focuses on.



EXCHANGES, FUTURE FACTORY

'The goal of the future is full unemployment, so we can play.'
Arthur C. Clarke

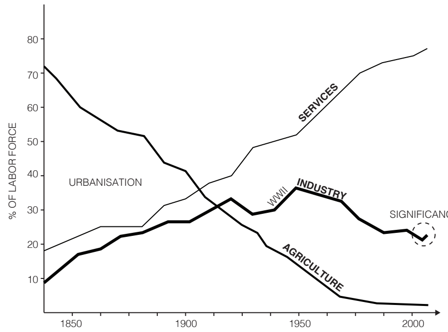
<u>The fourth revolution</u>

While the very tangible machine age of Le Corbusier's enthusiastic *l'Esprit Nouveau* may be over, as argued by Vittorio Gregotti11, today's machines is busier than ever. But industrial output and employment have 'decoupled', in the words of Erik Brynjolfsson.[12] The digital age generates 'winner-takes-all-markets' contributing to the trend of return on capital outpacing growth, famously observed by Thomas Piketty[13]. Productivity and wages are no longer correlated.

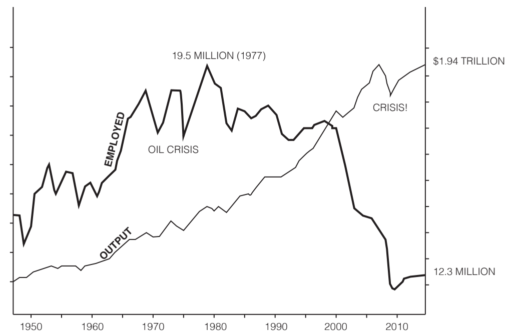
Economists like Paul Krugman are acknowledging looming long-term technological unemployment, feared since antiquity, with 'sympathy for the luddites'[14]. The executive summaries on emerging technologies concur: *this* time is different. There is certainly no shortage of potentially disruptive technologies, and increasingly automated and data-intensive manufacturing will likely replace traditional manufacturing as we know it today[15].

Joseph Schumpeter's 'creative destruction' is sweeping away old manufacturing structures at an accelerating pace. A widely published study[16] concludes that 47% of U.S jobs are at high risk in the next decade or two, especially in the manufacturing sector, with the process largely completed in the agricultural. There is of course nothing inherently bad about this shift, but the dystopian implications has tended to overshadow the utopian.

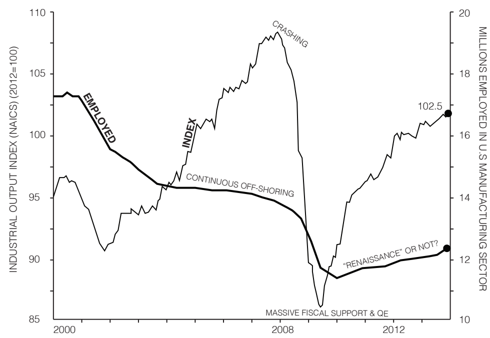
Leftist accelerationists such as Nick Srnicek and Alex Williams are advocating an improved pace of this transformation and destruction of jobs. Arguing the repurposing of technology for socially beneficial and emancipatory ends, their manifesto demands 'fully automated luxury communism', [17] a system where man is liberated by a largely automated infrastructure.



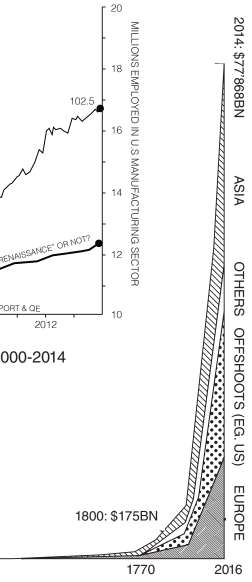
DISTRIBUTION OF U.S LABOR FORCE BY SECTOR, 1850-2010



U.S INDUSTRIAL OUTPUT AND EMPLOYED, 1945-2015



U.S INDUSTRIAL OUTPUT AND EMPLOYED, 2000-2014



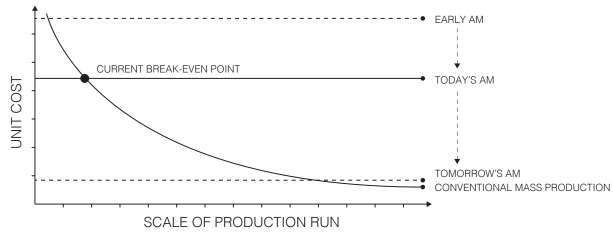
WORLD GROSS PRODUCT (1990 INTL$)

12. BRYNJOLFSSON, E., MCAFEE, A. (2014) THE SECOND MACHINE AGE.
13. PIKETTY, T. (2013) CAPITAL IN THE TWENTY-FIRST CENTURY
14. KRUGMAN, P. (2013) SYMPATHY FOR THE LUDDITES
15. SHIPP, S., ET AL. (2012) EMERGING GLOBAL TRENDS IN ADVANCED MANUFACTURING
16. BENEDIKT FREY, C., OSBORNE, M., (2013) TECHNOLOGY AT WORK
17. SRNICEK, N, WILLIAMS, A. (2015) INVENTING THE FUTURE: POSTCAPITALISM AND A WORLD WITHOUT WORK

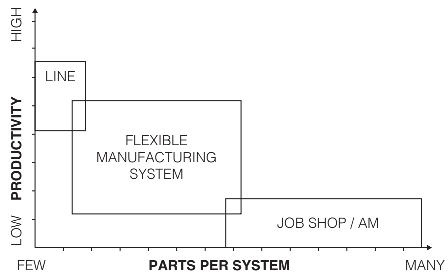
Such a system seems to imply centrally organised manufacturing. On the other end, praising decentralization, former *Wired* editor Chris Anderson stresses the revolutionary potential of the ‘Maker Movement’ to serve the ‘long tail’ of demand through mass customization.[18] Open-source soft- and hardware and decentralization of manufacturing could complement Marx’s ‘owning’ with ‘renting’ in a democratizing way, putting the means of production in the hands of the consumers.

Indeed, consumer-oriented 3D printing service bureaus is becoming more and more accessible, and industrial ‘print shops’ are contributing further to the atomisation of the manufacturing supply chain. This move from large, self-sufficient enterprises to networks of smaller actors is likely to be boosted by autonomous transport, especially by air. Speculating on the future of logistics, architect Sam Jacobs references the spatial networks of contemporary battlefields, describing the future ‘smart city’ as an ‘automation and regulation of flow’ with ‘devices, machines, buildings, infrastructure in constant information-jabber aimed at optimised efficiency’.[19] During the fourth industrial revolution, it appears the city itself is increasingly turning into manufacturing infrastructure.

As manufacturers move from specialized equipment to generic platforms, the factory becomes more universal and reconfigurable. In the more distant future, taken to its ultimate conclusion, this would imply that only 3D printers and robots are needed, besides the occasional human. Factories would be platforms themselves, only distinguished by the scale of equipment. Rapid changeovers would provide total flexibility and scalability. Trucks produced one week, helicopters the next. This is not the scenario for the Corner Factory, set in a much closer future.



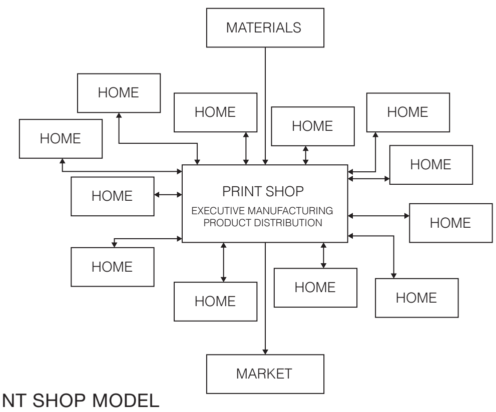
ECONOMIES OF SCALE: ADDITIVE VS CONVENTIONAL



PRODUCTIVITY VS FLEXIBILITY

	ROUTINE	**NON-ROUTINE**
COGNITIVE	CALCULATION, RECORD-KEEPING CUSTOMER SERVICE ***SUBSTANTIAL SUBSTITION***	FORMING / TESTING HYPOTHESES MEDICAL / LEGAL DIAGNOSIS ***COMPLEMENTARY***
MANUAL	PICKING / SORTING REPETITIVE ASSEMBLY ***SUBSTANTIAL SUBSTITION***	JANITORIAL SERVICES CHANGING ENVIRONMENTS ***STRONG COMPLEMENTARY***

AUTOMATION POTENTIAL (AUTOR ET AL, 2003)



PRINT SHOP MODEL

18. ANDERSON, C. (2012) MAKERS: THE NEW INDUSTRIAL REVOLUTION
19. JACOBS, S. (2015) MACHINES OF LOVING GRACE

Work and play

As a ‘first step’ of the ‘robot replace human’ programme at Changying Precision, producing cell phone components, 90% of the human workforce was replaced with robots[20]. The result was a three-fold productivity increase with far higher accuracy. The remaining people merely control and monitor production. Is this supervisory role the human element in future factories?

As the trend towards shorter product cycles and mass customization continues, the reprogramming of machines is one of the tasks that will require human input for a long time to come. The calibration and configuration of functions is probably the area where most factory work ‘on the floor’ will occur.

This field could be described as ‘robot farming, where workers instruct increasingly dexterous ‘cobots’ - collaborative robots - like animals on a farm. When numeric, this programming was time-consuming and required a high level of expertise. With a new breed of anthropomorphic machines like ReThink’s *Baxter*, ABB’s *YuMi* or KUKA’s *IIWA*, the input can be haptic, with human instructors physically guiding the robot ‘hand’ to record a motion. These machines are basically harmless and easily moved. It isn’t hard imagining their descendants learning a task by watching, or perhaps even being told what to do. Linking the physical factory with a digital environment manipulated by ‘factory workers’ through virtual reality is another possible interface for man through which to ‘farm’ robotic labor.

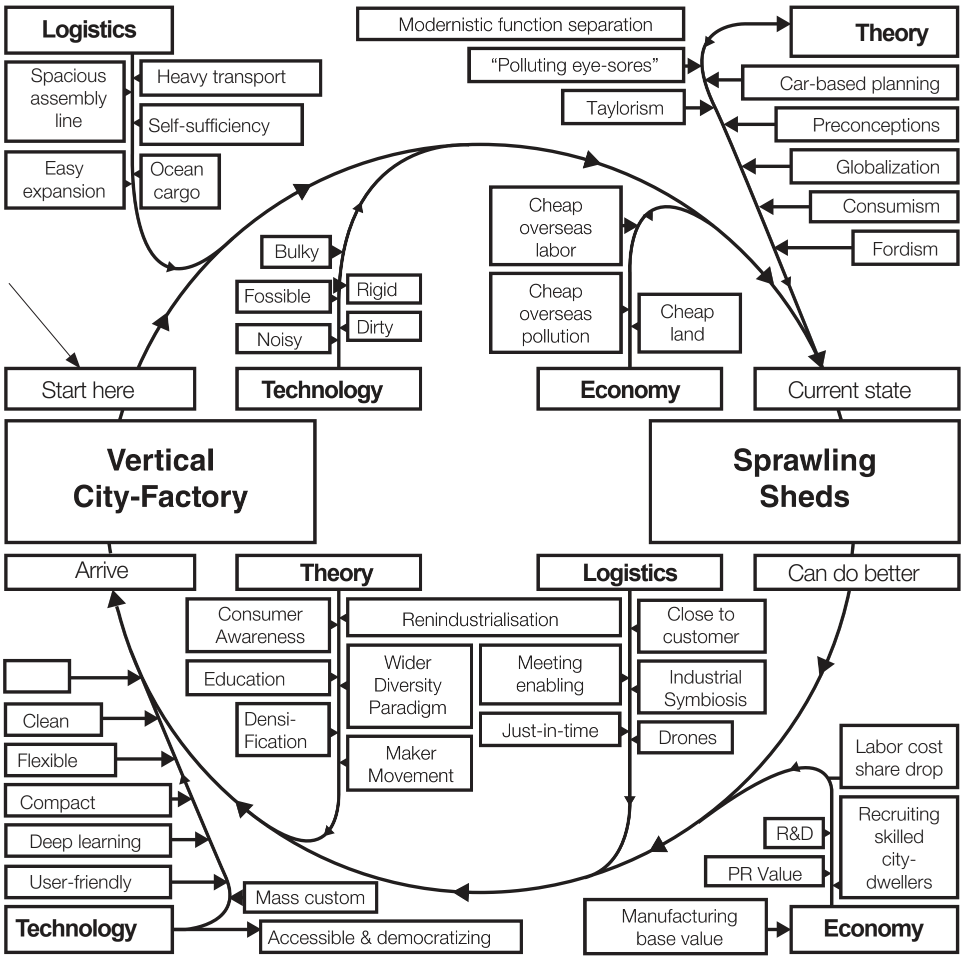
Fordism is a thing of the past: tomorrow’s factory worker is likely to be well educated, live in a city and want personal self-fulfilment through his or her work. Commuting to a suburban industrial district, far removed from a variety of lunch spots, is unlikely to appeal to this individual. In a future such as the one imagined by Srnicek and Williams, where most dull and monotonous tasks are automated, some of what still classifies as ‘work’ could be highly advanced forms of playful instruction of machines.

This machine ‘teaching’ is anticipated by philosopher Vilém Flusser (1920-1991) in the essay *Die Fabrik,* where he presents a vision of the replacement of *homo faber* (making man) with *homo ludens* (playing man) in post-industrial society.[21] Speculating on the resemblence of future factories to schools, his factory worker learns together with the apparatus, new programs being the outcome of ‘playful’ processes.

	#1, ~1770	#2, ~1890	#3, ~1970	#4, ONGOING
SHIFT TECHNOLOGICAL DISRUPTION	STEAM POWER FORCE MULTIPLIER SUPER-CHARGING INDUSTRIAL OUTPUT	ELECTRIFICATION MASS PRODUCTION-ENABLING DISPERSION OF WORKSTATIONS	DIGITALISM ACCELERATING AUTOMATION BY IT AND ELECTRONICS	AI, AM, IOT ETC AUTOMATION APPROACHING FULL POTENTIAL
LOCATION LOGIC FACILITY PLACEMENT	CITY CLOSE TO WORKERS AND RESOURCES - IN CITIES	CITY / ZONE VERTICAL INTEGRATION MAKING SOME INDUSTRY SELF-SUFFICIENT	ZONE COMPLEX SUPPLY CHAINS DISPERSING MANUFACTURING	CITY / ZONE HUMANS MAINLY WORK IN CITIES, ROBOTS ANYWHERE
OBJECTIVE MAJOR DESIGN CONSIDERATION	POWER DISTRIBUTION MECHANICAL FORCE TRANSFER FAVORING COMPACTNESS	MASS PRODUCTION BUILDING TAYLORISM, PROJECTING IMAGE	FLEXIBILITY EASY EXPANSION, SPACIOUS HOUSING OF PRODUCTION LINE	INDUSTRY 4.0 EFFICIENCY, NETWORKING, ADAPTABILITY, PUBLIC RELATIONS
FACTORY BUILDING CHARACTERISTICS	MULTI-STOREY COMPACT BRICK MILLS DRIVING URBANISATION	MIXED COMPANY EXPRESSION, VERTICALITY, CONCRETE GRIDS	SHED FLAT FLOWS, EXPANDABLE, CHEAP, SHEET METAL	MIXED COMPACT, URBAN FACTORIES ARE FEASIBLE AND DESIREABLE

REVOLUTIONS

21. ECONOMIC TIMES INDIA: CHINA SETS UP FIRST UNMANNED FACTORY; ALL PROCESSES ARE OPERATED BY ROBOTS
22. HARDENS, T. (2010) VILÉM FLUSSER AND TECHNICS – FROM HOMO FABER TO HOMO LUDEN



THESIS / ARGUMENT: RETURN OF THE URBAN FACTORY

Process

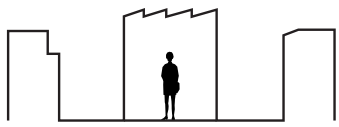
Future factories will of course come in many forms, scales and places. Likewise, the design proposal was naturally never supposed to be an exhaustive physical summary of this vast field. Instead, the aim was rather the translating of fairly abstract aspects into a specific vehicle for an idea, or thesis: the return of the vertical urban factory.

Evoking images of the local, accessible and urban, the project title chosen for this facility was *Corner Factory*.

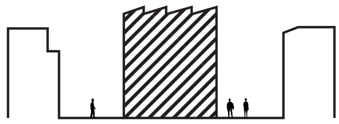
<u>Criteria</u>

Five points or key issues for this specific future factory were identified and outlined in the bullet points below.

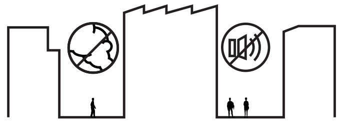
<u>Human</u>
The Corner Factory cannot be a lights-out robotic operation - it is justified by human presence.



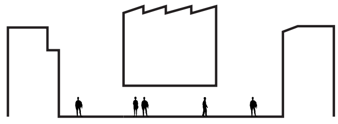
<u>Compact</u>
In marked contrast to its sprawling suburban peers, the Corner Factory increases city density by verticality.



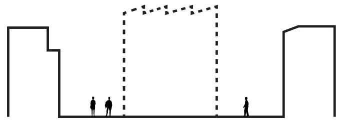
<u>Clean & Silent</u>
Used by light industry employing the latest technologies, the Corner Factory is an agreeable neighbour.



<u>Accessible</u>
Enabling curious consumers to become fabricators, the Corner Factory manufactures entrepreneurs.



