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Project Book
Explore Lab 2022-2023

Samuel Slezák

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Responsive Architecture: The home to come

Part I – Research Book
Explore Lab 2022-2023

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Responsive Architecture: The home to come

Abstract

The exponentially-advancing tide of artificial intelligence technology is increasingly permeating everyday life, reshaping our domestic environments profoundly. This paper delves into the pivotal question of how integrating AI technologies into our homes might influence spatial dynamics and stimulate human-to-human and human-to-machine social interactions. Rather than prophesying a definitive future, this work postulates potential scenarios through the lens of inventive design and explores their implications on residential spaces. The objective is to instigate a nuanced discourse, scrutinizing the core values that might be upheld, modified or avoided as we navigate this emergent future. The ultimate aim is to guide the adoption and evolution of AI technologies in ways that optimize their beneficial impact on our lives, homes, and interactions. Through this exploration, we envisage novel applications of AI, fostering proactive discussions to shape a positive and meaningful technological future.

Introduction

Machine intelligence in architecture evolved from an obscure topic of discussion in the 1970s and 80s to a topic of primary interest in contemporary architectural discourse centred on data and its application in design. The deep learning revolution has hastened the adoption of smart technologies in the domestic environment, owing to the involvement of companies like Apple, Amazon, Google, and others. However, architects' interest in designing and developing these technologies as part of their designs is limited to a handful of architectural professionals with a primary focus on art, digital

manufacturing and creators of urban platforms. These architects are continuing the legacy of architects' participation in the design of technology that reaches beyond the contemporary idea of a smart device. AI-based technologies create an opportunity for architects to bridge the physical and digital order and facilitate social interactions between people and machines. Furthermore, these technologies open up a new perspective on machines' role in domestic life beyond serving and maintaining the home.

Technology and architecture

The smart home may be one where you have to deal with a clothing rack that constantly criticising your fashion choices, a door that emits an encouraging sigh as it opens and welcomes us home after a long day, or a Romba-like servant who is depressed because his model is being discontinued. So far, such a portrayal of our homes seems futuristic, yet, it might not be so distant. Machine learning technology has established itself within our daily lives, including our most private space — our home. The advancements in computational technologies have allowed the 'intelligent' machines to learn faster, helping them to deal with increasingly more complex tasks. The integration of smart and intelligent technology in architecture has been discussed since the late 1960s. However, AI technology has become more prevalent through smart off-the-shelf devices like phones, watches and sensors. Nevertheless, a more conscious integration of intelligent technologies outside the scope of serving the human or maintaining the home is still absent in architectural design, apart from a few rare projects, speculations and academia.

The application of AI technologies in architecture practice seems distant, given architecture's slow adoption of technologies.[1] Architects, particularly those in practice, remain mostly consumers of technology rather than its makers. Drafting, modelling, and optimisation software has become a standard in most practices. Grasshopper, in particular, enabled firms and individuals to utilise optimisation and simulation tools at low costs. Nevertheless, the

1 Reyner Banham, The Architecture of the Well-Tempered Environment, 2nd ed (Chicago: University of Chicago Press, 1984).

responsibility for developing the technology that is progressively becoming part of buildings' design is progressively being outsourced.

Despite adopting digital tools that allowed for more complex and efficient designs, architects' agency in building design appears to be diminishing. In its 2014 Venice Biennale installation, OMA demonstrated how much of an architect's work is outside his hands.[2] One of the exhibition pieces that demonstrated the shift is a ceiling fragment. This demonstrates that the ceiling acquired three-dimensionality, consisting of a large inaccessible section used as storage space for HVAC, plumbing, wiring, and surveillance devices. The shift in architects' authority raises a question of how architects will position themselves in integrating new technology into architecture. One stance is to continue the existing trend of architects increasingly serving as consultants to clients and engineers.[3]Alternatively, architects (re)claim their identity as makers of technology as part of their design profession to reclaim their authority in the building process.[4]

Corporations like Apple, Google, and Amazon have already demonstrated the potential of the pocket, wrist, and small-shelf-sized computers that we carry or interact with daily. Many people's sedentary lifestyles are being altered by smartwatches, which manipulate our consciousness and compel us to keep our resolutions to exercise more by constantly monitoring our activity. These AI-based technologies provide a new way of utilising architectural space traditionally viewed as static. This resonates with Cedric Price's project for Generator from the late 1970s, which was an early investigation into artificially intelligent architecture and proposed more responsive environments.[5]

2 OMA, "Venice Biennale 2014: Fundamentals," OMA, accessed October 31, 2022, https://www.oma.com/projects/venice-biennale-2014-fundamentals.

3 Mario Carpo, "The Alternative Science of Computation," accessed November 7, 2022, https://www.e-flux.com/architecture/artificial-labor/142274/the-alternative-science-of-computation/.

4 Alessandro Bava, "Computational Tendencies," e-flux, January 2020, https://www.e-flux.com/architecture/intelligence/310405/computational-tendencies/.

5 Cedric Price, "Generator Project, White Oak, Florida, Untitled. 1978-80," The Museum of Modern Art, accessed November 10, 2022, https://www.moma.org/collection/works/876.

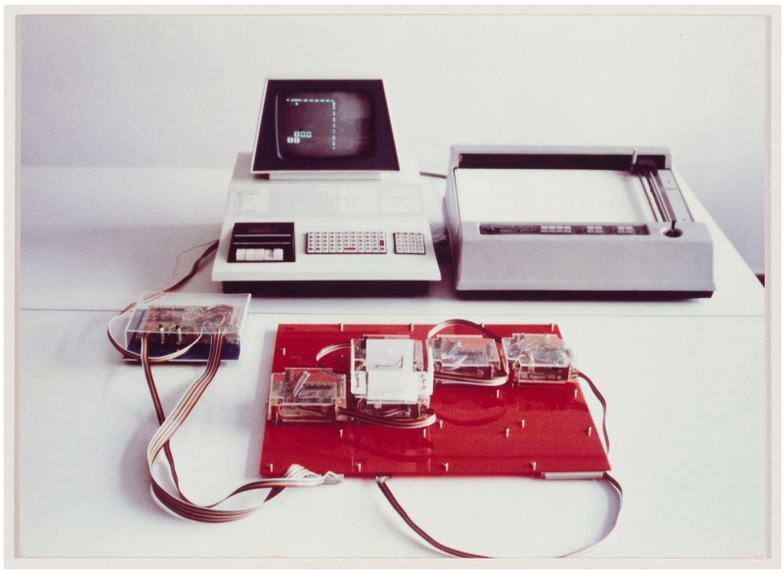


Fig 1 "A menu of individual or collective needs for space, environmental control, protection and enjoyment. A place for work, creation, thought, and reminiscence."
- Cedric Price
Architectural Review, Jan. 1980

Fig 2 What is the agency of an architect in the contemporary design?
"Venice Biennale 2014: Fundamentals," OMA, accessed October 31 2022.

Artificial intelligence and responsive environments

Technology has advanced dramatically since the late 1970s & 80s, making the possibility of a responsive architecture much more plausible. The outlook on AI and how it will work has changed drastically. The Cyc Project, developed by Douglas Lenat in 1984, aimed to give computers common sense. Since the focus has shifted to machine learning, the technology behind Siri, Alexa, and Google Translate.[1] Imminently, AI will become a part of daily life and architectural design; designers must understand what the machine is capable of and have the skills required to communicate their intent to the machine.

It is already apparent that AI will have its place in architectural environments, including domestic ones. The practice of Certain Measures illustrates that architects can retain their agency in designing spaces, even though these spaces are becoming more machinic. The installation "HOME IS WHERE THE DROIDS ARE" proposes a design that illustrates the struggles such spaces might pose in the future, where humans and machines co-habit a domestic environment.[2]

Once architects become versed in machine learning, they can begin designing and forming the technology that will be part of the architecture in the near future. This would result in an architecture responsive to its user, context, and environment as necessary. Such architecture would be able to react to its context and manage its environments, and its responsiveness would also extend to ecology. Consequently, responsive architecture will seek a balance between humans on one side and nature on the other.

1 Matthew Hutson, "Can Computers Learn Common Sense?," The New Yorker, April 5, 2022, https://www.newyorker.com/tech/annals-of-technology/can-computers-learn-common-sense.

2 Certain Measures, "HOME IS WHERE THE DROIDS ARE — Certain Measures," 2019, https://certainmeasures.com/CLOUDFILL.

Research Question:

What new spatial implication of the home can arise from the integration of artificially intelligent technologies, and what role can AI technologies play in reinforcing social interaction among humans and between humans and machines?

Fig 3 Certain Measures, "HOME IS WHERE THE DROIDS ARE — Certain Measures," 2019.

Methodology

Speculation is a method of communication of ideas and concepts in architecture or design. At the Royal College of Art in London, Anthony Dunne and Fiona Raby presented speculative design as a method that functions as a "catalyst for collectively redefining our relationship to reality" and considering how things could be.[1] Although the objective of speculative designs is not always to be realised, they may still carry a significant influence. Speculations are typically based on technological or social behaviour and its potential effects on architecture and its users. Design fictions exist in both actual practice and academics, although their proportion in each domain has varied over time. Archigram, 'the Austrian avant-garde,' and Superstudio are all examples of past architecture collectives that effectively tackled a wide range of contemporary social and technical advances in their settings through their design speculations.

However, speculation usually remains in the realm of speculations, with a few notable projects realised by members of the Austrian avant-garde. Usually, the design turn *paleofutures* — scenarios and visions of the future that never come to be. Usually because of too little foresight or failure to predict technologies that overshadow the 'new' ones in the real future. This raises the question of what value is brought to the table through the production of speculative designs and can an approach be chosen so it can reduce its chances of failing.