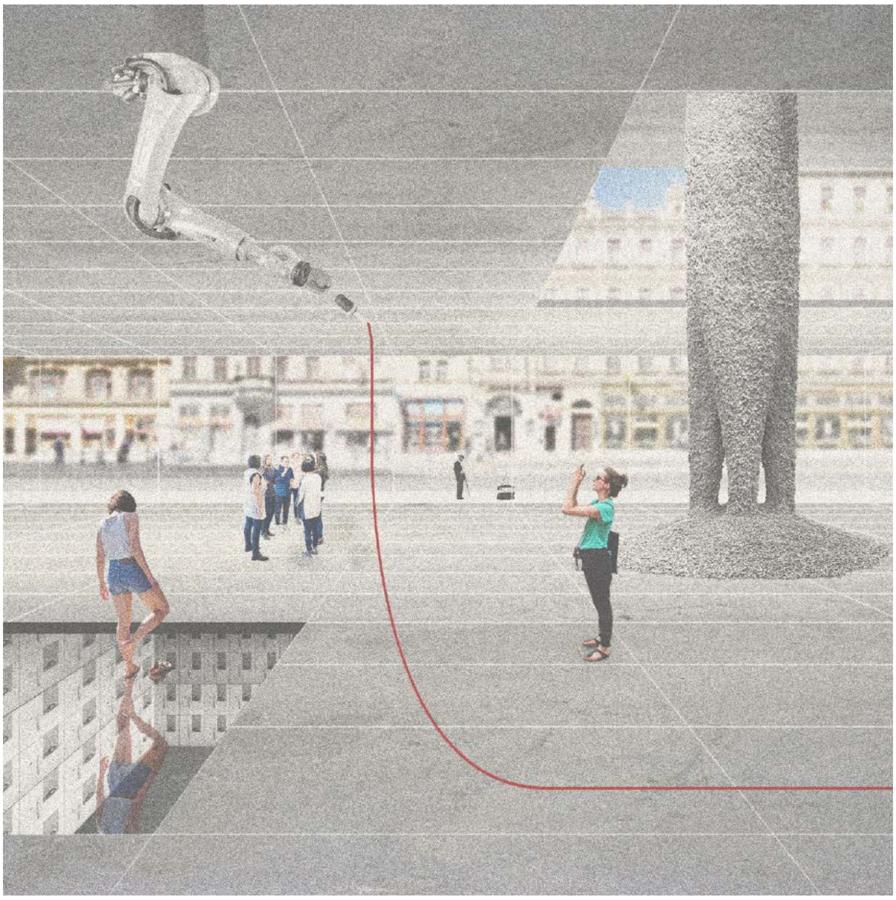
<u>Transparent</u>
The Corner Factory celebrates manufacturing itself, advertising its dazzling processes to an general public.



OPPOSITE: STUDY MODELS

Conceptual collages

After a lot of research and no design, a few sketchy collages depicting ideas about the athmosphere of the main space types were put together.



LOBBY

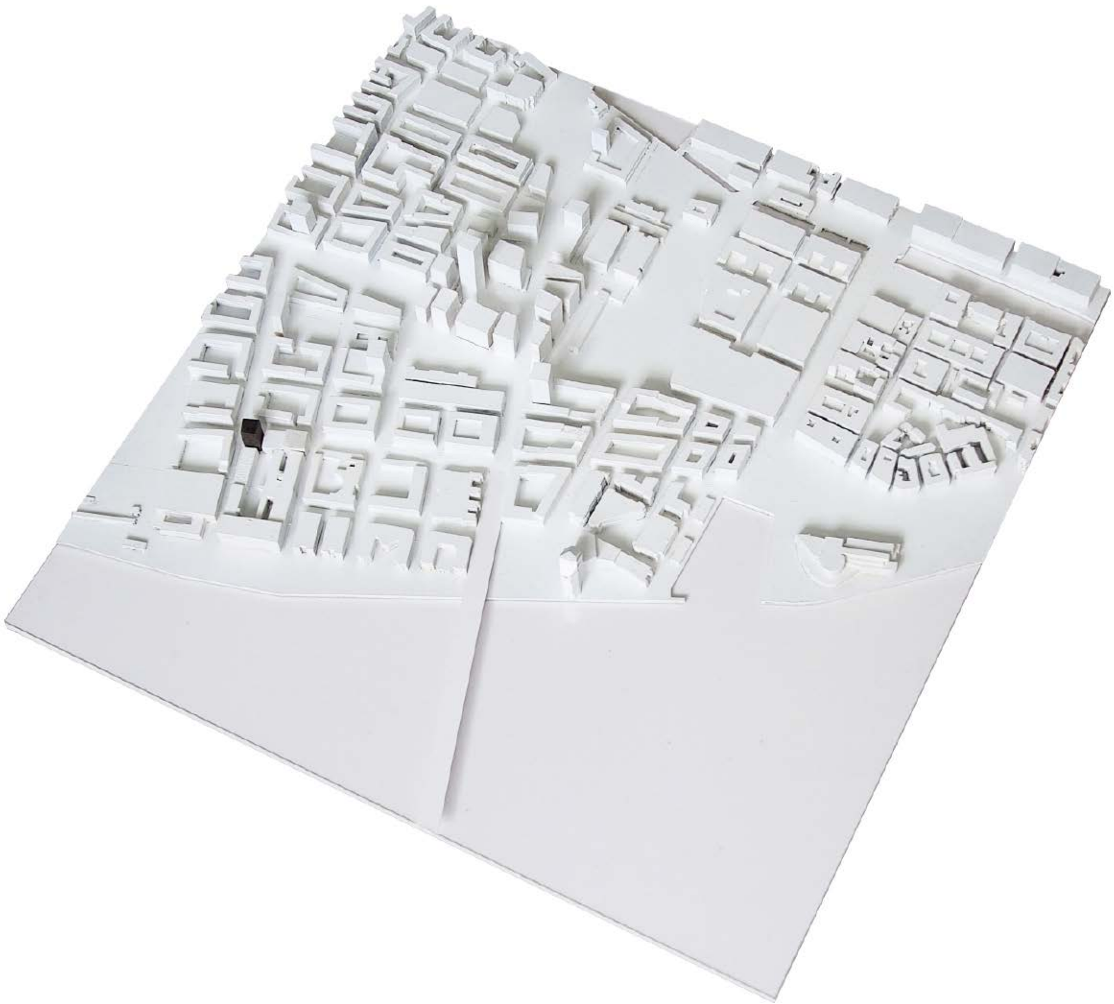
FACTORY SPACE

CORE

Future context

A city with a rich industrial heritage, Gothenburg was as natural a testing ground as any. The area finally selected was Gullbergsvass, as the riverfront is historically intimately connected with the city's harbour industry. This district is also set to take on an increasingly strategic position in the long term development of central Gothenburg.

Currently occupied to a large extent by heavy infrastructure, it is planned to be transformed into a dense neighbourhood. Adjacent to the envisioned RegionCity high-rise development around the central station, featuring skyscrapers of about 120 metres[23], the projected neighbouring building scales is accomodating to a large, vertical factory.



FUTURE CONTEXT MODEL
NEXT SPREAD: GULLBERGSVASS, CURRENT (BING MAPS 2016) AND FUTURE SITUATION

23. WSP., WHAT!. (2015) PLANERINGSUNDERLAG: HÖGA HUS, CENTRALENOMRÅDET

Development analysis

Gullbergsvass is arguably the most significant development area in the whole of Gothenburg. There is enormous potential here, in the absolute city center, which makes it extra important to get it right. Eliminating barriers caused by heavy infrastructure, without cumbersome overdeckings, and achieving a dense urban fabric of diverse use is of utmost importance. Shown below are a synthesis of various planning documents and studies[24,25,26], combined and slightly modified. This imagined development forms the future urban context for the building proposal.

24. SBK GÖTEBORG. (2014) CENTRALENOMRÅDET: STADSUTVECKLINGSPROGRAM 1.0
25. CITY PLANNING OFFICE, GÖTEBORG. (2013) SAMRÅDSHANDLING: DETALJPLAN FÖR BRO ÖVER GÖTA ÄLV
26. SPACESCAPE, WEST8, WHITE. (2013) QUEENS PARK: CENTRAL STATION AREA PARALELL STUDY

SITE ANALYSIS (INTERVENTION IN BLACK)

Logistics

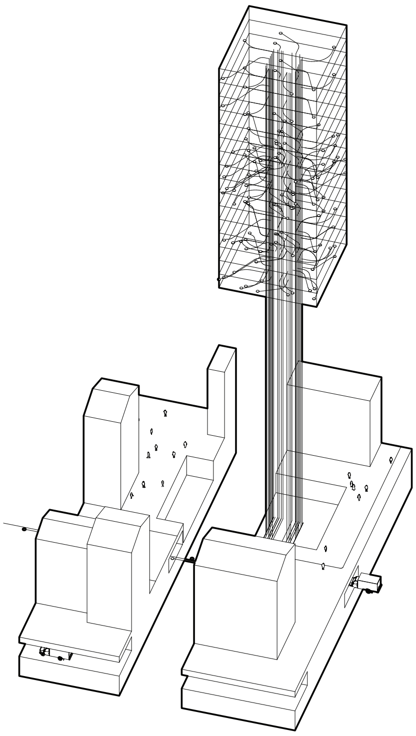
Fundamental to the operation of any factory is the conventient flow in and out of the facility. Therefore, the site chosen was close to existing heavy infrastructure. Ideally submerged, this highway could be accessed by delivery trucks (probably automated) by a likewise underground loading bay.

The factory would be be a plug-in unit into a larger network of manufacturing spread across the city, a constant flow of material and goods passing unnoticably in and out of the facility in a dense city context. It is possible to imagine this underbround artery serving as an organising logistical spine at the urban level, forming a line or factory row along which to string functions requiring frequent and heavy transport.

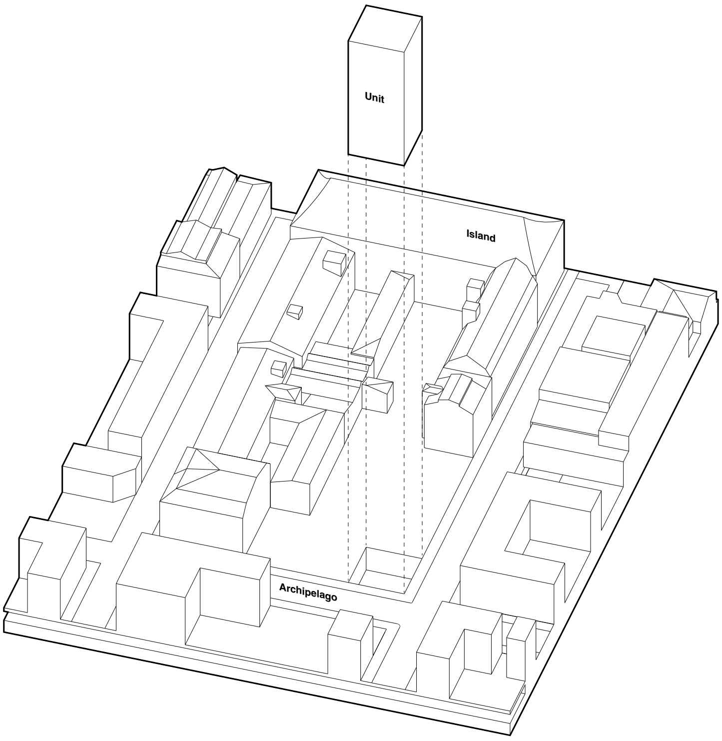
Morphology

With the surrounding parameters set, a set of possible building volumes were quickly and heuristically explored (opposite page). Meaning little as forms in themselves, especially set in an arbitrary immediate context, the final building envelope would depend on the functions within. Working within the most generic boundary possible, a square, the process went on. In the end, the building volume was a simple extrusion of this footprint to a appropriate height. Avoiding a discussion of local urban adaption and for argument's sake streamlining the project to focus on content and program, this choice of a very simple volume was deemed the most appropriate strategy.

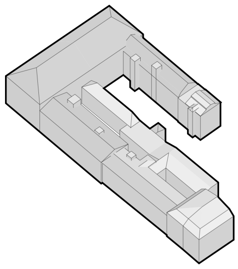
A manufactured object for the manufacture of objects, the Corner Factory is an autonomous architecture that could exist in a number of places. It is is not tied to its site, but depends primarily on a convenient logistical connection. This is not to say it is autistic to its surroundings. The city-block in question also contains the landmark building Pagoden, a monumental former tobacco warehouse. Likewise, the Corner Factory is also a building with monumental properties, possibly viewed separated from any context.



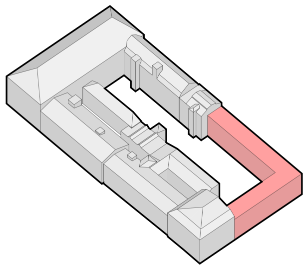
LOGISTIC CONNECTION TO UNDERGROUND HIGHWAY



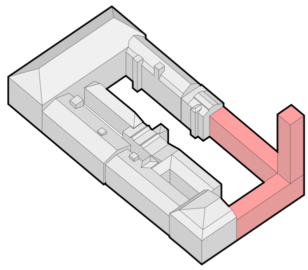
AUTONOMOUS UNIT IN CITY-FABRIC



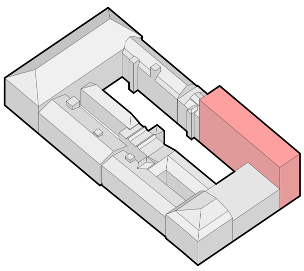
Current state



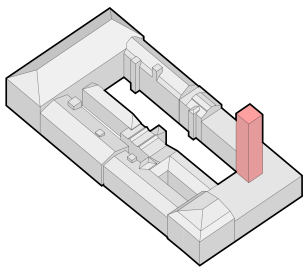
Closed perimeter block - 12m depth



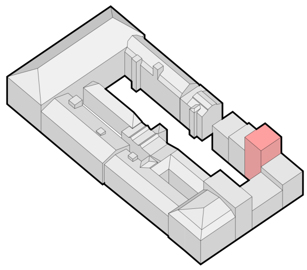
Knot block



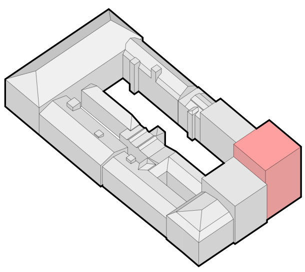
Two lots



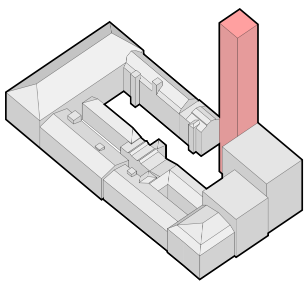
Podium + tower



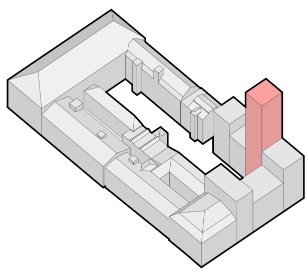
Narrow and low



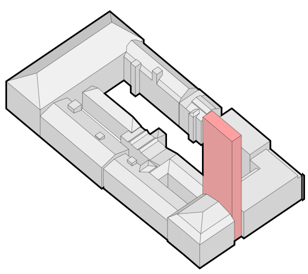
Rising towards corner



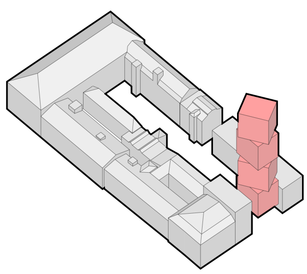
Power plant massing



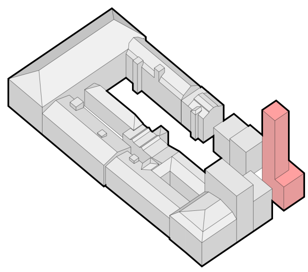
Narrow lots



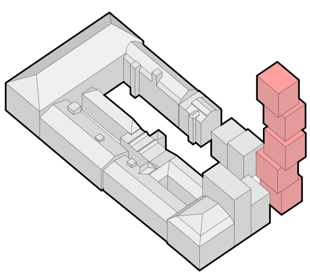
Squeezed slab



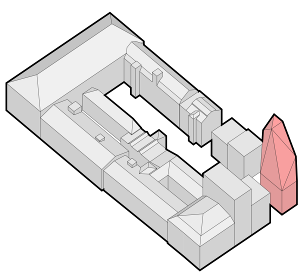
Raised portal



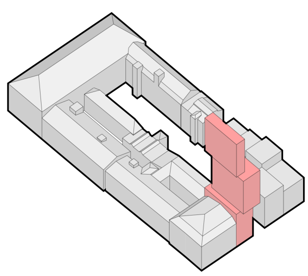
Discrete object



Irregular stacking



Prism



Narrow stacking

Use

In a future economy characterised by more sharing, various user models could be concieved. For instance, as part of the infrastructure, a service bureau operating a ‘print shop’ for additive manufacturing is imagined as a permanent tenant in the building. Naturally it would strive for maximum use of its machines. In pursuit of this, excess capacity could be offered to outside industry, printed parts delivered just-in-time to meet peaks in demand.

Most of the building floor area was decided to consist of generic loft space, reminiscent of the manufacturing lofts of the Garment District skyscrapers of the 20's. These areas would basically be industrial halls, bright and spacious, tall enough to comfortably fit mezzanine floors in. Available for long-time leases, these stacked halls or sheds are the essential factory space.