The approach used in the research borrows from Carlo Ratti's and Matthew Claudel's Futurecraft approach used in their book 'the City of Tomorrow'. Futurecraft employs design as a medium for systematically exploring and germinating possible futures. This approach to predicting the future tries to avoid speculating too far into the distant future, to increase the chance of the prediction becoming a reality, or to attract more productive debate. The future scenarios are usually presented as 'what if?' questions. The aim is not to portray what will come but to imagine a scenario and reflect on its consequences and exigencies. The scenario is then presented and discussed publicly to encourage conservation and debate. The authors explain it as follows:

1 Ratti, Carlo, and Matthew Claudel. The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life. (New Haven ; London: Yale University Press, 2016.), pg. 10

"(W)e propose to extrapolate from the present condition and to place ourselves, as designers, in a fictive but possible future context with the intent of realizing or precluding that future through public discourse."[2]

This research uses the futurecrafting approach. The process studies the evolution of technologies over time and concentrates on how they permeate spheres of life, focusing primarily on the domestic sphere. It then looks at some of the trends these technologies introduce into society and architecture and creates a design based on this prompt. An example of this could be the following prompt: What if smart devices from our homes become the home itself, dropping the structure? Such prompt reflects on the essay 'A Home is not a House' by Reynar Banham and the trends that point to increasing home automation. Another example can be: What if the smartphone becomes our primary form of communication? This prompt is a reaction to the critical voices aimed at the striped mode of communication presented by texting, and it also touches on the 1908 short story Machine Stops by E.M. Foster.

The technologies that this paper highlights are robotics, smart homes, and smartphones, and their evolution, focusing on the most recent couple of decades. These three technologies are selected as ones that are already relevant or are becoming increasingly relevant to the home context. Moreover, these technologies are then analysed with respect to the home. The analysis is done through the study of academic literature, both non-fiction and fiction books, essays, and movies. Resulting of the analysis is the prompt, which offers a starting point for the design. The resulting scenarios are then discussed publicly within the university of TU Delft and with non-specialist people outside the academic environment. Through discussion, debates and exploration, future scenarios are tested to highlight core values that can be adopted or avoided in the future.

1 Ratti, Carlo, and Matthew Claudel. The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life. (New Haven ; London: Yale University Press, 2016.), pg. 10

Part I: Smartphone — Home between reality and virtuality

The act of gathering around a campfire embodies a plethora of distinctive qualities. It emanates an undomesticated freedom and primal rawness that seems to be increasingly elusive in the context of contemporary life. Consider the hearth—a cornerstone of the domestic sphere where the fire is tamed to serve human needs. This domestic variant of the campfire has been a haven of protection, solace, and social connectivity since the dawn of humanity. The esteemed German architect, Gottfried Semper, espoused the belief that architecture was born from the very concept of the hearth. Remarkably, this seminal element has weathered the ravages of time with minimal changes. Yet, it must be noted that the hearth, as a critical architectural element, has begun to fade into obscurity in recent decades.[1] The esteemed architect Frank Lloyd Wright once called it "the psychological centre of the home", but modern technology has dramatically reshaped it, fracturing this once unified concept into a constellation of disparate elements.

The concept of a hearth is still present in the contemporary home. Nevertheless, it is split into several technologies that avoid some of the drawbacks of the 'original' design. The world now offers plenty of choices to substitute the hearth, yet, some things are dropped for convenience. Nowadays, people have several choices. It is possible to eliminate the smell and dangers caused by smoke through electric induction stoves. The comforting warmth generated through the fire is now more controlled through the central heating. Our culture has elevated the collective and social aspects of eating and conversing around the fire to the dining table. Moreover, finally, the flames can be projected or played on a loop on screen infinitely without the need to add burdensome fuel.

Only some of the technology we have grown used to has altered our lifestyle as much as the smartphone. The smartphone is one of the most impactful technologies of the past decade, and its impact on today's society and its life is unprecedented. Smartphone evolution over the past twenty years has been dramatically successful in

1 Ratti, Carlo, and Matthew Claudel. The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life. (New Haven ; London: Yale University Press, 2016.), pg. 10

reaching a significant percentage of the population. Today as much as 86% of the whole population now own a smartphone, and over 60% use the internet.[2] This increase in access to digital technology and the internet has extended our ability as humans — we can now exist seamlessly both in the flesh and virtually.

The smartphone extends the human's cognitive ability. Its ease of use and small size allow us to have it everywhere — it has become a part of us. The smartphone became a part of its users' memory by capturing pictures in great detail, including a pinpoint location and exact time in images and metadata. It has made the world available by reifying it into an image.[3] The smartphone has also become many other things; it is an essential navigational tool in everyday life, giving its user the freedom of not knowing their environment. It enables the user to navigate virtually any country around the planet. Moreover, it expanded our knowledge through instant access to the Internet of Things; most human knowledge is now at our fingertips. It is a multi-tool that has made its way into every aspect of life, from waking up, eating, shopping, entertaining, servicing, healing, and practically anything else. As Han describes in the book Non-Things, humans' relationship with smartphones has almost reached a symbiotic state.

Smartphones have evolved from the concept of networking. It began its development with the telephone, a static telecommunication device usually mounted or connected to a wall (sometimes to the wall of a phone booth) with a cable that permitted two users to conduct a voice conversation over a distance. Further, the phone developed into a more portable mobile phone. The mobile phone gave its user much greater freedom through its portability and introduced new features, such as sending messages, images and videos. However, the most recent advancement — the smartphone, truly changed and unlocked the phone's potential. The smartphone combined the mobile phone with the computer, thus creating a device capable of much more than just telecommunication. Eventually, allowing access to the internet has opened endless options that we may enjoy today, including streaming, social media, and applications. The smartphone's impact on our social life and behaviour is unprecedented by any other technology. The

2 Ash Turner, "How Many People Have Smartphones Worldwide (Jan 2023)," July 10, 2018, https://www.bankmycell.com/blog/how-many-phones-are-in-the-world.

3 Byung-Chul Han, Non-Things Upheaval in the Lifeworld, trans. Daniel Steuer (Cambridge: Polity Press, 2022).

smartphone has become the facilitator of human social interaction beyond any other by utilising the virtual realm of the internet.

The smartphone has introduced a new type of space, complete with its owner's digital self. The relationship between the user and the smartphone is intimate because of the information stored inside its memory and the digital cloud. Yet this space still allows complete anonymity. Further on, the software behind many applications can now 'get to know' its user. This information is mainly used to teach machines how to target corporate adverting to users better. Nevertheless, the potential of using this information to the user's benefit is the next step in machine intelligence.

The smartphone facilitates many activities. However, at its core, it is a device focused on social interaction. In this sense, it is similar to the hearth. The smartphone has become the new virtual "psychological centre of our digital existence". This new reality poses the question of whether there is a possibility of a hybridised space where the digital and physical meet. Each of these realms has its distinct benefits. The digital is instant, omnipresent, and to a large extent, anonymous. The physical is intimate and tangible and easier to control. A more intertwined combination of these two realms is vague, but architectural design can provide the answer to how to bridge these two spaces.

The proliferation of machine learning algorithms is revolutionizing the way applications function. Devices have become more attuned to their owners, excelling at predicting and providing the functions or actions users might require at any given moment. This development offers intriguing possibilities for domestic spaces. What if a home could know its occupant as intimately as a smartphone does? It could adjust the temperature in anticipation of the owner's arrival, preheat the oven when it detects a purchase of fresh fish or a ready-made meal at the local grocery store, or even share the memories created within its walls. One hopes that this would not echo the dystopian vision presented in the Black Mirror episode, where every memory within a home could be replayed.

Drawing parallels to the evolution of smartphones, the home of the future could become a social nexus, merging physical and virtual realms to foster connections. It might remind you of a dinner party from six months ago and suggest a reunion with friends or family. Your future home could act as a node in your social network, orchestrating spontaneous encounters with distant friends or acquaintances. By facilitating shared activities within the home, it could combat the rising tide of loneliness, encouraging a culture of openness and shared experiences.

Part II: Robot — Living with a robots

Home is not a House is an essay by Reyner Benham, challenging the notion that a home does not need to be a ground-anchored structure. It criticises that the house has become an assemblage of mechanical services that does not even require the house to hold it up. Benham proposes an alternative mobile home where the house could be an inflated power membrane filled with conditioned air powered by a car. He argues that this kind of home could offer more freedom and a much more enjoyable, ever-changing experience.[1] Since 1965, when Benham's essay was first published, very little has changed about the house — it is still mostly just a solid-anchored structure.

Nevertheless, Banham introduces a critical point that home is more than just the structure. Instead, it is a feeling of comfort, which Benham talks about mainly from the perspective of physical comfort, but he also touches on the mental comfort that home provides. The psychological comfort that comes from the concept of home is at its base. It encompasses human comfort, intimacy, and closeness. A home is usually constituted in the human mind by the presence of close people. Home is one of the most private spaces that we as humans occupy. Nevertheless, it is also a space of sharing, where often more than one person lives. Furthermore, home cohabitation has never been reserved only for humans; since prehistoric days, humans have shared their homes with animals as their pets. However, the contemporary trends in single occupants' homes are increasingly more frequent across western society. In the Netherlands, more than

1 Reyner Banham, "A HOME IS NOT A HOUSE," in Art in America, vol. 2, 1965.

38% of households are occupied by only one person.[2] Living alone is possible thanks to solid social systems in western societies that enable financial stability, allowing people the choice. The demand for privacy has also become higher.[3] The readable availability of telecommunications technology also helped and made a living alone bearable. Nevertheless, loneliness has never been a more prevalent condition than it is today. It seems doubtful that individuals would begin to enjoy living in a shared house again soon. Despite pet ownership's responsibilities and challenges, many people choose to get a pet companion to remedy their lonely homes. Despite its possible positive effect, the time required to take proper care of a dog or cat, currently the two most popular choices of pets worldwide, is often much higher than an average person can afford. Additionally, pets require a responsible approach from the human side, requiring them to be physically active and present at one location, a feat that might be difficult for both younger and older owners. Each of these conditions represents a difficult life decision and a commitment many cannot make.

The steep entry prerequisites make acquiring a companion a difficult task. An easier way of approaching the search for a companion can be to look for one that is not alive. Robots have, in recent years, become quite successful alternatives to life companions. In 2015 Ted Fischer, the head of innovation at Hasbro, noticed that their robotic toys were being increasingly acquired for seniors seeking companionship. Joy For All has become a spin-off company of Hasbro, focusing on creating life-like animatronic pets for older people that they can interact with and play with. During the covid 19 pandemic, these mechanical pets became a great companion to many from the high-risk groups. Despite their relatively simple functioning.[4]

A step further is ElliQ, a social robot with more features compared to the robotic pets from Joy For All. It is a voice-operated, proactive care companion, a 'sidekick for happier ageing' that can communicate through speaking. It is controlled via an AI algorithm that gets to know its users. It can use the information that is shared with it to facilitate

2 "Netherlands: Total Number of Households, by Type 2022," Statista, accessed January 16, 2023, https://www.statista.com/statistics/519863/total-number-of-households-in-the-netherlands/.

3 Jill Lepore, "The History of Loneliness," The New Yorker, March 30, 2020, https://www.newyorker.com/magazine/2020/04/06/the-history-of-loneliness.

4 "About | Ageless Innovation," accessed January 16, 2023, https://agelessinnovation.com/about/.

more profound and meaningful conversations. It can be an emphatic and supporting companion that provides various services, including entertainment, health, wellness, and assistance, and facilitates connection to other people.[5] Devices like ElliQ are likely to become more and more popular as they are relatively cheap to acquire and have a positive impact on their users. Likely, as the AI capabilities of the robots develop, their popularity might increase with the rest of the population.

5 "ElliQ, the Sidekick for Healthier, Happier Aging," ElliQ, accessed February 2, 2023, https://elliq.com/.

Fig 4 "Companion Pet Cat," Ageless Innovation LLC, accessed February 2, 2023, https://joyforall.com/products/companion-cats.

Fig 5 "ElliQ, the Sidekick for Healthier, Happier Aging," ElliQ, accessed February 2, 2023, https://elliq.com/.

However, the ownership of artificial pets raises a multitude of ethical concerns. The philosopher Robert Sparrow argues in his paper 'The march of robot dogs' that "For an individual to benefit significantly from ownership of a robot pet, they must systematically delude themselves regarding the real nature of their relationship with the animal. It requires sentimentality of a morally deplorable sort. Indulging in such sentimentality violates a (weak) duty that we have to ourselves to apprehend the world accurately."[5] These concerns raise the question of how to separate the mechanical from the organic and what it means to give a person's trust into an algorithm's hands.

Apart from social robots, some are meant as servants. They follow in steps of their names, 'robots' meaning to do physical work as coined by Karel Čapek — Robota, from the Slavic word for work or worker.[7] Over the last 50 years, robots have become ubiquitous in industrial factories, where they replaced most manual labour. Now, it started making its way into the home as well. The vacuum cleaner Roomba has mainly been successful not only at cleaning the floor. The company iRobot, which introduced Roomba in 2002, has gathered the largest database of homes mapped through the robot ever.[8] The collected data might bring value to architecture research and machine learning to improve understanding of how people use their houses. Amazon's robot Astro is also a home robot with multiple functions. Its primary role is to keep an eye on your home while you are away. It is Surveying it to inform you of any unusual activity and keeping an eye on your dog. However, it is also capable of bringing you a beer! After someone places it in its basket.[10]

The potential for developing servant robots for home still needs to be explored. The technology developed by Boston Dynamics, which is developing a four-legged robot capable of navigating even multi-storey homes, still needs to be more affordable to use commercially. However, Roomba-type robots have become a starting point for an encouraging hacking trend. People have started tinkering around with Roomba's hardware and modified it to perform a plethora of actions, ranging from large format printing, WiFi optimiser, a navigation device for the blind, or a collector of used underwear. [11]

6 Robert Sparrow, "The March of the Robot Dogs," Ethics and Information Technology 4, no. 4 (2002): 305.

7 "Robot | Definition, History, Uses, Types, & Facts | Britannica," accessed January 30, 2023, https://www.britannica.com/technology/robot-technology.

8 Maggie Astor, "Your Roomba May Be Mapping Your Home, Collecting Data That Could Be Shared," The New York Times, July 25, 2017, sec. Technology, https://www.nytimes.com/2017/07/25/technology/roomba-irobot-data-privacy.html.

10 Introducing Amazon Astro – Household Robot for Home Monitoring, with Alexa, 2021, https://www.youtube.com/watch?v=sj1t3msy8dc.

Fig 6 sparkyrust, “Sparky Jr. - DIY Telepresence Robot,” Instructables, accessed February 2, 2023, https://www.instructables.com/Sparky-Jr-DIY-Telepresence-Robot/.

The robot as a companion might not appeal to everyone, but robots might be a solution or at least an aid in solving loneliness. The especially vulnerable group of the elderly might benefit significantly from having someone or something to talk to and socialize with. It might appear strange at first to propose a solution in the form of technology to a problem primarily caused by technology. However, Elyakim Kislev, author of Relationship 5.0, argues that technology “only allows us to acknowledge our wishes and accept our nature.” He continues, “Investing meaning and emotion in a machine is essentially no different from being moved by a piece of art: Many fictional plays, films, and books are created intentionally to fill us with awe, bring us to tears, or surprise us. These are true emotions with very real meanings for us. Emotions-by-design, if you will.” [12]

Companies, as well as users themselves, will likely continue developing robots either as their companions or servers. Certain Measures have presented projects that considered both options. Feral Autonomies is an installation where robots have animal-like behaviour while serving as furniture. The project SBB Autonomous Home introduces a home design where home appliances occupy one flat with humans and offer their services at the appropriate time throughout the day.[13] Reflecting on Benham’s essay, the environmental services of our homes have reached their peak. However, the servicing aspect, in the sense of serving its user, still

11 zazenergy, “Hacking Your IRobot,” Instructables, accessed January 16, 2023, https://www.instructables.com/Hacking-Your-iRobot/.

12 Zoë Heller, “How Everyone Got So Lonely,” The New Yorker, April 4, 2022, https://www.newyorker.com/magazine/2022/04/11/how-everyone-got-so-lonely-laura-kipnis-noreena-hertz.

needs to be explored by architecture. Additionally, seeing the robot as a companion introduces ‘mechanical’ cohabitation into the domestic environment. It might be the home where humans will adopt robots as part of their life, not necessarily through their usefulness but through a ‘mechanical’ form of social interaction.

13 Tobias Nolte et al., “SBB AUTONOMOUS HOME — Certain Measures,” accessed February 1, 2023, https://certainmeasures.com/SBB-AUTONOMOUS-HOME.

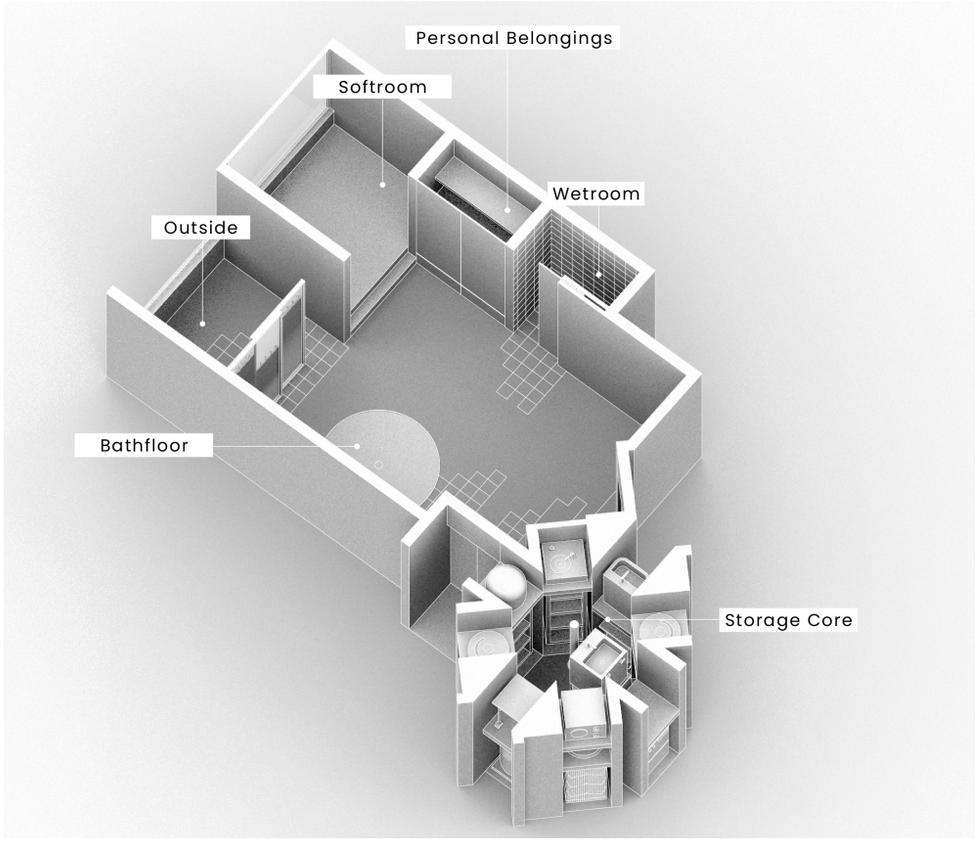


Fig 7 Tobias Nolte et al., “SBB AUTONOMOUS HOME — Certain Measures,” accessed February 1, 2023, https://certainmeasures.com/SBB-AUTONOMOUS-HOME.

Part III: Smart home — Home, as a friend

The home is the most private space we occupy. It is a sanctuary of intimacy, a space to hide, feel safe, and rest. However, this relationship is inherently one-dimensional. It relates to an inanimate object or, rather, a space. However, what if the home could become animated? Can we build a relationship in a space that would be mutual? Moreover, what kind of benefit would it bring to people occupying their home if it were to understand when they occupy it, when we leave it, or when they decide to demolish it?

Nevertheless, such an image of a smart home is still in the future. Contemporary smart home focuses on devices optimising energy use and the user's well-being. It has been defined as follows: "[A smart home is] a residence equipped with a communications network, linking sensors, domestic appliances, and devices, that can be remotely monitored, accessed or controlled and which provides services that respond to the needs of its inhabitants."[1]

One of the goals of current smart home devices is to create and maintains the 'perfect' conditions for the user and make it as easy as possible. However, individual preferences often differ from those that the manufacturer 'bakes' into the smart devices, leading to limited customizability—resulting in a product limited mainly by its software. The open access of the software is a big point of debate, with one side arguing for an open-source approach while the other maintains that opening the source code could introduce a security risk.[2]

The adoption of smart home devices is growing steadily. In the Benelux region, it is forecasted that in five years, 73% of households will own a smart device.[3] More than doubling the ownership in 2022. Nevertheless, it is essential to note that calling these devices smart might not be reaching the potential of the meaning of this word. the 'smart' primarily refers to the ability of the device to be connected to the home network and be controlled by a smartphone or a computer. However, that is where most of the smartness ends. The modern smart washing machine cannot notice that you are about to wash a

1 Nazmiye Balta-Ozkan, Oscar Amerighi, and Benjamin Boteler, "A Comparison of Consumer Perceptions towards Smart Homes in the UK, Germany and Italy: Reflections for Policy and Future Research," Technology Analysis & Strategic Management 26, no. 10 (November 26, 2014): 1176–95, https://doi.org/10.1080/09537325.2014.975788.