FOR THE MANUFACTURER

FACTORY SPACE

QUALITY CAPITAL & SPACE AVAILABLE
RAPID PROTOTYPING & SHORT LOOPS
SMART, NIMBLE & SAFE ROBOTS
COMPETITIVE LOCATION & LOGISTICS
LEASING OPTIONS

FOR THE ‘MAKER’

PUBLIC WORKSHOP

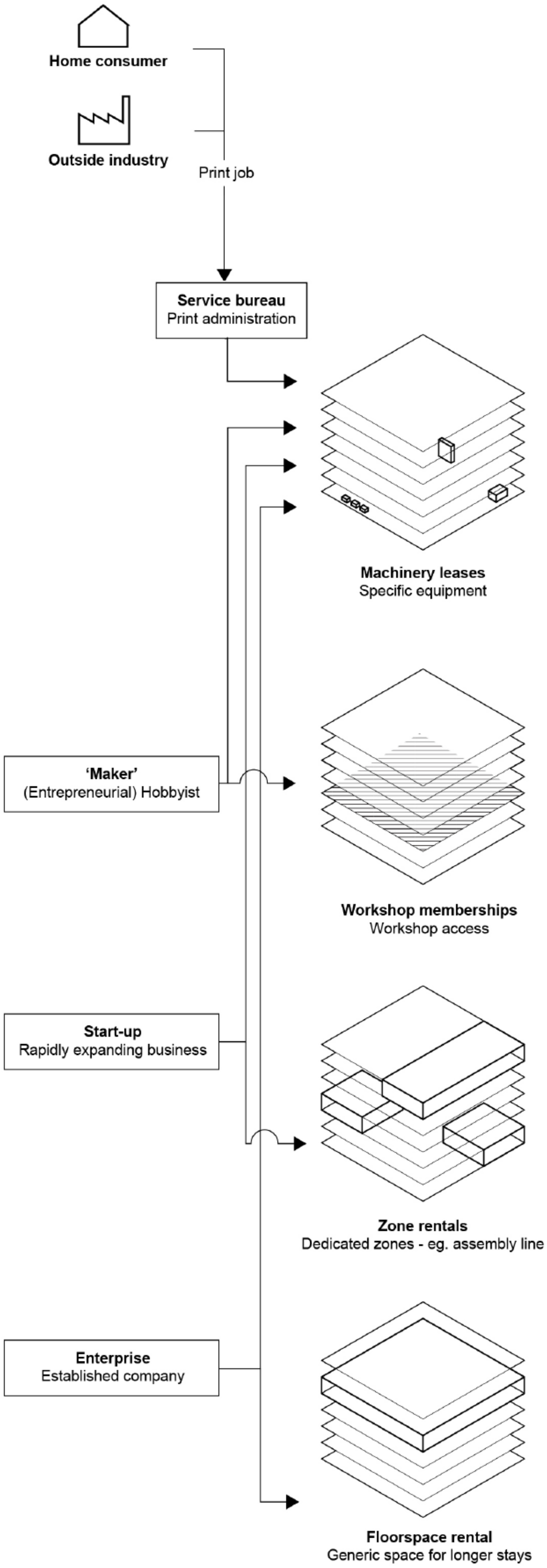
ACCESSIBLE EQUIPMENT
PERSONAL PROJECTS & REPAIRS
PRODUCT DEVELOPMENT
EMPOWERING INCUBATOR
MEMBERSHIP OPTIONS

FOR THE CONSUMER & OUTSIDE INDUSTRY

PRINT SHOP

LARGE CAPACITY SERVICE BUREAU
SELECT, UPLOAD OR SCAN OBJECT
AGILE MEETING OF EXTRA DEMAND
WIDE RANGE OF PREMIUM MATERIALS
PAY PER CM^3

BASIC DIVIDE, FIRST DRAFT



Users

In conversation with a property development consultant, a 'factory hotel' model was devised. Like in an office hotel, certain amenities and infrastructure would be provided. For the sake of detail and specificity, four synergetic tenants are imagined, cherry-picked for exposing the various themes previously discussed.

The Aerospace Company
As part of a larger supply chain, a smaller aircraft engine model is manufactured in the bulk of the buildings spaces. A high-tech, low-run product still relying on plenty of human input, it is a spectacular artifact in itself. Final assembly is carried out in the lower, more robust floors, exposed to the city. The many small parts are provided by the in-house print shop, precision assembly by a fleet of mobile robotic arms.

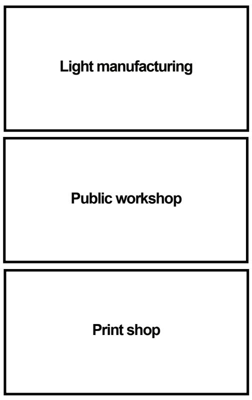
The Service Bureau
An integral part of the facility, the service bureau operates an array of 3D printers, in close collaboration with other tenants. Using electron beam melting, various sintering techniques, fused deposition and stereolithography, all materials and finishes can be accomodated.

The Drone Startup
A growing drone service operates the air delivery terminal. Finetuning a standardised mass production process, the finished drones are put directly into service delivering printouts from the service bureau, or delivered as products in themselves.

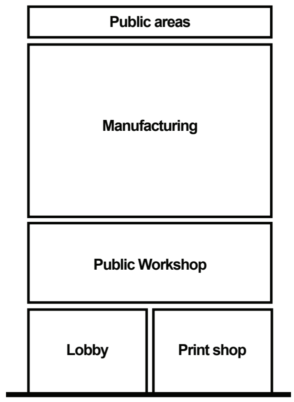
The Public Workshop
At the top floor, a public workshop makes the translation of ideas into objects possible for the ordinary consumer. On a day pass or membership basis, quality equipment and and expertise is easily accessible.

Program

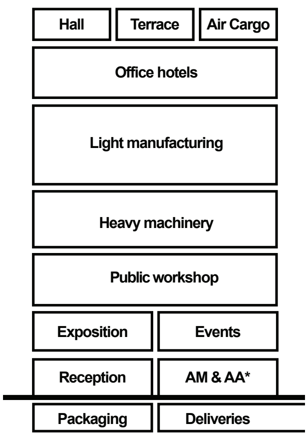
Following the defining of use and users, the functional program was sketched out in a program draft. The stacking of these spaces were continously evaluated and reconfigured, resulting in the opposite program diagram.



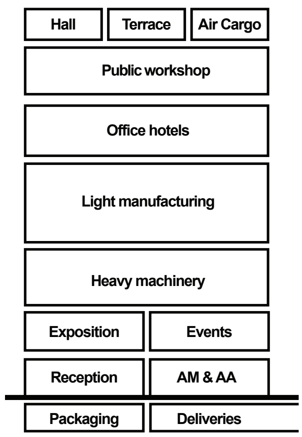
BASIC DIVIDE



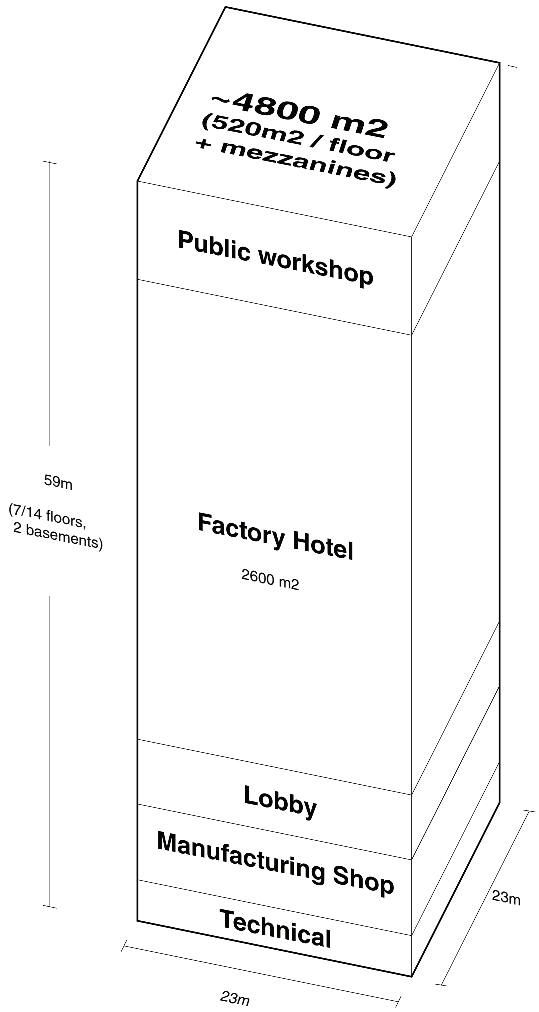
INITIAL STACKING



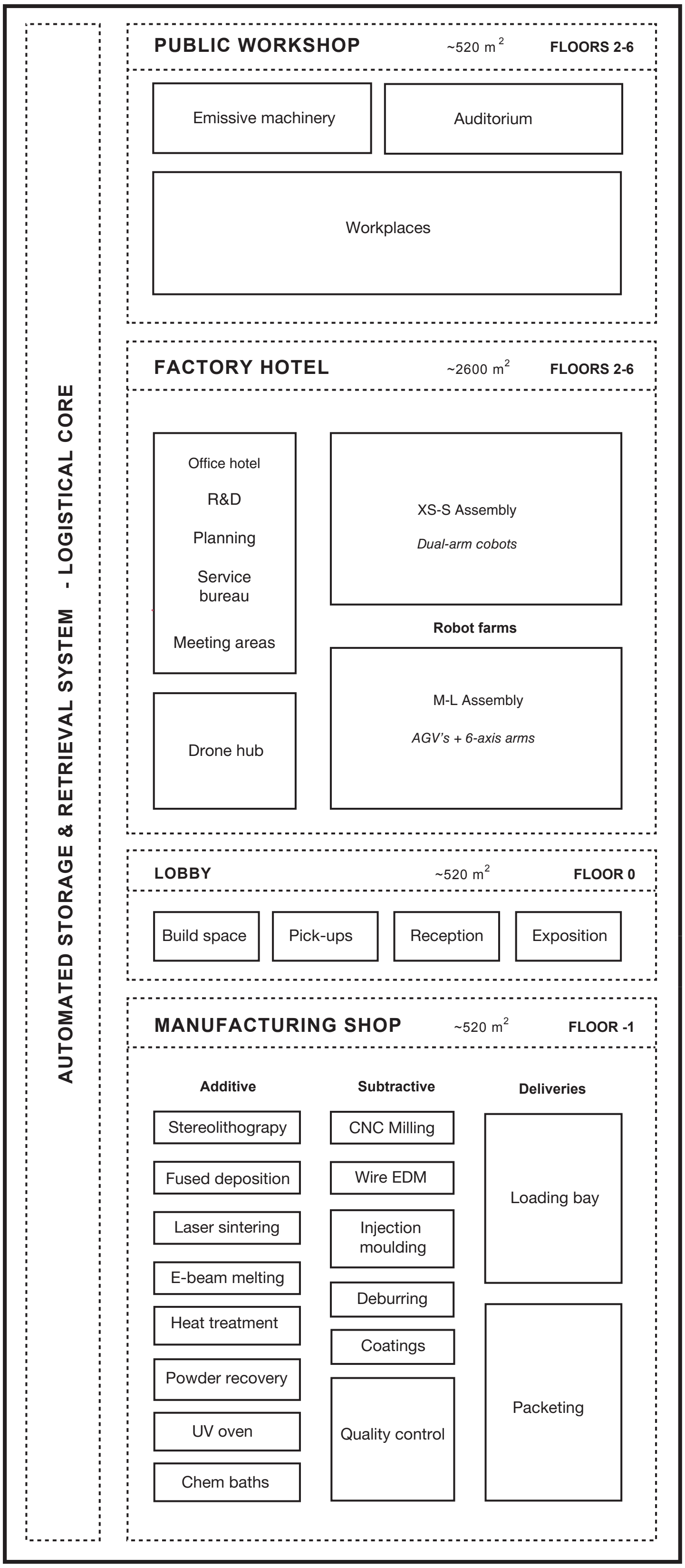
FURTHER DIVISIONS



PUBLIC WORKSHOP ON TOP

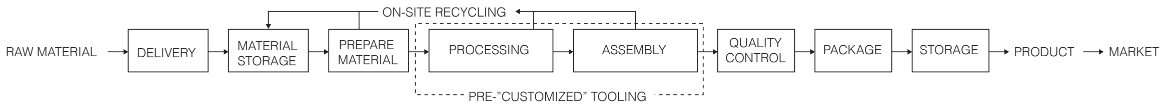


FINAL PROGRAM, SIZE

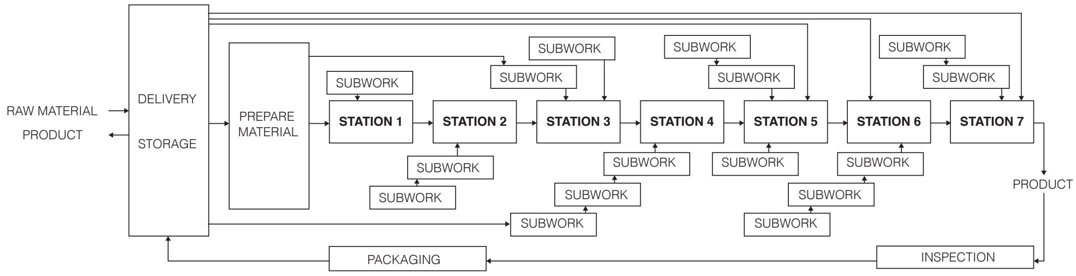

AUTOMATED STORAGE & RETRIEVAL SYSTEM - LOGISTICAL CORE
PUBLIC WORKSHOP
~520 m2
FLOORS 2-6
Emissive machinery
Auditorium
Workplaces
FACTORY HOTEL
~2600 m2
FLOORS 2-6
Office hotel
R&D
Planning
Service bureau
Meeting areas
XS-S Assembly
Dual-arm cobots
Robot farms
M-L Assembly
AGV's + 6-axis arms
Drone hub
LOBBY
~520 m2
FLOOR 0
Build space
Pick-ups
Reception
Exposition
MANUFACTURING SHOP
~520 m2
FLOOR -1
Additive
Subtractive
Deliveries
Stereolithograpy
Fused deposition
Laser sintering
E-beam melting
Heat treatment
Powder recovery
UV oven
Chem baths
CNC Milling
Wire EDM
Injection moulding
Deburring
Coatings
Quality control
Loading bay
Packeting

Process flow studies

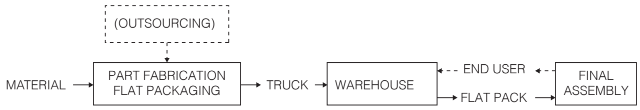
Essentially, a factory is an enclosure for the sheltering of a production process. A number of these, generic and specific, were studied in preparation for the drafting of a preliminary flow diagram for the Corner Factory.



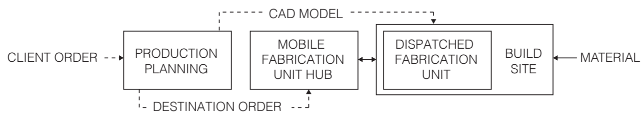
PRODUCTION LINE PRINCIPLE



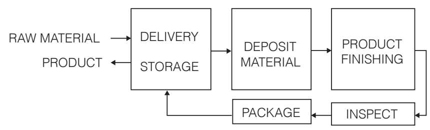
PRODUCTION LINE WITH SUBSTATIONS - 'FISHBONE FLOW'



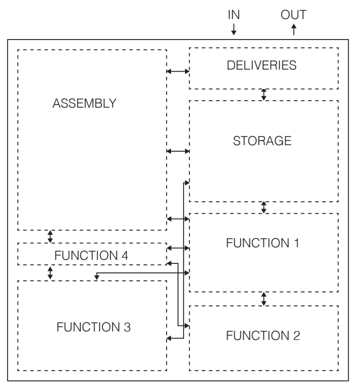
IKEA MODEL - END USER ASSEMBLY



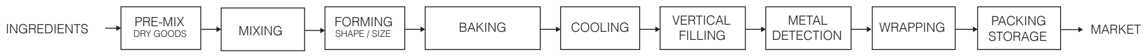
ON-SITE ASSEMBLY - DELIVERABLE ALL-PURPOSE MANIPULATOR