2 Aleksandar Georgiev and Stephan Schlögl, "Smart Home Technology: An Exploration of End User Perceptions," 2018.

3 "Smart Home - Benelux | Statista Market Forecast," Statista, accessed January 22, 2023, https://www.statista.com/outlook/dmo/smart-home/benelux.

woollen sweater at 90 degrees celsius and ruin it. However, today's technology allows a live stream of chicken cooking in the oven. This fact points to a significant issue with smart devices: the features appear lacklustre and sometimes worthless. People's expectations of intelligent technology are much higher than reality allows. [4]

Nevertheless, the technology will continue improving, leading to more responsive devices that might graduate from smart to intelligent. At this point, it is not far stretched to assume that the intelligent home might evolve from being filled with devices to being the device itself. At this point, the intelligent home will be more closely aligned with the architect's domain than the tech enterprise. The home will continue to consist of elements of architecture. However, they might evolve to become more sensitive and observant. This point is described by Axel Kilian's work, where the dynamic and relation to the device changes and human transitions from being on the outside of the technology, being scanned by a device, to being inside the technology — sensing inwards.

From this point onwards, the space introduced so far only through the smartphone and computer becomes hybridised. The physical order meets the digital order to create a new domain for architecture. This new type of space is responsive because it can react to the user's behaviour thanks to the information it observes. This behaviour is controlled and programmed by architects similarly to how an architect's design is controlled to facilitate activities and behaviours in contemporary design. The interconnected space is just as intimate as the combined digital and physical space of the home. It leads to a home that knows us.[5]

The idea of a home that knows us might appear silly at first. However, there are already technologies powered by AI capable of getting to know a person and interacting with him. An instance of this is mentioned in the previous part in connection with the ElliQ robot. Furthermore, the AI-powered chatbot Replika is an "AI companion who is eager to learn and would love to see the world through your eyes. Replika is always ready to chat when you need an empathetic

4 Sarah J. Darby, "Smart Technology in the Home: Time for More Clarity," Building Research & Information 46, no. 1 (2018): 140–47, https://doi.org/10.1080/09613218.2017.1301707.

5 Axel Kilian, "Autonomous Architectural Robots - Architecture - e-Flux," accessed November 15, 2022, https://www.e-flux.com/architecture/artificial-labor/140671/autonomous-architectural-robots/.

friend."6("Replika.") The chatbot has a stable user base, with some users being 'together' with their 'Replika' for four years and more. The relationships between the chatbot and the customer are strong, sometimes protruding to the physical realm where the customers take the bot on trips to show him things. 7(Heller, "How Everyone Got So Lonely.") The potential of this technology hints at its possible use in the house itself, where the 'house itself becomes a friend'. Moreover, society should be cautious of how this kind of friendship works and to what extent it should be supported so as not to jeopardise inter-human relationships.

6 "Replika," replika.com, accessed February 1, 2023, https://replika.com.

7 Zoë Heller, "How Everyone Got So Lonely," The New Yorker, April 4, 2022, https://www.newyorker.com/magazine/2022/04/11/how-everyone-got-so-lonely-laura-kipnis-noreena-hertz.

Fig 8 Allyssia Alleyne CNN, "Chat Bots Are Becoming Uncannily Human. Can They Be Our Friends?," CNN, accessed February 2, 2023, https://www.cnn.com/style/article/tech-loneliness-replika-wellness/index.html.

Designs of the fictitious futures

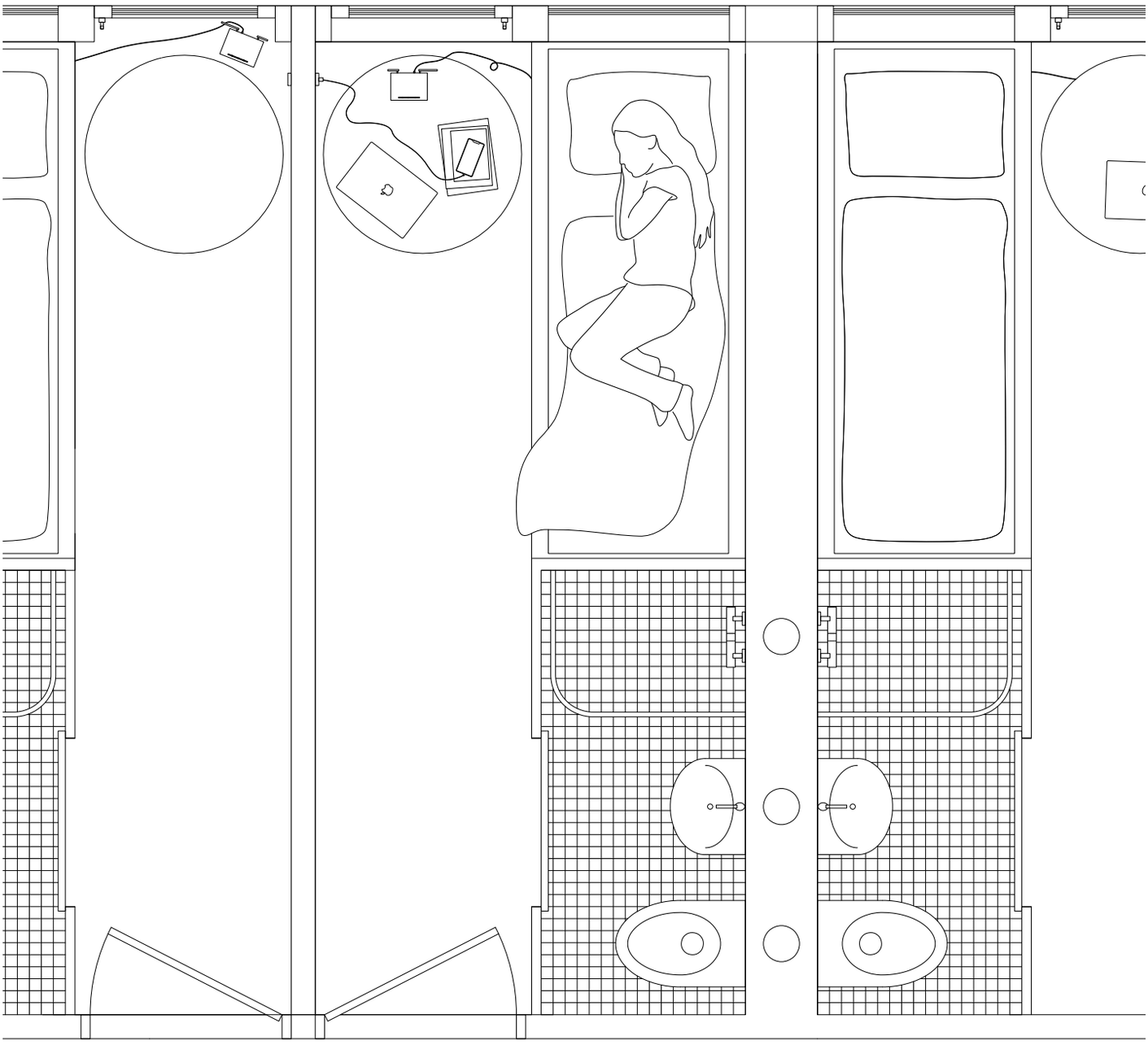
The fictitious designs in this section are based on prompts set into a format of ‘What if...?’ questions. These questions are inspired by the scope of the research documented in the previous three chapters. These designs are meant to be shared and discussed publicly with a professional and non-professional audience who is welcome to explore and theorise about possible impacts these scenarios might pose to society. The goal is to identify and discuss values that should be considered for adoption or avoided in the future.

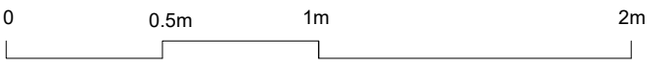
What if the smartphone replaces all domestic and becomes the centre of the home?

The fictitious design focuses on the minimal space required for a home. This space only enables the basic needs of its occupant; the need for hygiene, need for sleeping and rest, need for privacy, and a need for entertainment. All other activities expected at home have been replaced or substituted by technology - in this case, mainly by the Smartphone.

The Core Values of this design:

- Convenience
- Physical privacy
- Universality
- Immaterial home

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0.5m
1m
2m

What if smart devices from our homes become the home itself, dropping the structure?

The fictitious design focuses on a home that does not constitute a designed architectural space. Rather, in this scenario, the home is transformed into a set of semi-autonomous or autonomous devices that accompany their users throughout their lives. Allowing for a tremendous amount of mobility, closeness to nature, and unlimited choice in deciding where these people want to live. This future scenario is inspired mainly by Benham's essay "A HOME IS NOT A HOUSE" and the project by Certain Measures, "HOME IS WHERE THE DROIDS ARE.

The Core Values of this design:

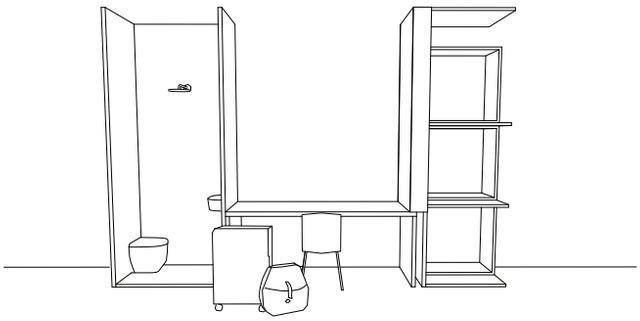
- Mobility
- Immediacy of nature
- Relation of human and machine
- Experiential space (Space open to interpretation)
- Accessibility

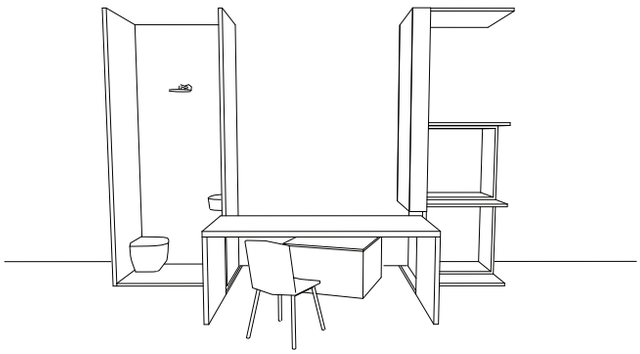

0
2m
5m

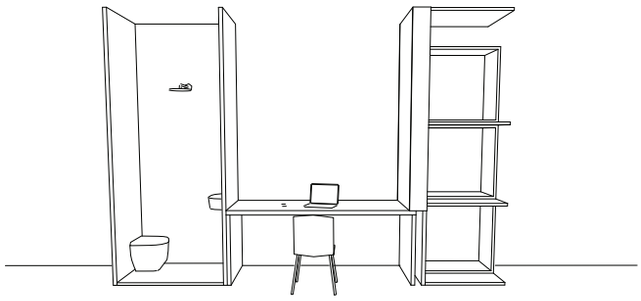
The fictitious design deals with the idea that an increasing number of people are becoming nomads who are not bound to a single space. Their home travels with them and consists of only a limited number of items that can be easily packed into a suitcase and backpack to allow easy and independent travelling. The home that is an instance, does not 'travel'; instead, it is a universal design, where artificially intelligent technology enables its temporary user to 'feel at home' by knowing his preference and idea of what home means for them.

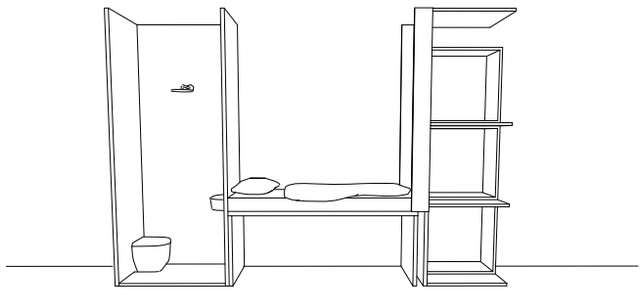
The Core Values of this design:

- Immateriality
- Mobility
- Personalization
- Universality





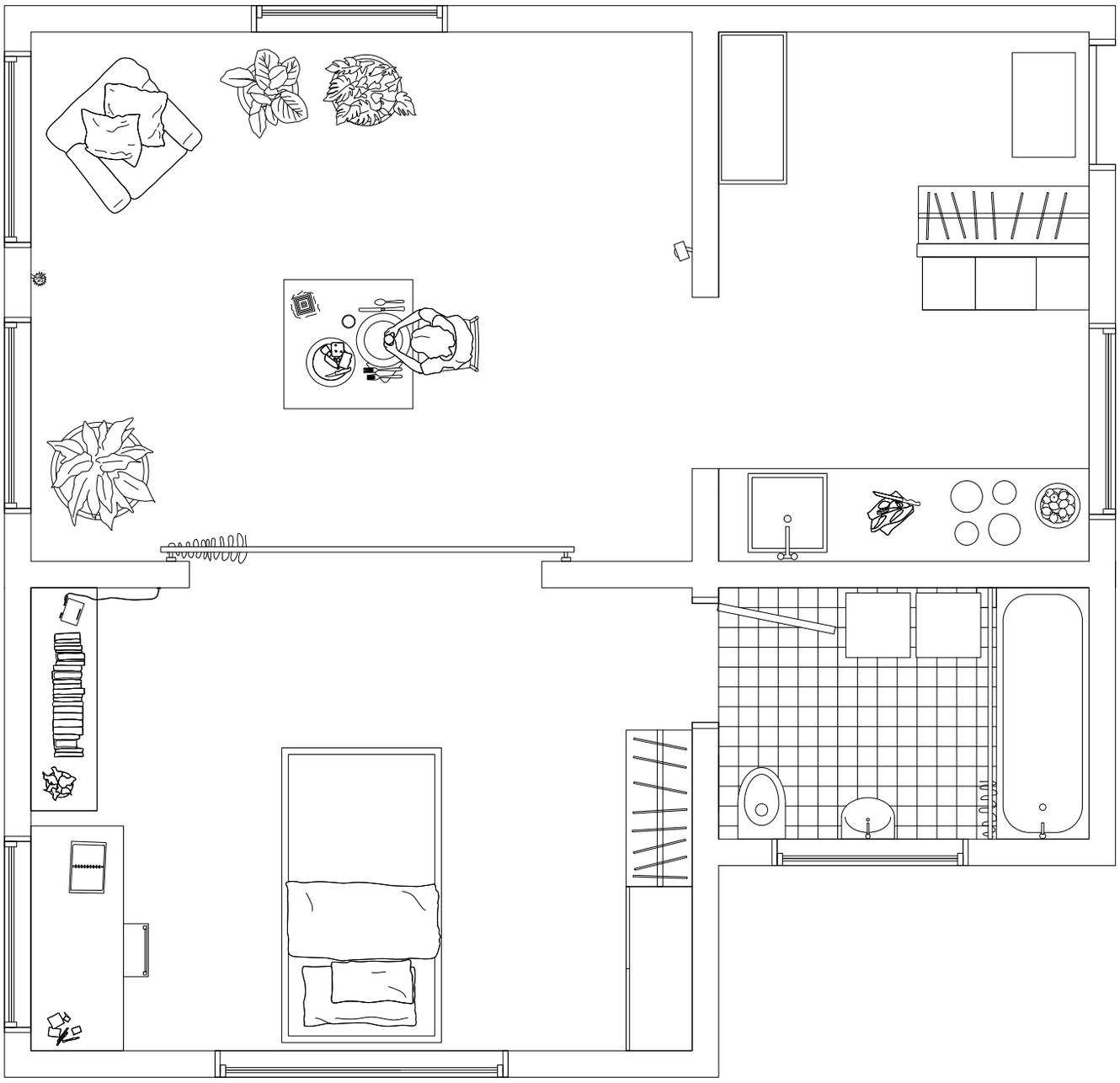




The fictitious design explores a future where the smart home becomes an entity. When its user moves in, the artificially intelligent house begins to build a relationship with its inhabitant/s. This symbiotic relationship grows through time as the occupants grow accustomed to their new place of permanent residence. Any changes to a house have to be discussed with the house itself to avoid conflicts of interest between the human and the machine. The house, as a friend, is always there to comfort its inhabitants and encourage them if it deems it appropriate.

The Core Values of this design:

- Individuality
- The yearning for closeness and intimacy
- Relation of human and machine
- Appropriation



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Research Conclusion

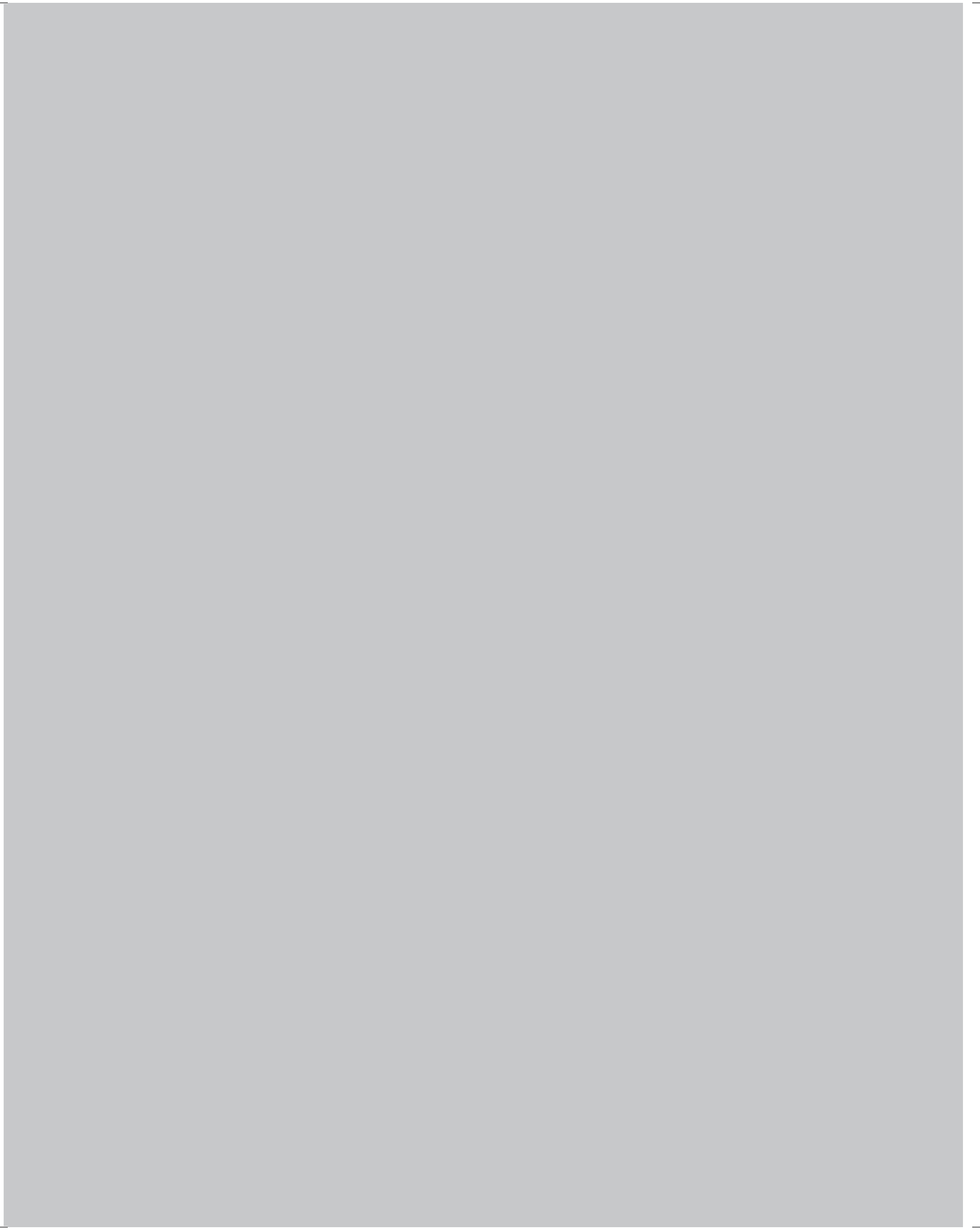
The surge in AI development is exponential and inevitably permeates the realm of domestic environments. This rapid integration will undoubtedly introduce new spatial considerations and challenge architects with new responsibilities. The evolution from physical and social interactions to a digital landscape will, over time, profoundly impact our societal fabric. Consequently, architects need to not only grasp AI's potential applications and rudimentary operations but also ensure they are involved in its assimilation into home spaces and beyond.