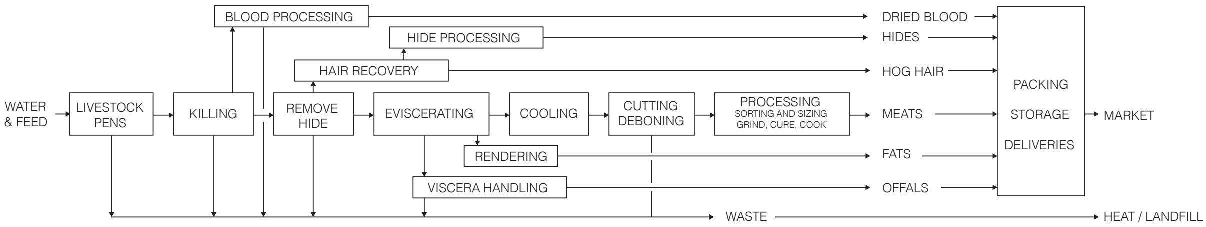
ADDITIVE MANUFACTURING - TOTAL FLOW



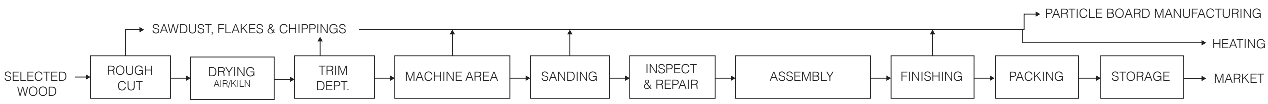
JOB SHOP PRINCIPLE



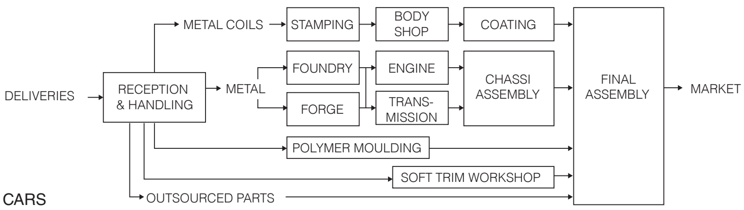
BISCUITS



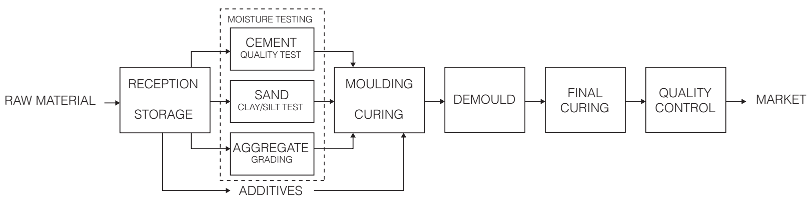
PORK BELLY



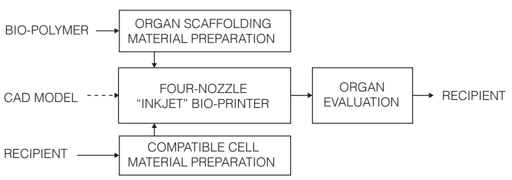
WOODEN CHAIR



CARS

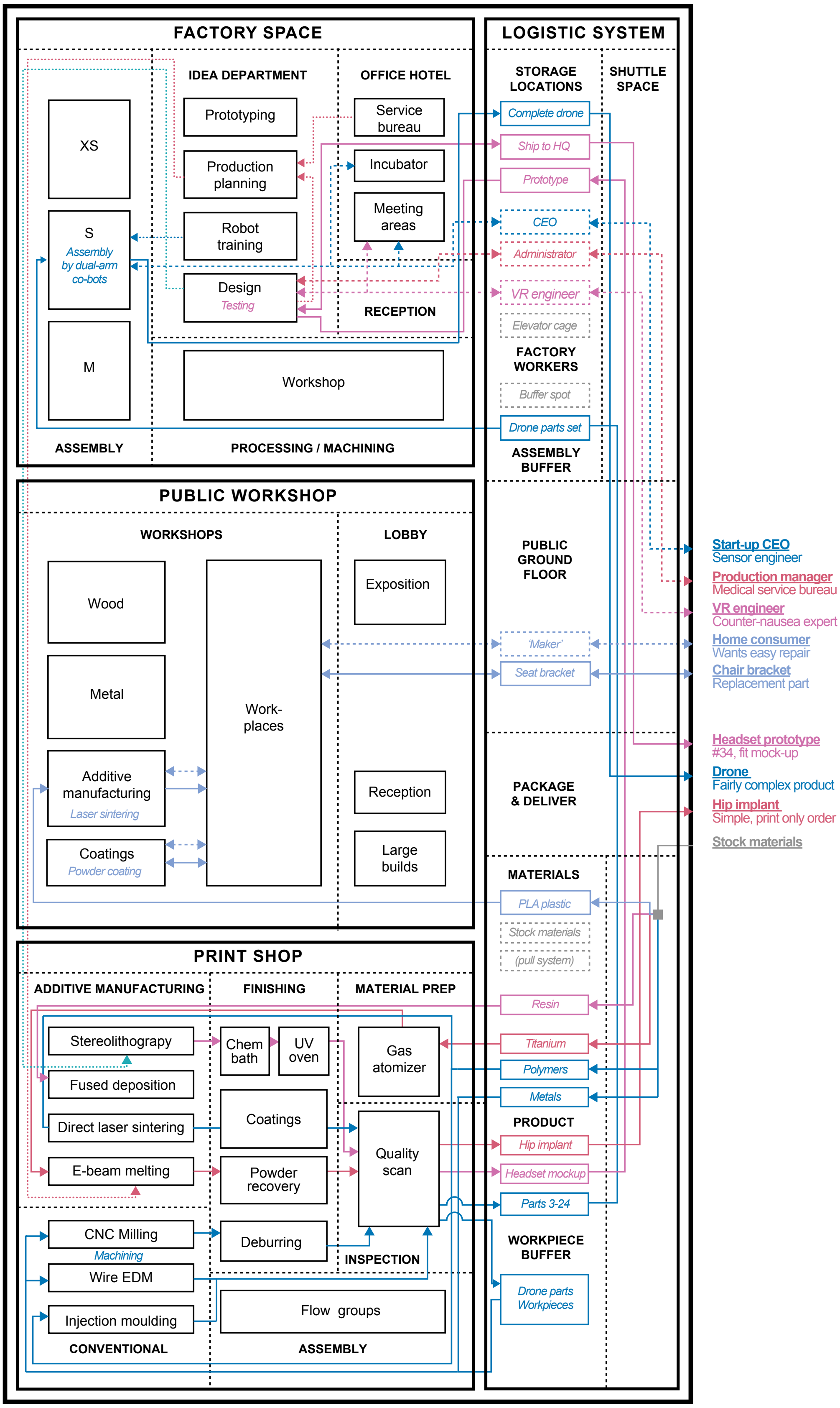


CONCRETE ELEMENT



KIDNEY

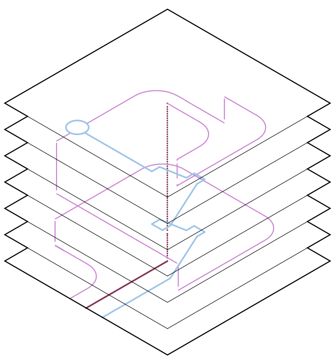
Flow chart



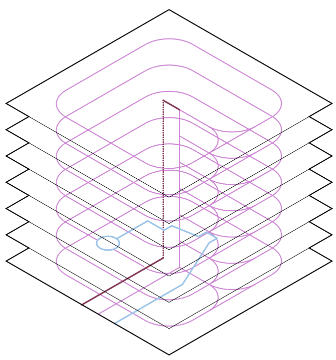
FACTORY SPACE
IDEA DEPARTMENT
OFFICE HOTEL
XS
S
Assembly
by dual-arm
co-bots
M
Prototyping
Production planning
Robot training
Design
Testing
Service bureau
Incubator
Meeting areas
RECEPTION
Workshop
ASSEMBLY
PROCESSING / MACHINING
LOGISTIC SYSTEM
STORAGE LOCATIONS
SHUTTLE SPACE
Complete drone
Ship to HQ
Prototype
CEO
Administrator
VR engineer
Elevator cage
FACTORY WORKERS
Buffer spot
Drone parts set
ASSEMBLY BUFFER
PUBLIC WORKSHOP
WORKSHOPS
LOBBY
Wood
Metal
Additive manufacturing
Laser sintering
Coatings
Powder coating
Work-places
Exposition
Reception
Large builds
PUBLIC GROUND FLOOR
'Maker'
Seat bracket
PACKAGE & DELIVER
MATERIALS
PLA plastic
Stock materials
(pull system)
PRINT SHOP
ADDITIVE MANUFACTURING
FINISHING
MATERIAL PREP
Stereolithograpy
Fused deposition
Direct laser sintering
E-beam melting
Chem bath
UV oven
Coatings
Powder recovery
Gas atomizer
Quality scan
CNC Milling
Machining
Wire EDM
Injection moulding
Deburring
INSPECTION
Flow groups
CONVENTIONAL
ASSEMBLY
Resin
Titanium
Polymers
Metals
PRODUCT
Hip implant
Headset mockup
Parts 3-24
WORKPIECE BUFFER
Drone parts
Workpieces
Start-up CEO
Sensor engineer
Production manager
Medical service bureau
VR engineer
Counter-nausea expert
Home consumer
Wants easy repair
Chair bracket
Replacement part
Headset prototype
#34, fit mock-up
Drone
Fairly complex product
Hip implant
Simple, print only order
Stock materials

<u>Vertical flow problem</u>

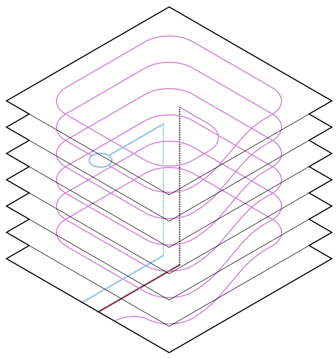
When Henry Ford abandoned the outdated five-storey Highland Park in favor of the sheds of River Rouge, organising vertical production lines was likewise abandonded. The ramps of Lingotto are spectacular in themselves, but not a very efficient way of organising space. This is the vertical problem. In search for a solution, the 'Direct Input / Output System' was found.



GRAVITY FLOW
Chutes and lifts moving material and product
Example: Highland Park, Murray's

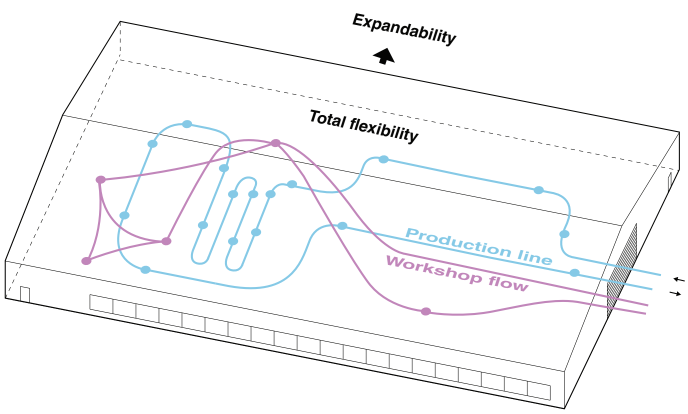


FLOOR LOOPS
Processes and business separated on floors
Example: Bricken Building, Starett-Lehigh

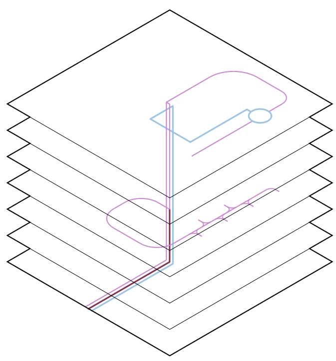


PRODUCTION LINE
Linear production throughout building
Example: VW Gläserne, Fiat Lingotto (reversed)

EARLY 20TH CENTURY FLOW PRINCIPLES



1930'S AND FORWARD: HORIZONTAL FLOWS



VERTICAL DIRECT INPUT / OUTPUT SYSTEM
'Smart' core handling all flows

THESIS FLOW CONCEPT

Direct Input / Output System

Handling the material flows is the main task of the infrastructure of a vertical factory. In this regard, the 'Direct Input / Output System' (DIOS) pioneered by *Seibu Electric co. of Japan* in the 80's has been influential. In its original form, it describes the flows in a flexible material system (FMS), where everything related to production is handled by a single, automated warehouse.

Translated to a building component in a high-rise factory, this logistic principle translates to a 'smart core' featuring an automated storage / retrieval system (see next page) acting throughout the building. This infrastructural spine handles all flows, coordinating transport orders with maximum efficiency. Components, equipment and anything that is not directly used are tucked away and stored by the common IoT-guided logistic system.

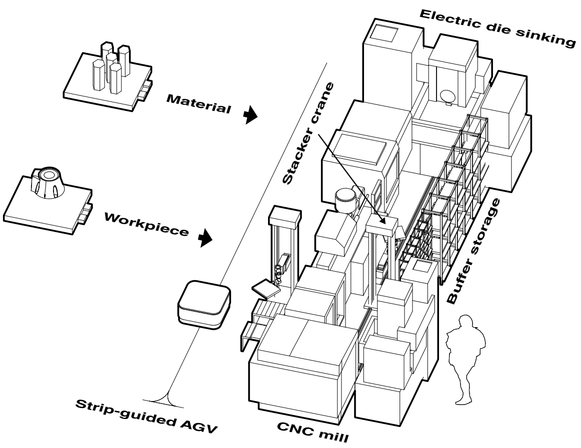
Kusuda, Y. (2008) *Direct input and output system.*

An automated warehouse with a stacker crane is installed at the center of a factory floor.

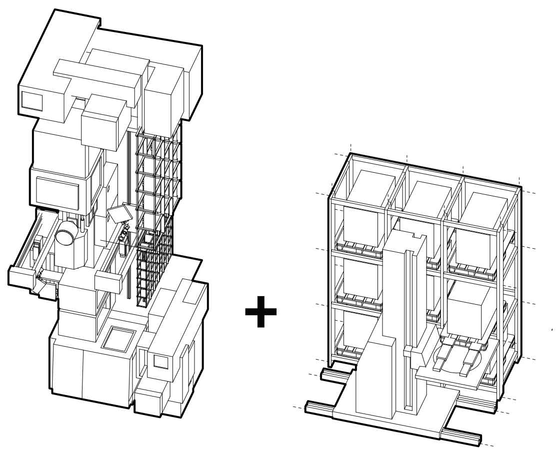
Machines are arranged around the warehouse and inlet and outlet holes corresponding to the machines are made on the side of the warehouse.

The warehouse stores everything related to the production – materials, parts, half finished products, finished goods, fixtures, etc.

A computer controls the material storage and material flow of the DIO system. It commands the stacker crane to take care of transportation from storage to machines, from machines to storage, from a machine to another machine, stock in storage, ship out, etc.



DIO SYSTEM

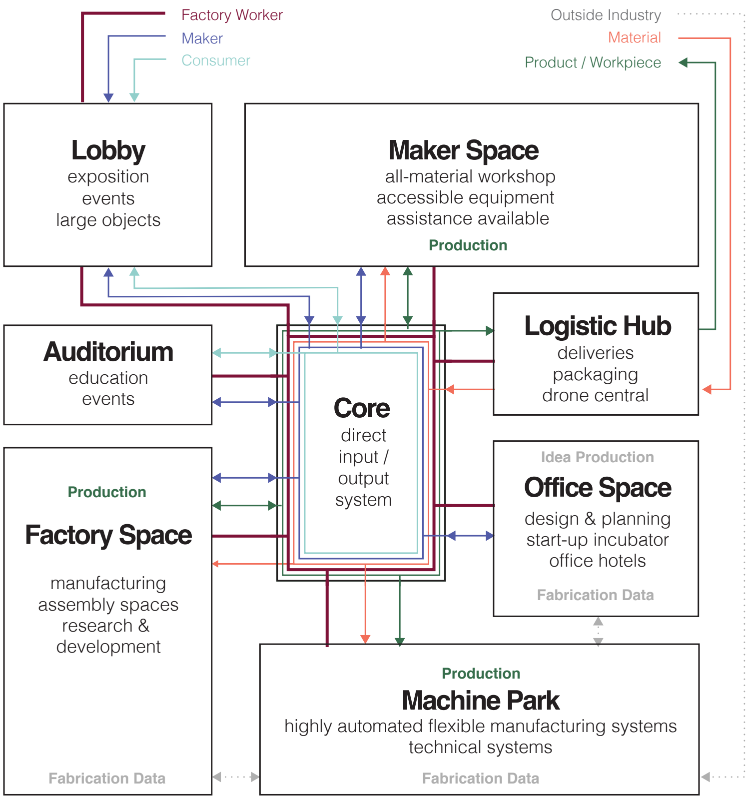


VERTICAL DIO SYSTEM + ASRS = FLOW PRINCIPLE

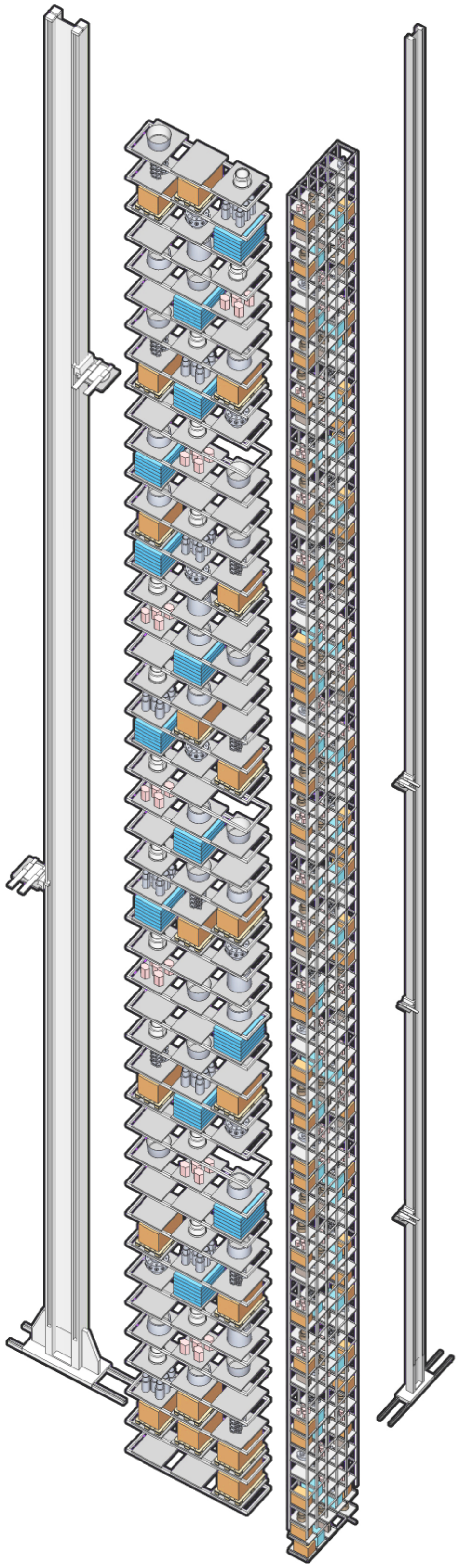
KUSUDA, Y. (2008) DIRECT INPUT AND OUTPUT SYSTEM.

Automated storage / retrieval system

Originating in the 60's, an automated storage / retrieval system (ASRS) is a compact logistic solution for computerized management of a warehouse. Reducing inventory and labor, they are typically used in applications where there are a high volume of loads being moved in and out of storage, space constraints make storage density important and where accuracy is critical because of expensive loads. Such as in the Corner Factory.



CORE FLOW HANDLING

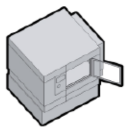


CORNER FACTORY ASRS

Machinery

Like the tenants of an apartment building, the machinery is just as much as the workers the inhabitants around which the factory needs to be designed. Below, the main types of equipment found in the Corner Factory are shown. These machines are in themselves a large portion of the spectacular quality provided by the Corner Factory to its neighbouring street. Increasingly automated, these robots works tirelessly around the clock, unconcerned with being watched, moving and assembling components with almost uncanny autonomy and precision. By day, workers arrive to tune and monitor their choreography.

Generic platforms
Basic, scalable components



3D PRINTER

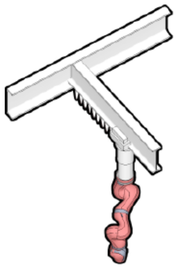
7-AXIS ARM

AUTOMATED GUIDED VEHICLE

Smart & mobile
Intraconnected IoT machinery

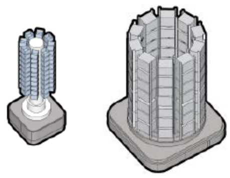
AGV + TELESCOPE + ARM S

AGV + ARM L



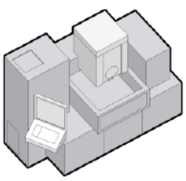
ARM + GANTRY

AGV + TRAY

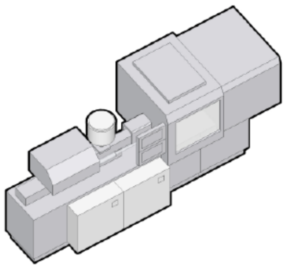


AGV + ASRS CAROUSELS

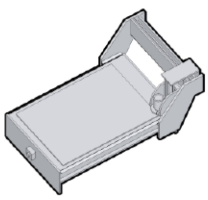
Conventional equipment
For when additive isn't rational



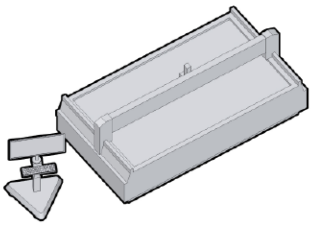
ELECTRIC DIE SINKING MACHINE



INJECTION MOULDING MACHINE

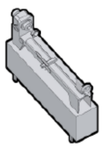


FLATBED CNC ROUTER

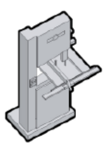


WATERJET CUTTER

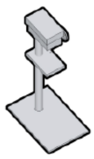
Classic tools
For the Public Workshop



LATHE



BAND SAW



DRILL PRESS

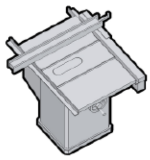
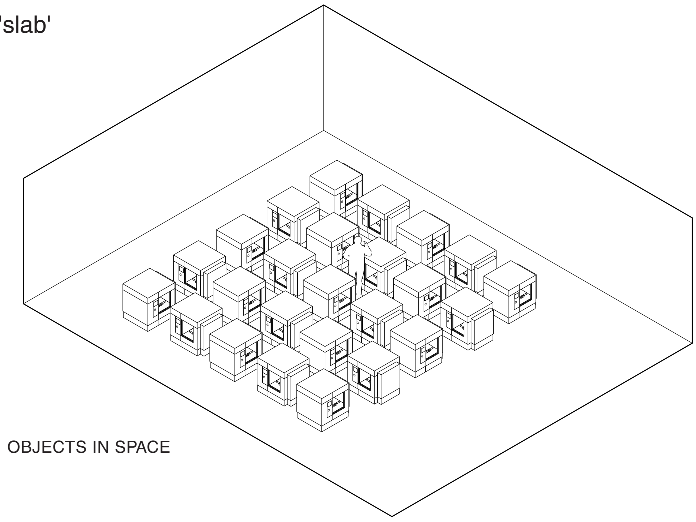


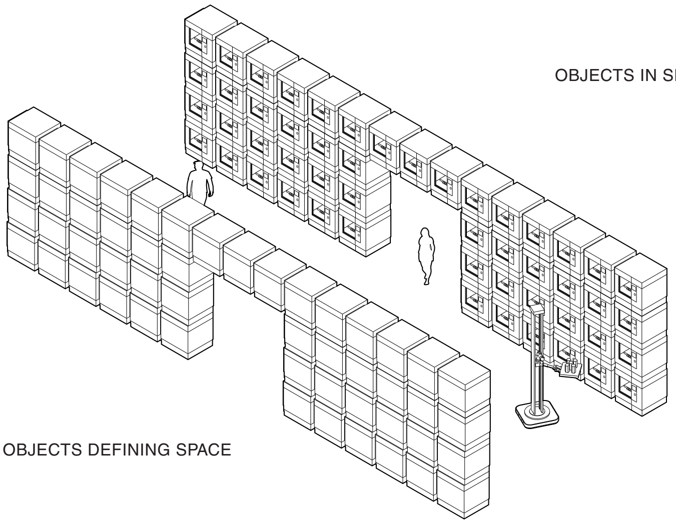
TABLE SAW

Space-making equipment

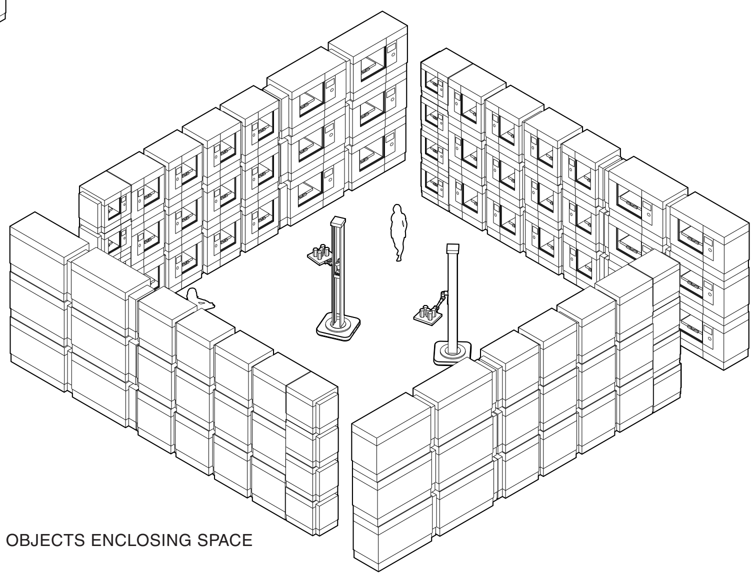
The potential for the machinery itself to act as space-making elements was recognized early. Shown right are 3D printers assembled into walls. In the final proposal, two of these elements acted in conjunction with the core 'slab' to define a logistic area.



OBJECTS IN SPACE



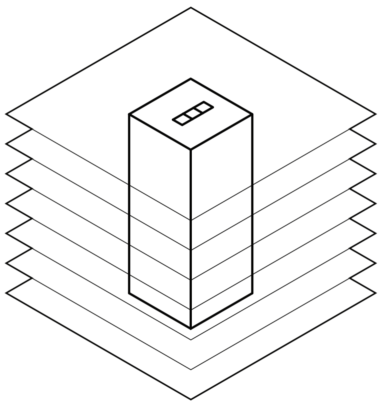
OBJECTS DEFINING SPACE



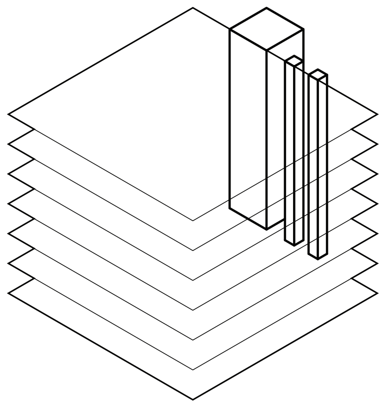
OBJECTS ENCLOSING SPACE

Core placement

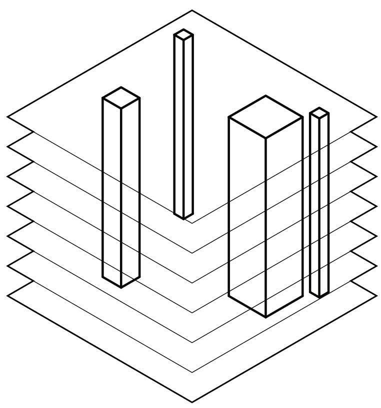
The position of the core defines the basic spatial configuration of a high-rise. An early decision to push the visually potent core towards the facade ruled out a central placement. The 'fragmented' option was thoroughly evaulated and found to have a lot of spatial potential, but to be more suited for a factory with a larger floorplate, or a typology with lesser demands on flexibility. The vast halls of mass production are no longer that relevant in most manufacturing, but the option to divide a larger volume of space at will is still appealing in this sector. In the end, clustering the core functions in a bundle, placed asymmetrically for a differentiation of space, was chosen.



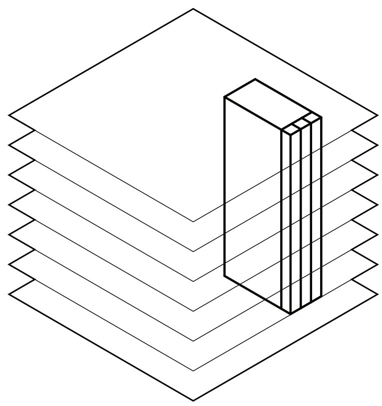
CENTRAL
BALANCED STRUCTURE GENERATING HOMOGENOUS SPACE



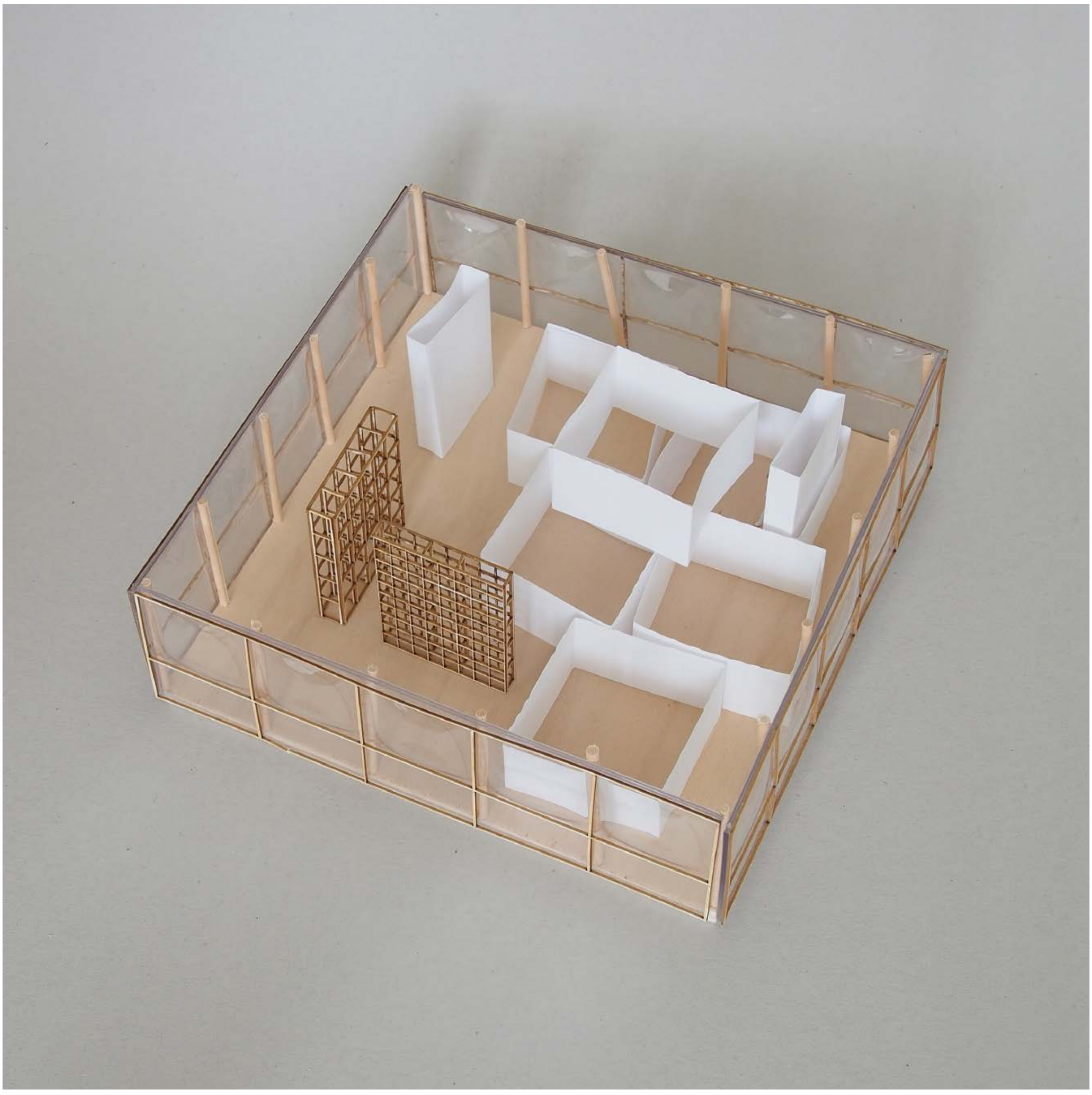
EXTERNAL
'TOTAL FLEXIBILITY' - IN EFFECT OFTEN STATIC



FRAGMENTED
NEEDS FAIRLY LARGE FLOOR PLATE



ASYMMETRIC
DIFFERENTIATING SPACE



STUDY MODEL FOR CORE PLACEMENT AND PARTITIONS

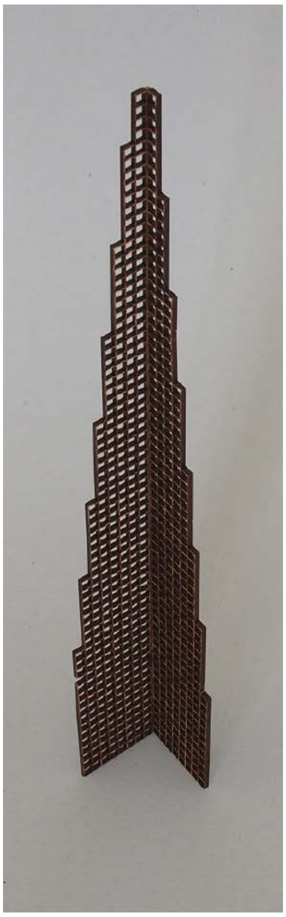
Core design

The 'smart core', or automated storage and retrieval system (ASRS), physically consists of a tall warehouse pallet racking with a stacker crane. Or, a large number of storage locations for objects of various scales. Considered as a large-scale object in itself, this pallet racking could be described as a lattice structure consisting of a myriad of sticks. This idea of sticks was to inform the entire building.

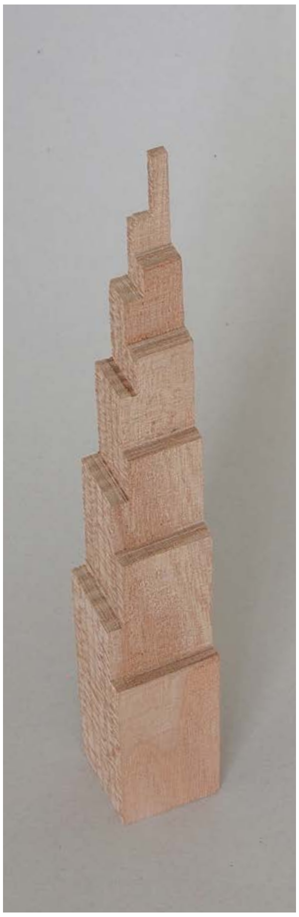
Considering the possibility of the pallet racking to act as a structural member, various configurations were explored below. The theme of a 'trapped figure' or 'shape within' was also explored. In the end, the core consists of a larger exoskeleton overlaid over a pallet racking divided for accomodating two packet sizes.

This larger lattice slab acts as the stiffening element for the entire building (see structure chapter). It also contains the other necessary functions: freight- and personnel elevators, fire escape stairs, air ducts, wiring and media piping.

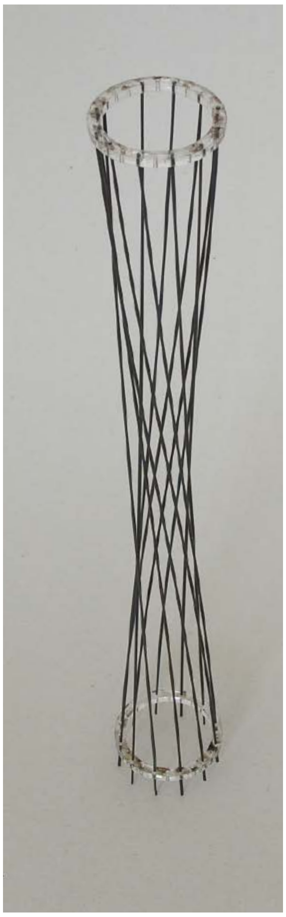
The core is the building component most associated with the spectacular. Normally, a high rise core is an opaque static element. But in the Corner Factory, the core comes alive while almost disappearing. Inside the delicate skeletal tube, the stackers shifts goods around, providing a constant activity especially prominent at night.