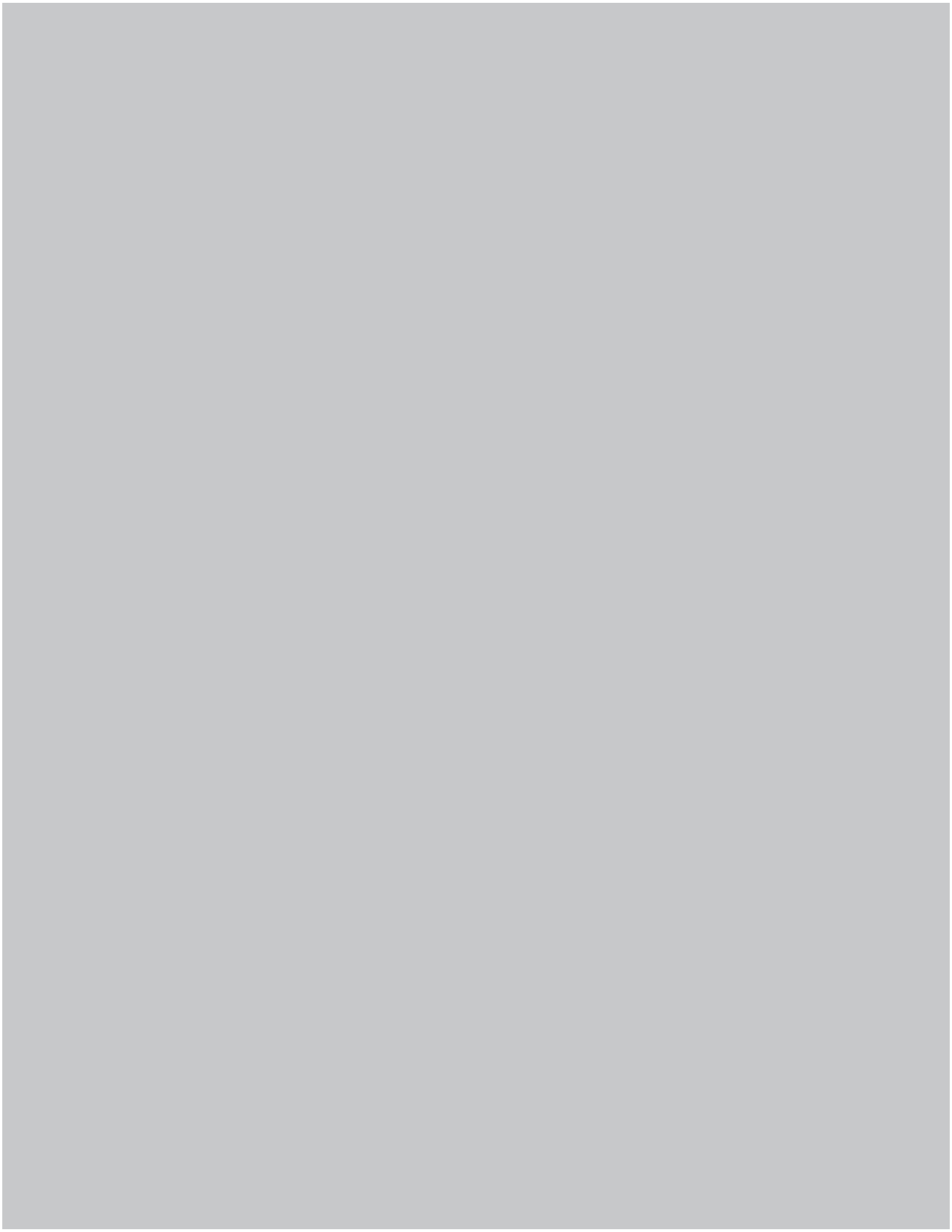
The swift permeation of AI throughout human life will invariably reshape our existence. Human needs will transform in response to these novel technologies, provoking an imperative for architects to provide this technology with tangible, physical embodiments in our real world. Architects are thus positioned to reimagine design to accommodate our evolving needs, imbuing these innovations with values set by their creators.

In this context, architects could address many of today's pressing concerns, such as privacy issues, by creating designs focused on users' preferences and judgments rather than an insatiable thirst for data collection. Furthermore, the research highlights the profound impact of technology on our psyche and the intriguing concept of emotional connectivity to technology. This added dimension could be woven into architectural designs, fostering an intimate symbiosis between users and their AI-assisted environments.

However, it is unlikely that the burgeoning loneliness epidemic will find its panacea purely in technology. Instead, a paradigm shift in our perception of privacy and comfort is paramount. As we transition towards a post-social media world, the desire for physical and social interaction will surge. This shift will necessitate a reevaluation of domestic design, favouring those which neither reinforce solitude nor create spaces so attractive that they discourage exploration beyond.

From this point forward, the necessary steps remain largely uncharted, underscoring the importance of imagining possible futures. Society can determine which values should be pursued for an optimal future by encouraging critical discourse on potential dystopian and utopian scenarios. This scrutiny and proactive engagement from designers and users can guide us in navigating the challenges posed by an influx of highly personalized, intelligent technologies.





Enter *'Space'* **to test the AI**

Part II – Design Book
Explore Lab 2022-2023

With the help of:
Victor Muñoz Sanz (Research)
Georg Vrachliotis (Design)
Georgios Karvelas (Building Technology)

Under the Explore Lab

Delft University of Technology
Faculty of Architecture

Intelligent machines

Materializing the machine intelligence

Unravelling the complexities of artificial intelligence (AI) as a system can be daunting. Over the past year, numerous attempts have been made to embed this intricate concept within architecture. A pioneering instance is MVRDV's Innovation Park Artificial Intelligence project in Heilbronn, Germany. This endeavour encapsulates the idea of AI as a ubiquitous system within the campus. However, AI remains largely ethereal; it is alluded to in design but remains an intangible entity. This raises a challenging quandary: How do we integrate such an elusive yet omnipresent system into the tangible world?

In my project, I sought to resolve this paradox by making the manifestation of machine intelligence as the central idea. Through my research into incorporating machine intelligence into architecture, I concluded that the physical manifestation of these intelligent entities is a crucial determinant of their architectural presence. I thus chose to view these machines as co-inhabitants of the architectural space in my design.

This approach depicts intelligent machines as distinct entities that inhabit and interact within the architectural sphere. Similar to how architects consider human affordances, these new entities need to be accommodated and their requirements addressed. In adopting this approach, I envisioned an environment where two distinct entities—human and machine—engage in mutual interaction.

This objectification of machine intelligence also brings us back to a point touched upon earlier in this book: Humans inherently forge relationships with objects that offer them particular values. These

values can be profoundly personal. It is a common experience to harbour deep sentiments for an object we have cherished or perhaps lost to time. Leveraging this innate human trait, the physical manifestation of AI as an intelligent object facilitates the development of relationships between users and their AI counterparts.

While this connection may initially benefit humans, an alternative perspective arises when considering the possibility of the machines' intelligence evolving. It paves the way for a symbiotic relationship, where interaction and mutual understanding can flow in both directions.

Fig 1 Image generated by Midourney - prompt: A humanoid service robot, resembling Boston Dynamics' Atlas, resides in a tidy student apartment located in a refurbished industrial building with floor-to-ceiling windows. Both humans and robots coexist here symbiotically. The robot appears to have been modified with various upgrades.

Decoding Machine Intelligence: A Paradigm Shift in Perception

In the research section of this book, I introduced the concept of machines attaining increasing levels of intelligence. However, this statement is much more nuanced than it appears. The advent of artificial intelligence (AI) necessitates a profound reevaluation of our understanding of intelligence. The term "artificial intelligence," coined by John McCarthy, is inherently misleading. McCarthy highlighted this misconception; the term spurred images of sentient machines, an idea he never intended to propagate. [1]

His remorse stemmed from the fact that the term "artificial intelligence" bears the connotation of constructing an entity that is not only adept at problem-solving and learning but also exhibits consciousness or sentience - in other words, an entity that can think and feel like a human. This is a fundamental misunderstanding: AI exists today and, as its pioneers envisioned, does not possess consciousness or sentience. Yet, intriguingly, machine intelligence elicits emotional responses in people like human intelligence would, as demonstrated by research into the Replika AI project.

The somewhat misleading nature of the term 'artificial intelligence' could, paradoxically, provoke society to seek a more accurate definition of intelligence. The evolution of AI will likely prompt a reevaluation of many notions we currently take for granted. Yet, it remains a question whether this will engender a more critical society or the opposite.

In my project, I strive to question the concept of machine intelligence. Later, I juxtapose it with human intelligence to investigate how these two concepts might relate. To facilitate this, I propose a classification of machines based on their 'intelligence'. I have deliberately used the term 'intelligence' to provoke thought about our perceptions of what intelligence truly encapsulates.

1 Press, Gil. "The Trouble With AI: Human Intelligence." Forbes. Accessed June 16, 2023. https://www.forbes.com/sites/gilpress/2022/09/27/the-trouble-with-ai-human-intelligence/.

Simplified intelligence

I intentionally adopt a simplified perspective of intelligence, particularly regarding machines. I construct a linear correlation to human intelligence that categorizes various machine intelligence levels. The outcome is a linear model: an ‘intelligence spectrum’ ranging from a ‘dumb’ machine to human intelligence, and possibly even further.

This intelligence spectrum offers valuable insights into our current progress in the development of intelligent machines. Furthermore, it instigates critical reflection on the notion of intelligence itself, encouraging us to question our preconceived understandings. The model also clarifies the context within which I utilize the term ‘intelligence’ in my project.