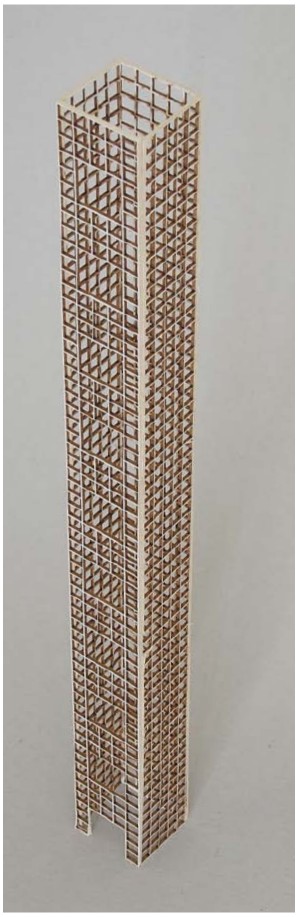
TAPERING PALLET RACKING



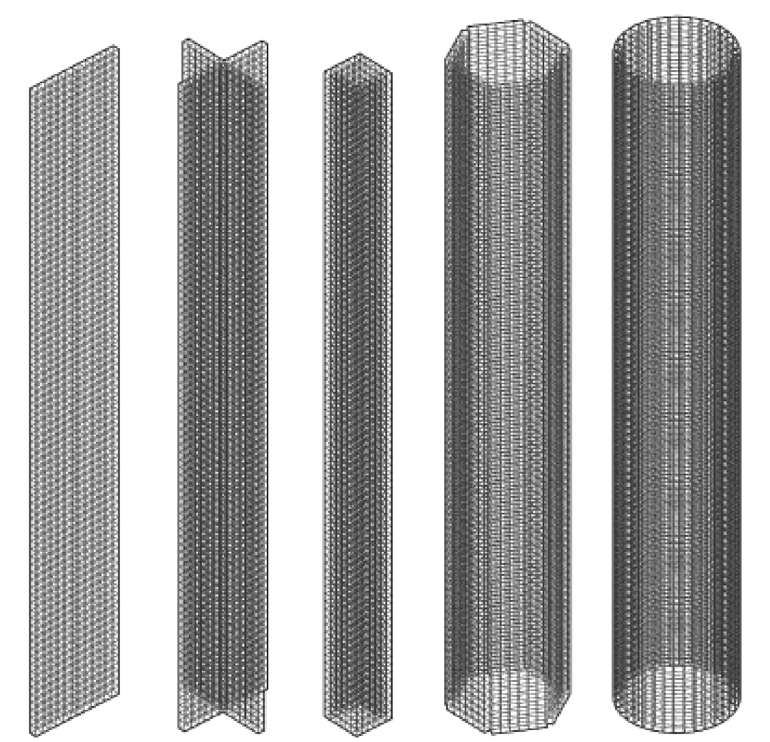
'TRAPPED FIGURE' VOLUME



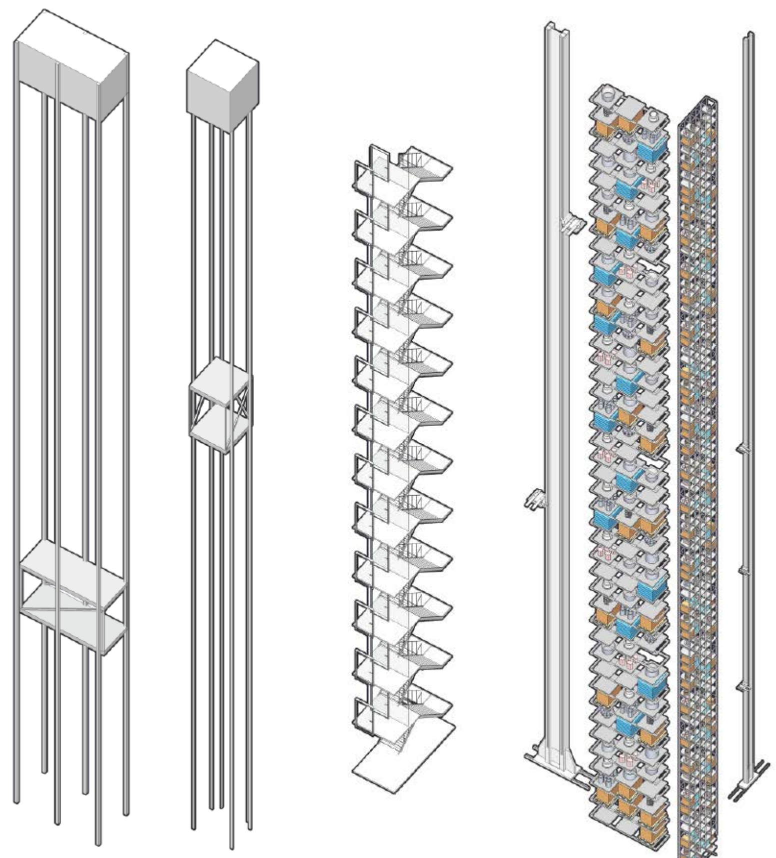
HYPERBOLOID CORE



LATTICE STICK



SLAB CRUCIFORM STICK HEXAGON CYLINDER

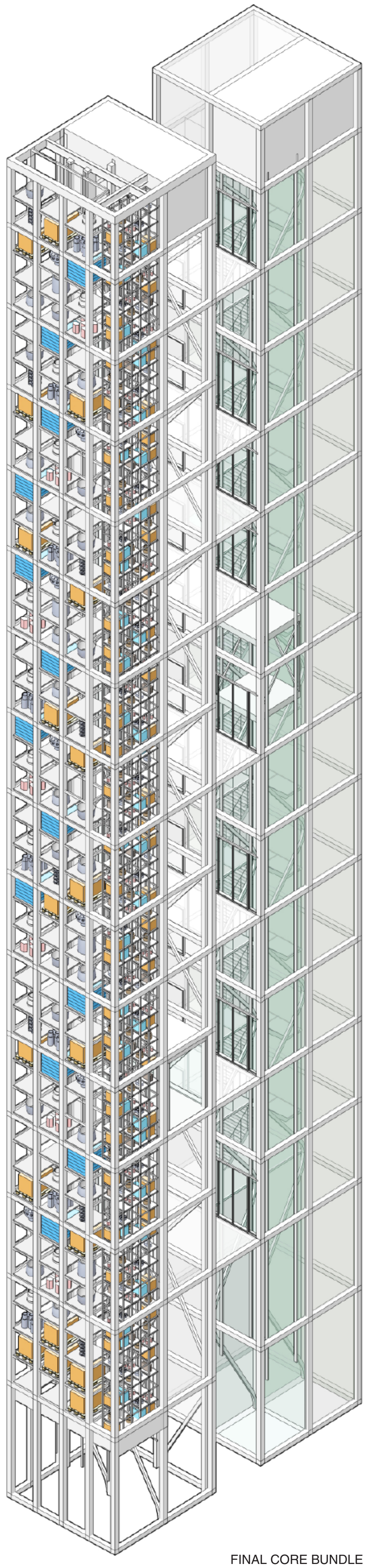


FREIGHT ELEVATOR

PERSONNEL ELEVATOR

FIRE ESCAPE

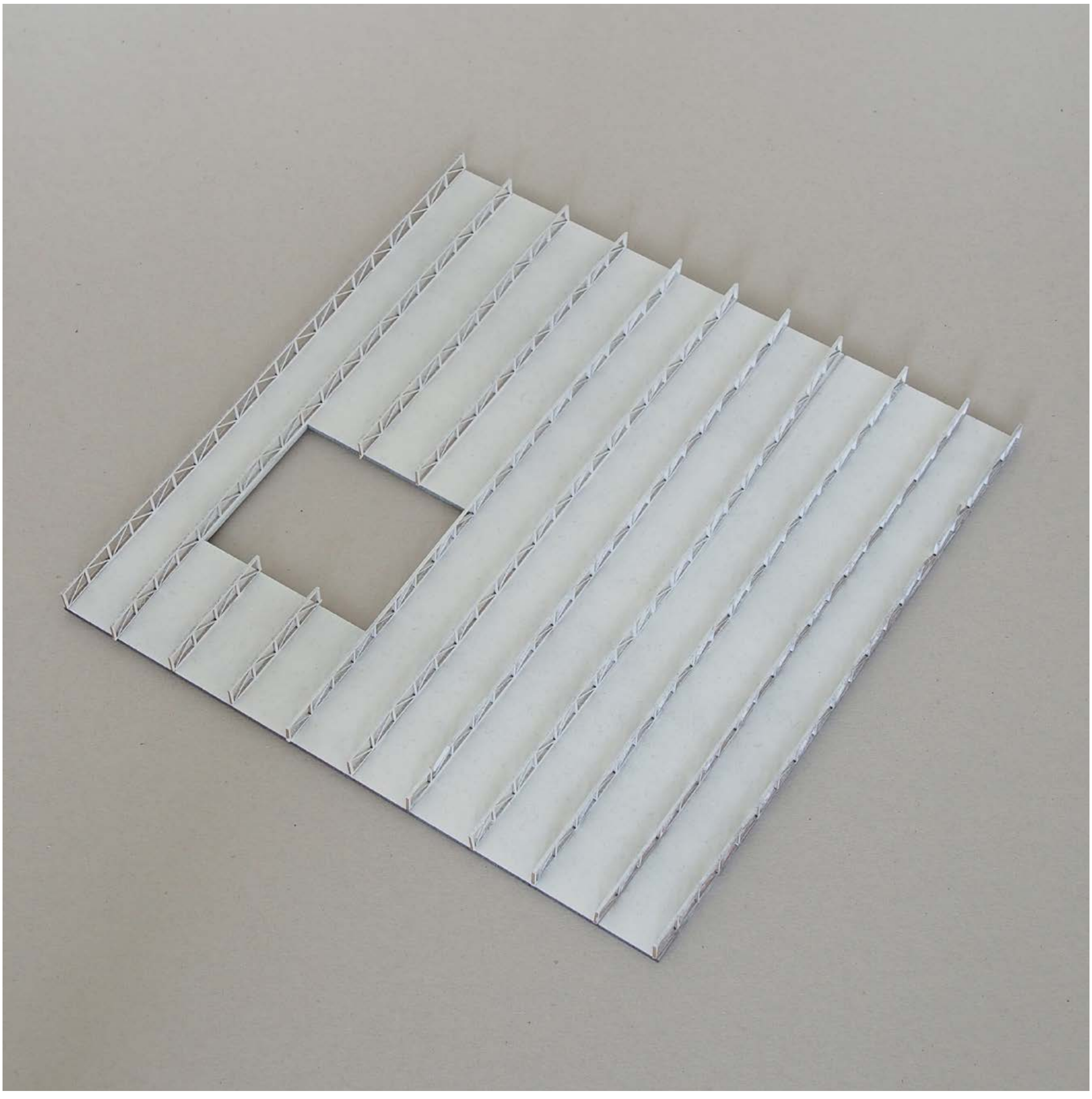
AUTOMATED STORAGE / RETRIEVAL SYSTEM



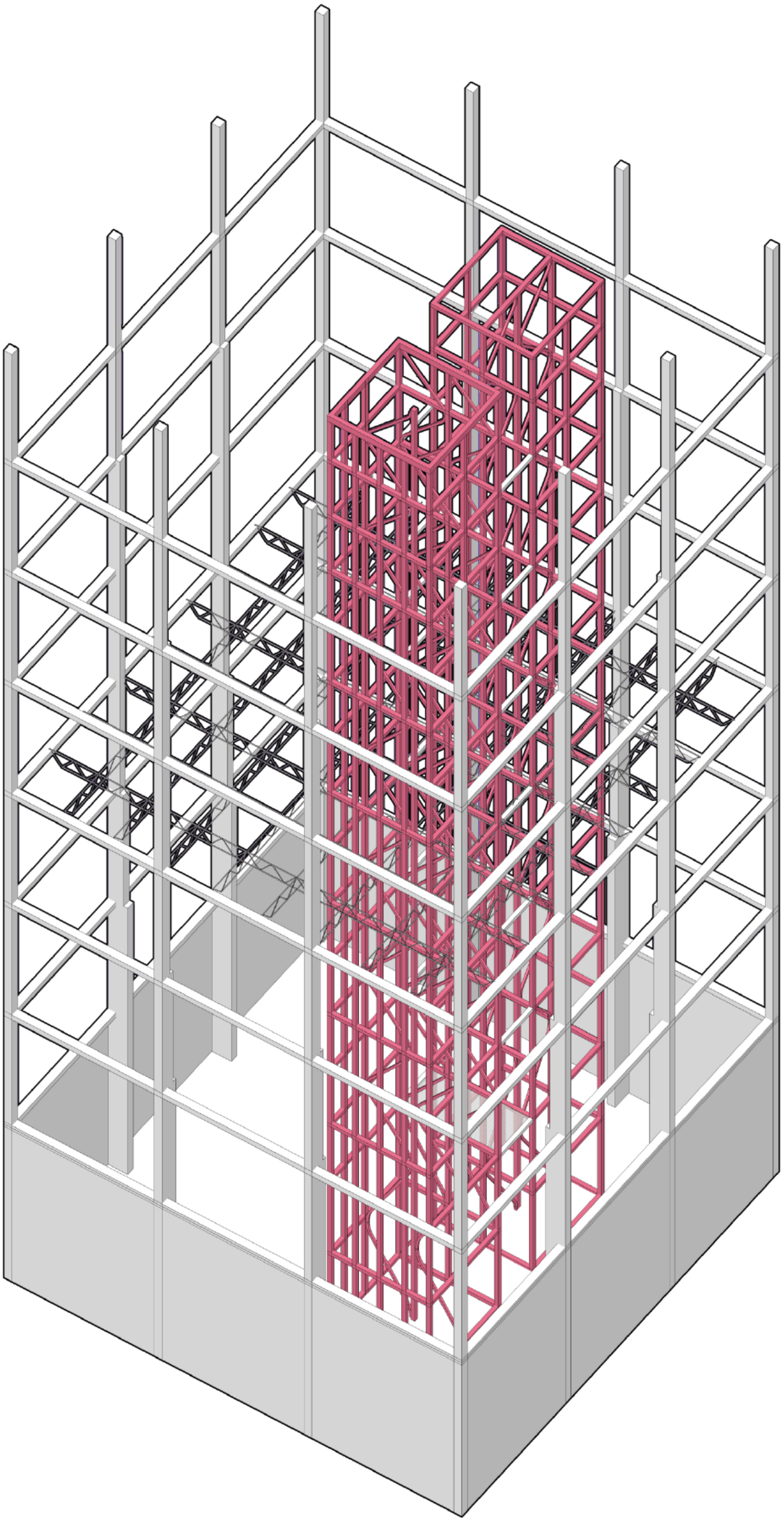
FINAL CORE BUNDLE

Structure

Building on the 'stick logic' of the core, the global structure was initially approached as a 'stick field'. This tectonic logic is especially prevalent in utilitarian structures due its inherent material efficiency. Columns and lattice girders were decided to be the basic components of the structural system, in which the amounts and thicknesses were constantly manipulated. Shown on next spread are some variations of slabs. Some heavily perforated, and perhaps more spatially rich iterations, were discarded in favor for basic, space-maximising compartments. The system can thus be read as a series of stacked 6m halls, the ones located higher up in the building coming with pre-inserted mezzanine floors. The columns system is placed on a subterranean box of concrete. A continous void, containing the logistic system, runs throughout the entire height.



SLAB UNDERSIDE STUDY MODEL



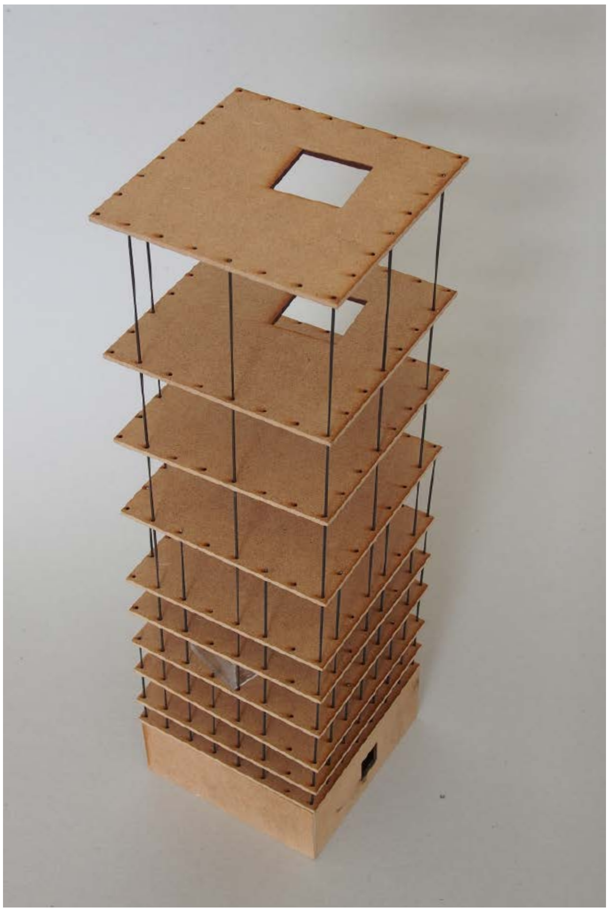
CONCRETE
FILLED TUBES,
TAPERING DOWN:
400X400
1200X400

CONCRETE
METAL DECK
SLABS ON
SINE PROFILE
GIRDERS
(H=800)

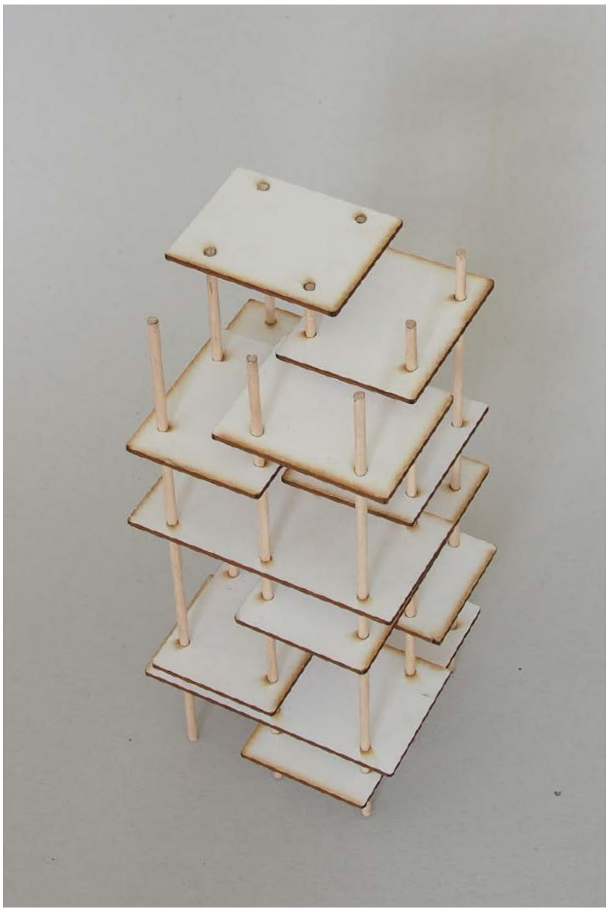
STIFFENING
LATTICE CORE:
STEEL SECTIONS
250X250
100X100

CONCRETE
BASEMENT
CASING

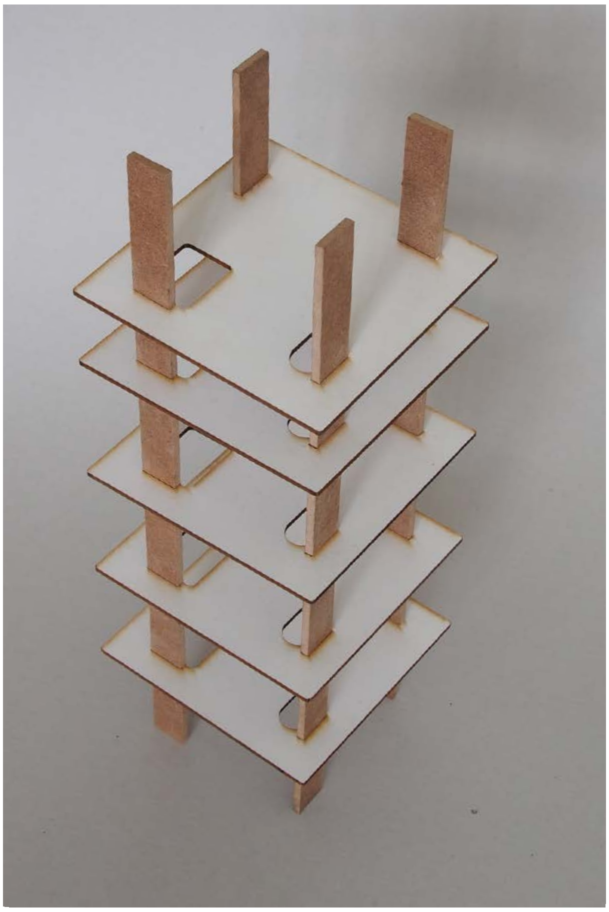
GRADATION OF STRUCTURE



OBSESSIVE THINNESS



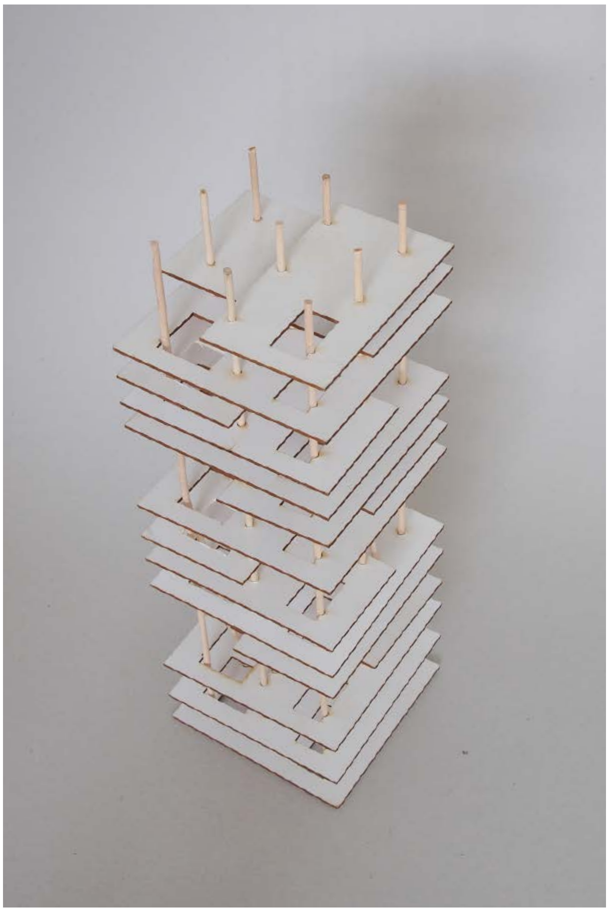
CASCADING PLATFORMS



MIESIAN CORES

JAUNTINESS

CONTINUUM



SLANTED COLUMNS

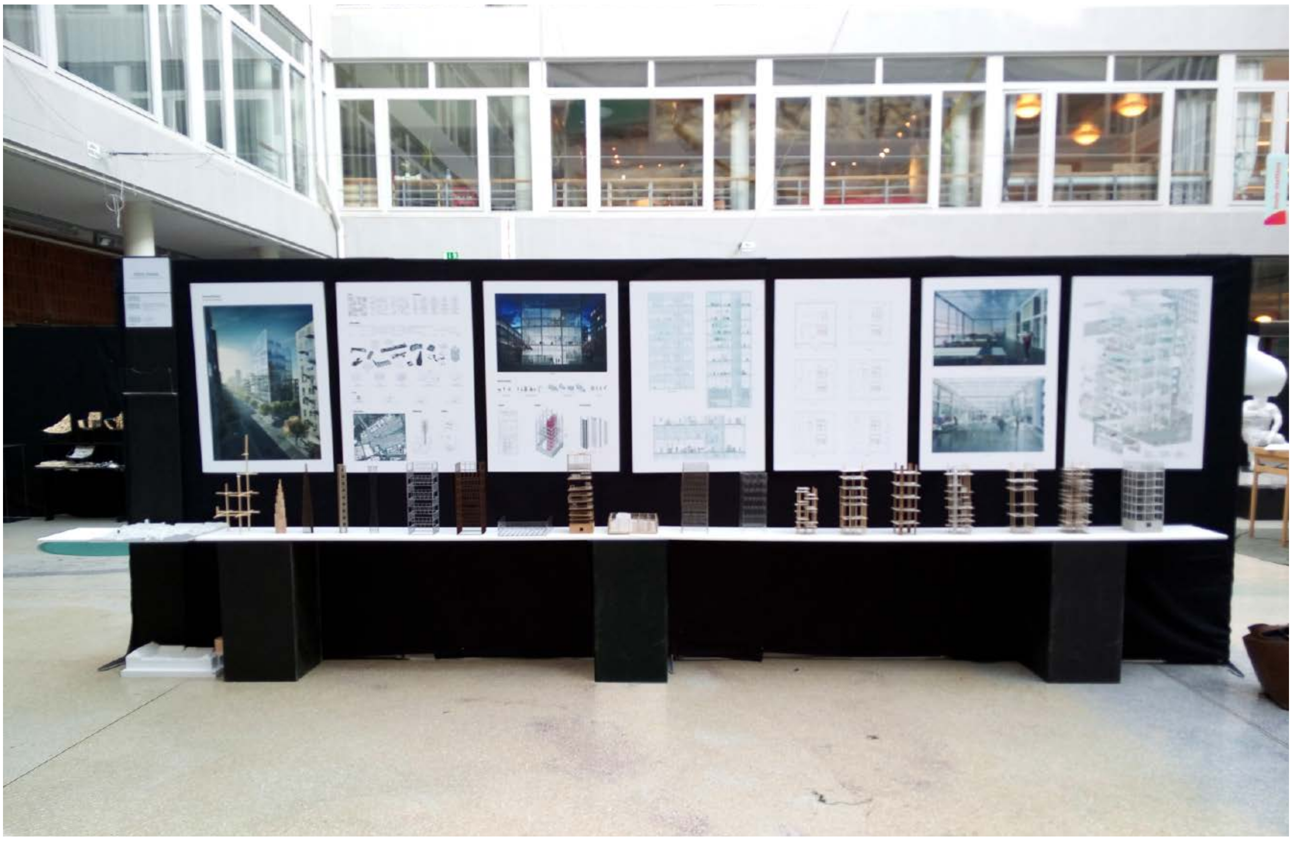
STACKED VIERENDEEL

Facade

The factory should not look like an office building or a cultural institution. The volume is the simplest possible, the facade the main contributor to visual impact. Given the column-based structure, a curtain wall facade was a given. The main objective was to be the showcasing and enhancement of the factory's contents, or the exposure of new manufacturing processes. As such, the facade interface called for a non-obscuring strategy. To this end, an architecture of disapperance or 'almost nothing' was pursued. Instead of exclusively working with glass, plastic ETFE membrane cushions was introduced to the material palette. Inflated with air, these lightweight elements adds depth and curves reflections, making the envelope more three dimensional. The other elements are large-pane glass elements and units with operable windows. Enhancing the spectacle inside the building, this gridded interface forms a certain rhythm, that like a comic strip format frames and directs attention.

CURVED ELEMENTS DISTORTING VIEWS
OPPOSITE: CUSHION EFFECT STUDY

Proposal



EXHIBITION 2016-05-25

OPPOSITE AND NEXT SPREAD: FINAL ITERATION

Views

SIDEWALK


NEIGHBOUR BALCONY

ASSEMBLY

PUBLIC WORKSHOP

Drawings

OPPOSITE: AXONOMETRIC

1 MATCHSTICK FACTORY
2 FUTURE CONTEXT
3 PUBLIC WORKSHOP
4 LOUD EQUIPMENT
5 AUTOMATED STORAGE/RETRIEVAL SYSTEM
6 DRONE STARTUP
7 AIR DELIVERY HUB
8 AEROSPACE COMPANY OFFICE SPACE
9 COBOT ASSEMBLY LINE
10 COBOT WORKSTATION
11 AUTOMATED GUIDED VEHICLE (AGV)
12 AGV + ITEM CAROUSEL
13 OVERHEAD GANTRY 7-AXIS ARMS
14 EXPERIMENTAL BUILD SPACE
15 LOBBY
16 LASER SINTERING MACHINE
17 4.5M SIDEWALK
18 BIKE LANE
19 INJECTION MOULDING
20 AUTOMATED PACKAGING
21 ADDITIVE MANUFACTURING ARRAY
22 LOADING BAY
23 CONNECTION TO E45 HIGHWAY
24 SERVICES EQUIPMENT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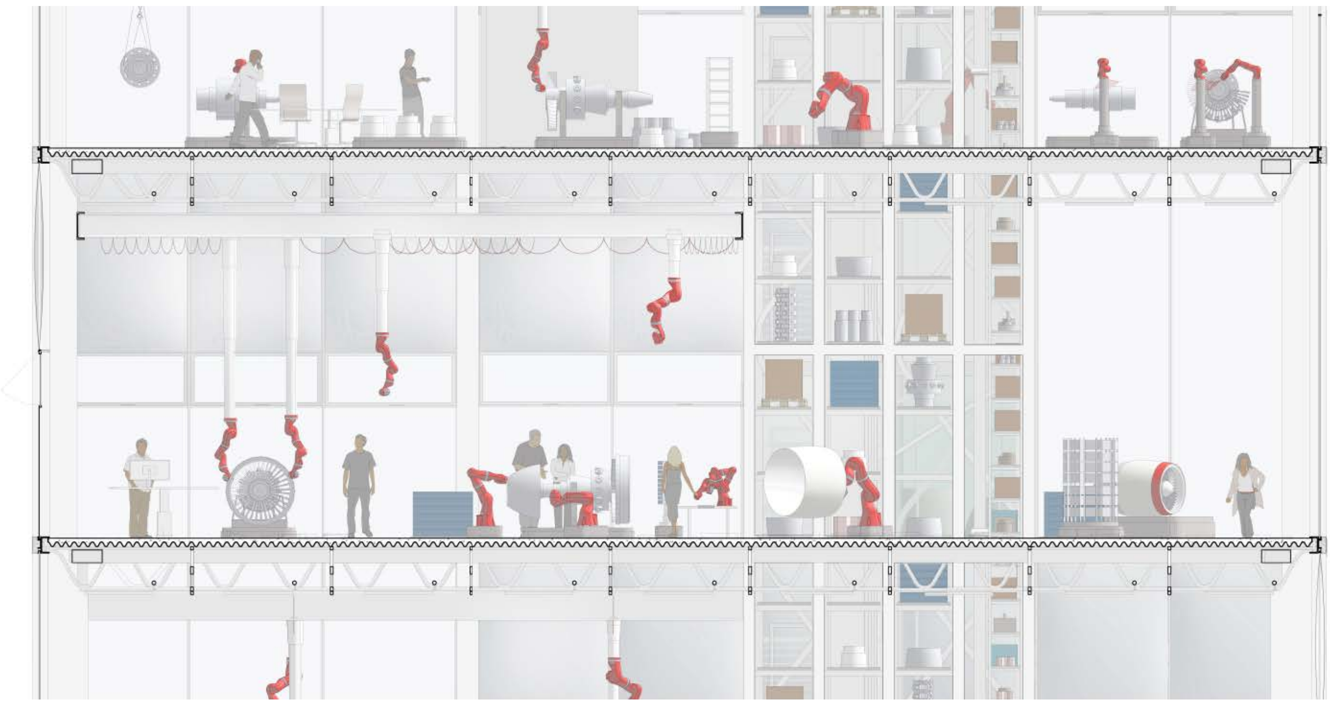
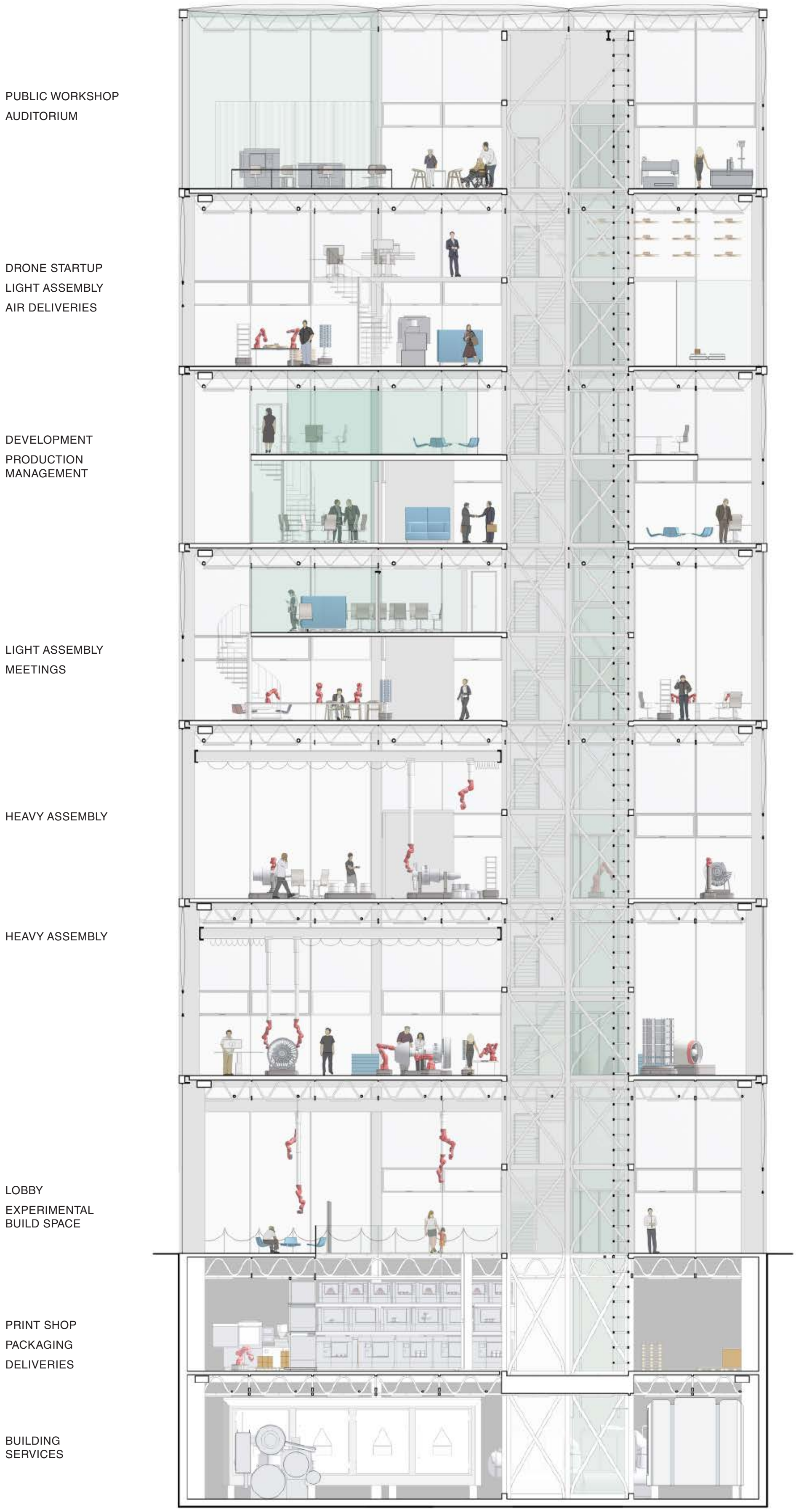
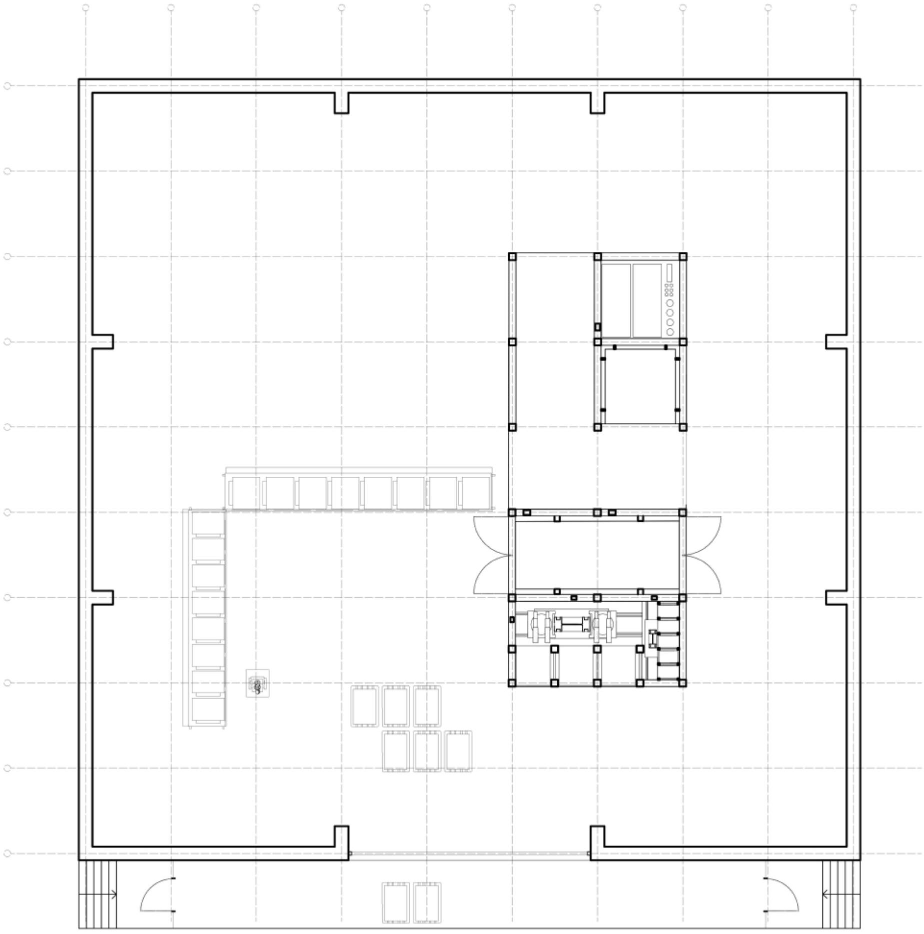