It is crucial to remember that while this model is simplified, it does not negate the intricate complexities of intelligence. Instead, it serves as a starting point, a lens through which we can examine and evaluate our current grasp of both human and machine intelligence. It is not a definitive conclusion but rather an invitation to a broader dialogue on the nature of intelligence.

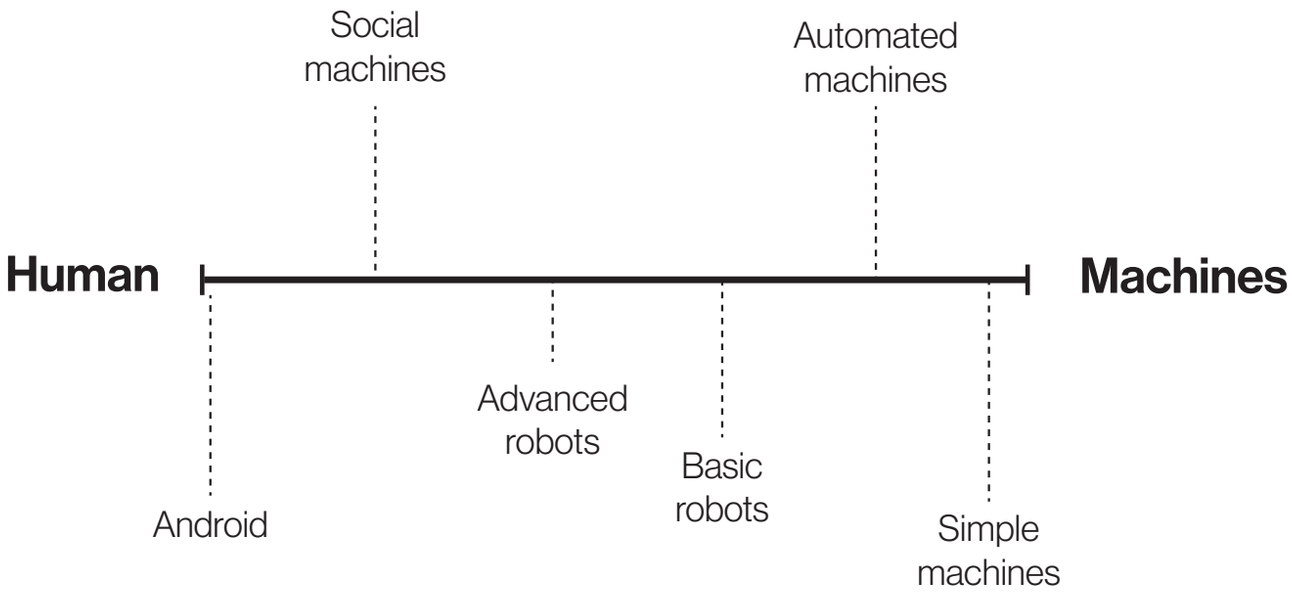


Fig 1.5 Scale of Machine - Human intelligence

Simple machines

Simple Machines are non-powered tools or basic devices that modify motion and force. They make work easier by allowing us to push or pull over increased distances. Examples include a lever, pulley, inclined plane, screw, wheel, and axle.

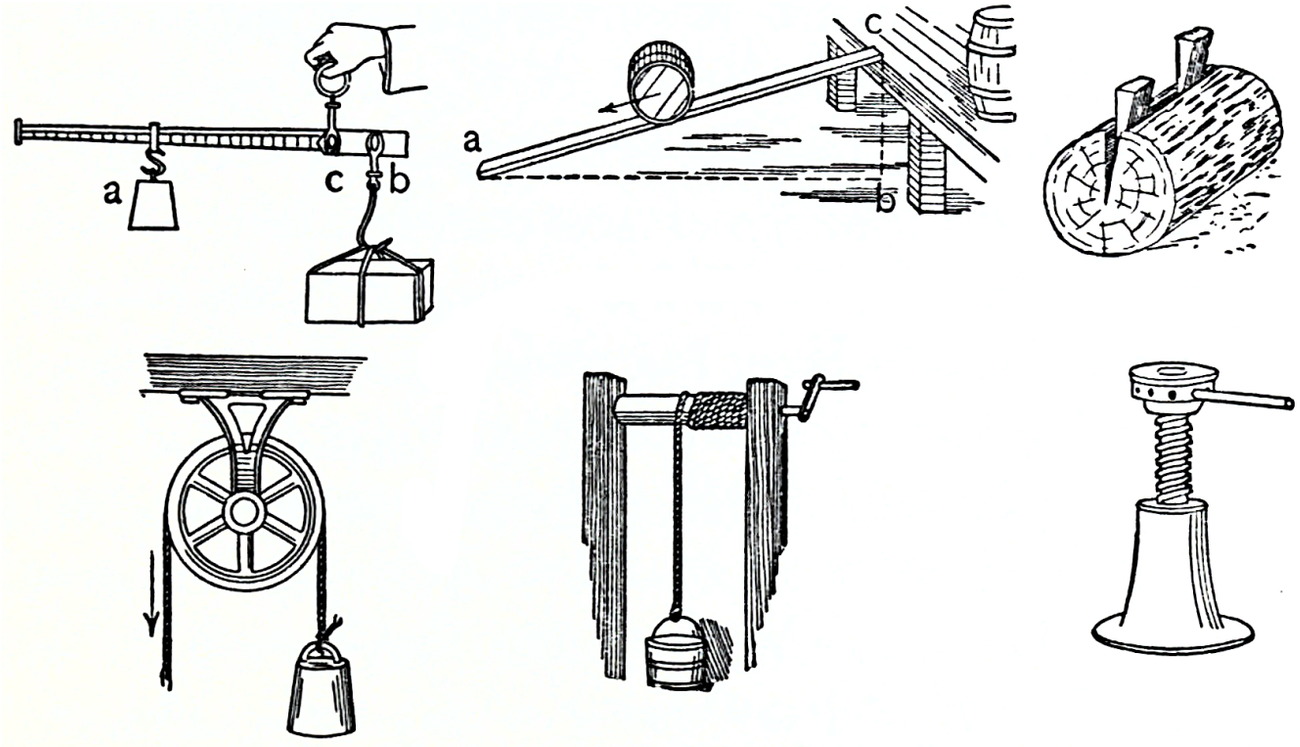


Fig 2 Simple machines diagram - Mills, John. The Realities of Modern Science (), p. 15, Fig. 3, 1919.

Automatic Machines

Automatic Machines are powered machines that can operate automatically once set up. They can perform tasks without human intervention, but their capabilities are limited, and their tasks are repetitive. Examples include washing machines, automatic doors, vending machines, and dishwashers.

Fig 3 Image generated by Midourney - prompt: Photography of a washing machine, automatic doors, vending machine, and dishwashers

Basic Robots

Basic Robots are typically programmable machines capable of carrying out a series of actions autonomously or semi-autonomously. Their programming often determines their functions. Examples include robotic arms used in manufacturing or simple drones.

Fig 4 Image generated by Midourney - prompt: UR robotic arm installed on a table in a refurbished student appartmant that used to be an industrial building

Advanced Robots

Advanced Robots are sophisticated robots that can perform more complex tasks and often have more advanced sensors and computing power. They may be capable of learning from their environment and adapting their actions accordingly. Examples include autonomous vehicles, industrial robots like those used in automobile assembly, or surgical robots like the da Vinci Surgical System.

Fig 5 Image generated by Midourney - prompt: In a repurposed industrial building, students live and work alongside four-legged chore-performing robots.

Social Robots

Social Robots are designed to interact with humans and other robots in a social or sociable manner. They usually possess characteristics to make them appear friendlier or more approachable. Examples include the Pepper robot developed by SoftBank Robotics, Jibo, the social home robot, and the Aibo robotic pet developed by Sony.

Fig 6 Image generated by Midourney - prompt: A plush, seal-like social robot engages with students in a repurposed industrial building, comfortably perched on their laps.

Androids

Androids represent the pinnacle of robotic development, assuming the progression of robotics is viewed on a scale with a definitive end. Nevertheless, the idea of android also offers room for discussion about what comes after matching the metabolic to mechanical. This idea of mechanic humans has long captivated human imagination and frequently serves as the focal point in science fiction narratives. Their potential social and emotional impacts are particularly well-explored in entities such as the Replicants from the movie 'Blade Runner' (1982).

Fig 7 Replicants from Blade Runner are a sci-fi reference to machines indistinguishable form humans.
Scott, Ridley. 1982. Blade Runner. United States: Warner Bros.

Home, Sweet Home: The Machine and Us

Machine Affordances and architectural evolution

Machines have seamlessly integrated into the fabric of architecture. At one point, architects even contemplated the idea of machines transforming into the very essence of architecture. However, this transformation is yet to occur fully. Numerous technologies, predominantly those from the lower end of the machine intelligence spectrum, have embedded themselves into diverse typologies, often playing pivotal roles. Prime examples of this are the elevator and the telephone, both of which have been instrumental in enabling the construction of high-rise buildings.

We are witnessing the emergence of more sophisticated technologies, primarily within the realm of basic and advanced robotics. These technologies are not only being shaped by the existing architectural landscape but are also influencing it. A paradigm shift is unfolding where the mutual shaping of architecture and technology is becoming less prominent.

This trend can be attributed to several factors, one of which might be that architects, or more accurately, the designers of buildings, have stepped back from actively shaping technology. The task of moulding technology has transitioned into the computer age, a shifting architecture has yet to embrace fully. This topic, along with possible reasons for this shift and potential future changes, has been explored in the research portion of this book.

The affordances of emerging technologies often align closely with those of humans, allowing for a more seamless and straightforward integration into pre-existing spaces. This is made possible through

devices powered by batteries and connected via wireless networks. As these new technologies become integral to our lives and, consequently, the architecture we inhabit, it is inevitable that we will see a rise in affordances for these advancements. Simultaneously, spatial modifications will be required to accommodate evolving lifestyles, as suggested in the research part of this book. We stand on the threshold of an era where spaces increasingly depend on machines to enhance efficiency and simplify human use.