DETAIL SECTION THROUGH HEAVY ASSEMBLY FLOOR

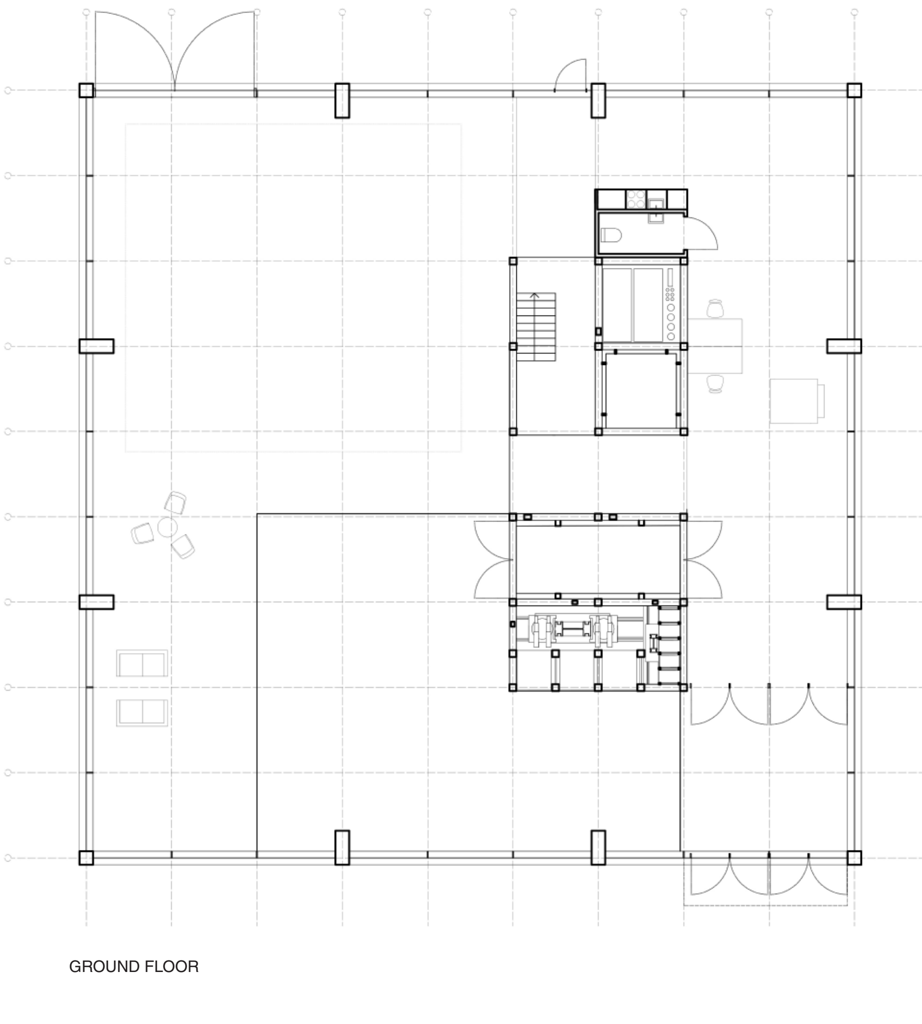


SECTION THROUGH CORE

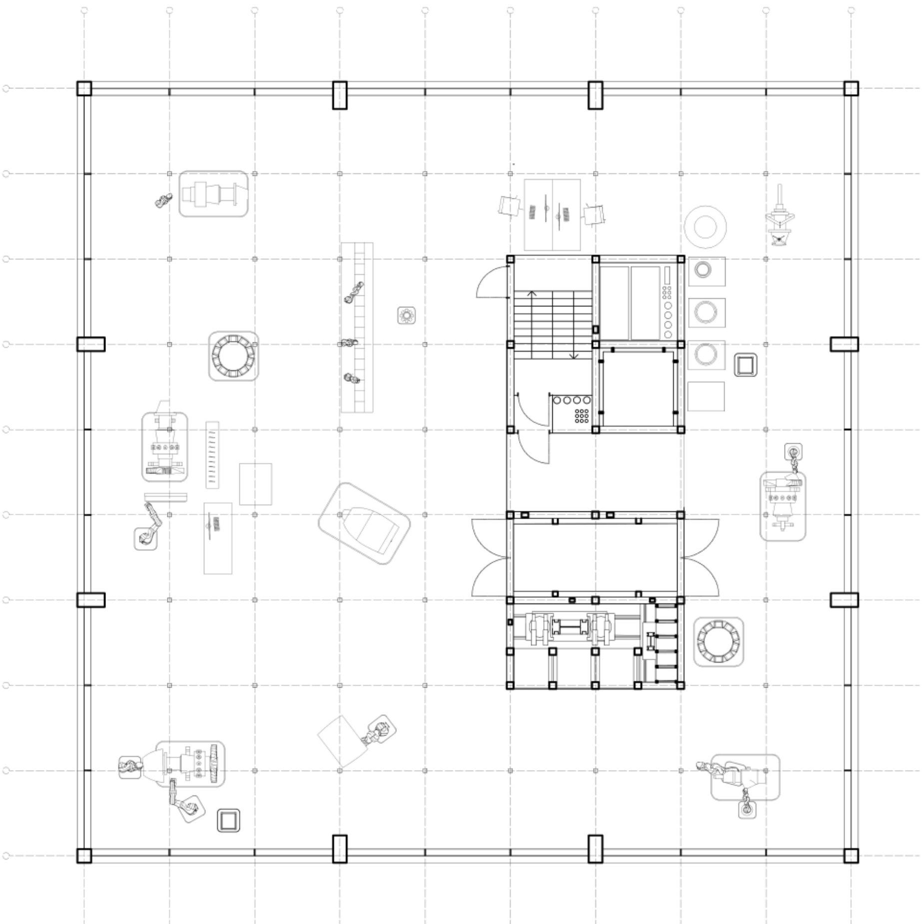
SOUTH ELEVATION



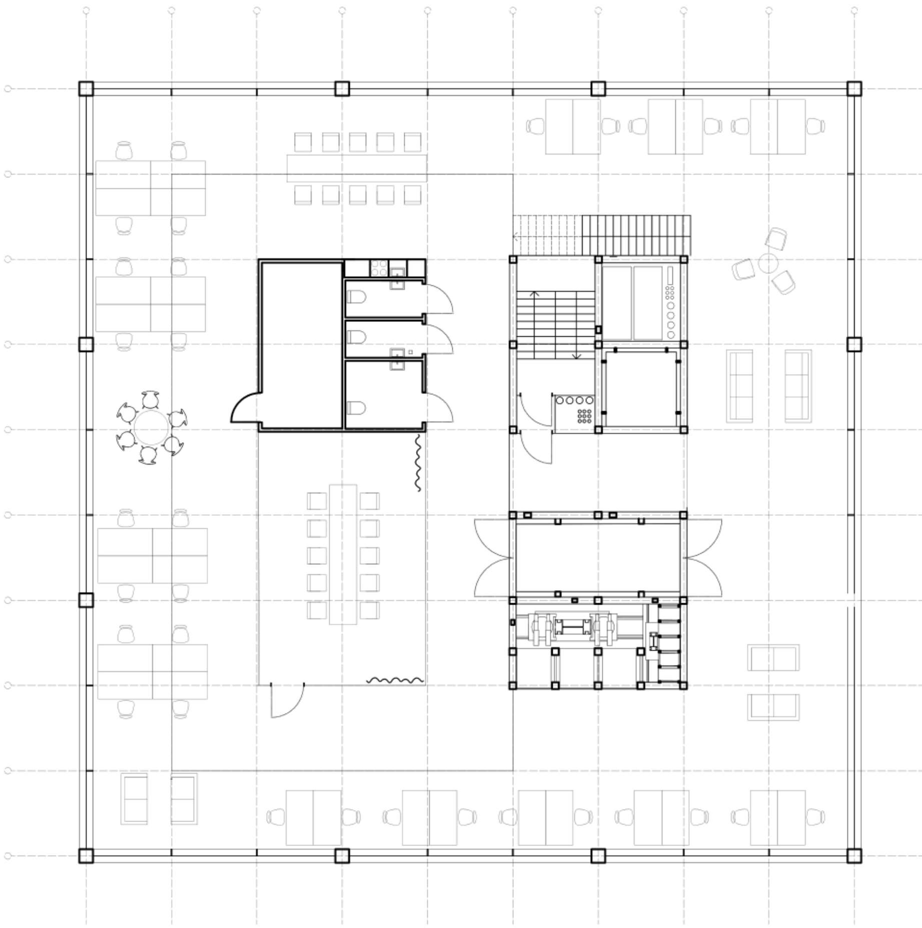
BASEMENT



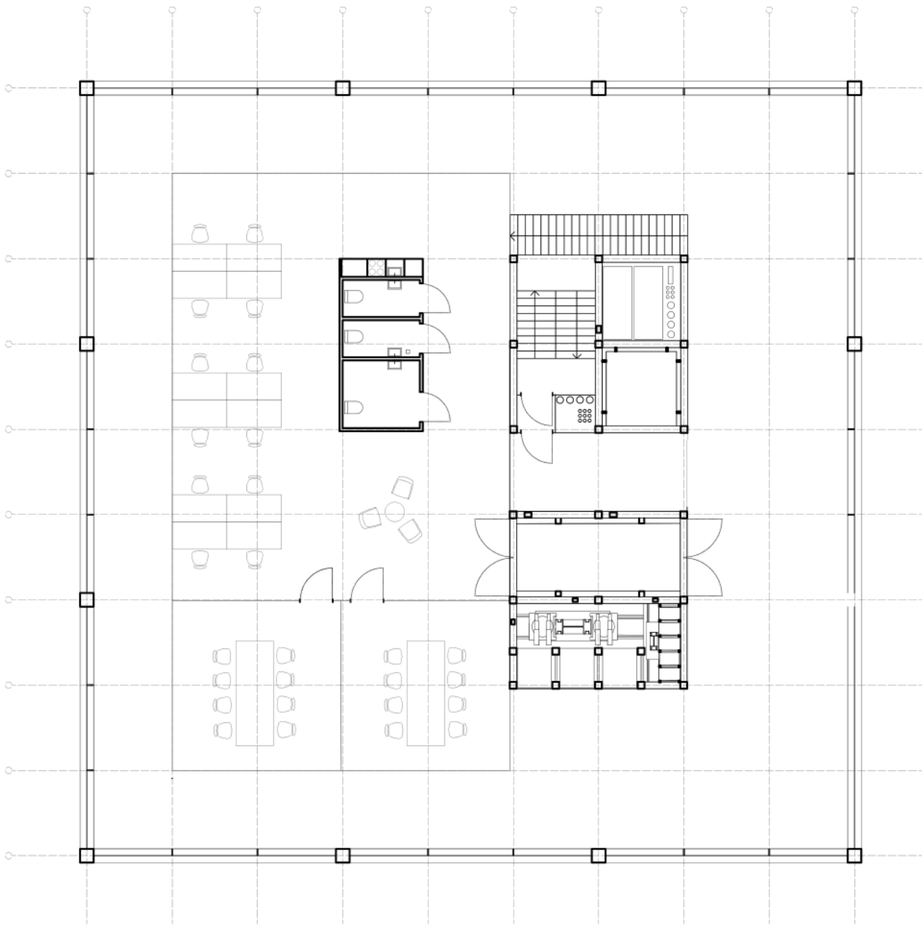
GROUND FLOOR



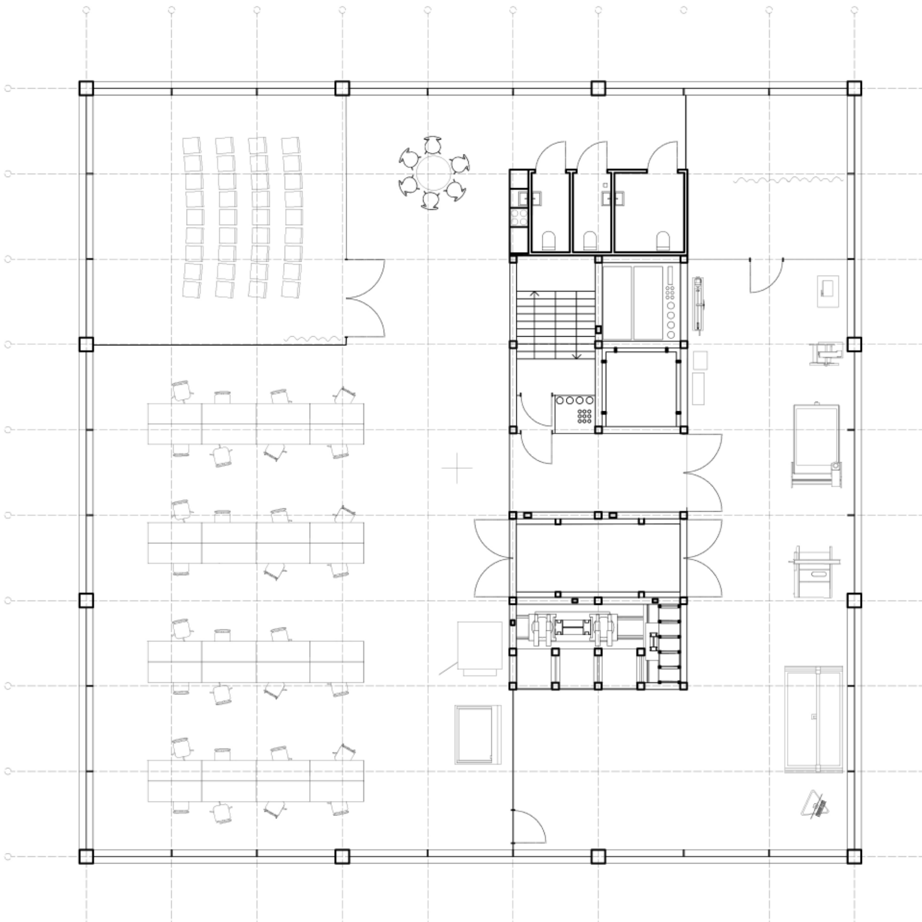
ASSEMBLY



OFFICE



MEZZANINE



PUBLIC WORKSHOP

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