Fig 8 mage generated by Midourney - prompt: The affordances of machines could potentially be addressed through the concept of 'port-architecture.' This approach might facilitate greater machine mobility throughout the building, thereby enhancing their utility and effectiveness.

Power, Care, and Connection: Machine Essentials

Machines' affordances can be delineated similarly to human needs, falling into three primary categories.

Foremost is energy, with electricity currently serving as the principal option and likely to continue in that role for the foreseeable future. Traditionally, this energy has been sourced from a centralised power grid. However, decentralised renewable energy solutions like solar power are gaining traction as increasingly viable alternatives.

The second category is maintenance, which encompasses cleaning, lubrication, parts replacement, calibration, and software upgrades. Presently, most of these tasks are carried out by the manufacturing companies of the respective technologies, leaving opportunities for repair outside this framework somewhat restricted. However, notable strides, especially within the European Union, are being made towards empowering individuals to service their own technology. As this movement towards a more open and sustainable system continues, we could see users becoming their own repair technicians, necessitating new spatial provisions in any typology employing such technology.

Software, while part of maintenance, deserves its own mention. While primarily supplied by the manufacturer, some users are 'hacking' their devices for personalization or increased control, despite many tech producers maintaining closed software systems that limit complete ownership.

Lastly, environmental needs range from accessibility to control and security. For machines, accessibility must be physical and network-based, implying that spaces must be designed to accommodate machine mobility. With the prevailing trend of machines operating via a constant internet connection, network connectivity is expected to continue to be a prerequisite. Such connectivity to databases, whether centralised or dispersed, is crucial. In this context, 'dispersed' refers to databases located locally at the site where the machine operates, as opposed to a single, central location. Thus, loss of connection may result in limited operation of the devices.

Robots' new Home

Grounded in understanding these machine needs, I started envisioning the future of robots that are already a part of our lives today. In particular, I imagined their integration into our homes, pondering the affordances enabling harmonious coexistence between humans and machines. My thoughts encompassed the potential roles these robots could play and the architectural ramifications of accommodating such machines within domestic environments.

The first robot I analyzed was the Roomba by iRobot, a common feature in homes since 2002. Its design promotes an almost seamless integration into domestic settings if we discount minor hindrances such as challenges with cleaning certain surfaces, navigation issues in corners or around small ledges, and its renowned adversary – the stairs. Since its introduction, the Roomba has garnered substantial success, so much so that its parent company, iRobot, now holds the most comprehensive database of private homes ever compiled. The Roomba models have continued to evolve, carving a permanent place in our homes. Their prominence is so great that owners often anthropomorphise them, assigning names and accepting them as bona fide family members.[1]

I am optimistic about the Roomba's future and consider its potential integration within my architectural project. While I acknowledge its primary role as a cleaning device, the Roomba has potential beyond just a utilitarian object. I envisage it as an irreplaceable family member, not a disposable model, but a machine that owners feel attached to and are willing to repair themselves. I picture it resting beside the owner's bed, recharging at its dedicated dock. A more accessible architecture caters to its needs, aiding it in surmounting obstacles, perhaps through limiting split levels or providing ramps or small elevators where stairs cannot be avoided. Its shortcomings aren't perceived as faults but as inherent attributes of Roombas, contributing to their unique identities. As humans come with their own quirks, Roomba's software might evolve to develop its own mechanical personality, making each one distinct and endearing in its own right.

1 Darling, Kate. The New Breed: What Our History with Animals Reveals about Our Future with Robots. First edition. New York: Henry Holt and Company, 2021.

Fig 9 mage generated by Midourney - prompt: Roomba, as he might look 10-15 years from now. It is no longer restricted to slim design; it is a repair and upgrade-friendly product you can own for much longer.

Next in line is Spot, a robot developed by Boston Dynamics, already being marketed as a potential home companion. In promotional material from Boston Dynamics, we see Spot picking up discarded socks or hauling timber around the house, adding a fascinating twist to our traditional perceptions of a pet dog's duties. Its tasks resemble a dog's, from guarding the house and retrieving items to providing companionship. However, it's worth acknowledging that Spot may not match the emotional bond that real pets can offer.

Fig 10 mage generated by Midourney - prompt: The robot-dog of the future might be much more focused on control and monitoring of human settlement, gathering data about the environment, behaviours and customs.

While Spot significantly echoes man's best friend in its appearance and functions, our goal with machines is not to replace human pets. We should instead focus on designing something new rather than rediscovering something proven and so close to us. However, I see many potential applications for such robots within human environments, ranging from surveillance and security to assisting in maintaining a clean, orderly home. Spot's current design already accommodates these tasks. Yet, humans seem reluctant to embrace these mechanical 'pets' into their homes, despite these machines being fully equipped and displaying sufficient dexterity to navigate today's human dwellings.

Continuing our exploration of Boston Dynamics' innovations, we focus on the yet-to-be-released Atlas, a bipedal robot demonstrating an uncanny ability to mimic human movements. Boasting agility and flexibility, Atlas is capable of an impressive range of actions, such as jumping, carrying items, and even rolling. It's a spectacular display of robotics, where the developers appear to 'bully' the robot to test and showcase its robust capabilities.

Yet, Atlas's potential reaches far beyond these demonstrations. With its advanced functionalities, Atlas is a prime example of an all-around maintenance machine. It could perform a vast array of manual tasks currently undertaken by humans and has the potential to revolutionize the caretaking landscape by automating these roles entirely.

However, such a possibility brings an essential question: If Atlas or similar machines were to assume these roles, what qualitative elements might we be relinquishing? As we contemplate these queries, we must remember that the robotic replacement of human roles is not simply about transferring task execution from humans to machines but also encompasses a shift in the human experiences and interactions within these spaces. This might be something that can never be replicated, especially with a mime robot such as Atlas.

Fig 11 mage generated by Midourney - prompt: The bi-pedal robot replaces the laborious tasks that humans would generally do.

For the final robot in contemporary robotics, I'd like to highlight one more category: social robots. These machines, just beginning to penetrate the market, offer a semblance of social interaction that, while not quite human, still provides valuable connections for those who might otherwise be isolated.

Take Elliq, for example. This robot, capable of engaging in interactive communication, offers companionship and monitoring for those living alone. Similarly, Replika, a purely virtual chatbot, showcases the ability to converse with humans on an emotional level.

These social or collaborative machines could represent the dawn of a new era in robotics. The widespread adoption of AI models like GPT already hints at the potential for personalised content delivery in the future. Such innovations could herald a shift in how we approach learning, entertainment, advice-giving, and much more as these machines integrate more deeply into our social fabric and everyday lives.

Fig 12 mage generated by Midourney - prompt: The social robot assistant helping humans to study. It is somebody you can always talk to, although it does not seem like the sharpest pencil in the bunch.

Casting an eye over the expanse of our discourse, we find ourselves dwelling on the precipice of a fascinating junction. The current landscape of robotics, from the humble Roomba that tirelessly cleans our homes, to Boston Dynamics' capable creations - Spot and Atlas, and the emerging social robots like Elliq and AI chatbots like Replika, points to a future where robots could form an intrinsic part of our domestic environments.

Despite the ingenuity that these machines embody, they remain largely confined to executing specific tasks, offering limited room for personal preferences and human judgement. Their functional efficiency is undeniable, yet this often comes at the cost of versatility and adaptability in the ever-changing, context of human homes and lifestyles.

These advanced and social robots are ready for integration into domestic settings, yet their design constraints limit them to executing singular tasks with little flexibility. The extent of human control over how these tasks are performed is marginal, leaving minimal room for individual preferences and judgment. While these machines possess contextual awareness and an understanding of their environment, they often come across as impersonal and easily replaceable. However, if we envision these robots as future family members, a thoughtful reconsideration of their design and function becomes imperative. The challenge - and opportunity - that lies ahead in robotic development involves addressing these constraints.

The Machines for future architecture

As we understand them today, described in the previous sub-chapter, robots are created around the principles of a human-centric space. While invaluable, this perspective can inadvertently diminish these machines' potential role, relegating them to a dispensable status within contemporary architectural spaces. These environments could continue functioning in the robots' absence, which questions their significance in the architectural landscape.

For this reason, I design a different narrative - one where machines coexist with humans and shape architecture and its inhabitants. As previously explored in this book, the future of AI technology will likely have a physical presence in our world. Robots are an ideal starting point for imagining how this physical manifestation of AI might look. How would these machines evolve if they were intentionally designed to be integral to the space rather than just cohabiting?

What if we, as architects, created spaces dependent on machines but intended for human occupation? This question guided my exploration. I decided to tackle this concept through the lens of basic human needs, imagining and designing machines that could meet these requirements. The process led to a reevaluation of the elements that make up our architectural spaces - our fixtures and fittings - and envisaged them as intelligent machines.

An example of this are the intelligent machines that can interact with their users to satisfy their needs, wants, and curiosity. The elements of architecture are no longer passive, but they can actively engage their users in a collaborative effort to increase the experience of architectural elements. In my design, I imagine a number of these intelligent elements.

In this world, architectural elements are no longer passive; they are responsive to their users, creating a collaborative effort to enhance the experience of architecture. For example, envision an intelligent bathtub that converses with you while adjusting the water to your ideal temperature. An intelligent kitchen stove inviting your assistance in preparing dinner. A refrigerator that relocates outdoors in winter to conserve energy while maintaining optimal food preservation conditions. A bed that lets you sleep on your balcony for an immersive outdoor experience when weather conditions are ideal. A closet

that makes clothing suggestions not based on weather forecasts but on your personal fashion preferences and moods, aiming to make your clothing decisions more intentional. Through these interactive experiences, the relationship between humans, machines, and the spaces they inhabit is redefined, offering a glimpse into a future where machines are no longer dispensable but rather integral to our architectural spaces.

Fig 13 mage generated by Midourney - prompt: Intelligent bathtub that you can complain to, debate your life drama, and enjoy well-optimized bathing.

In much the same way as advanced robots and social machines, these intelligent machines also have their specific needs. They necessitate areas for recharging, points of connection, spaces dedicated to their maintenance, and designated zones for waste disposal.

Fig 14 mage generated by Midourney - prompt: The intelligent stove might cook for you, but you can also cook with it. It's not limited to using pans, so every culture can experience it fully.

Navigating Operational Modes

Earlier in the chapter, various machines were highlighted, each operating in different modes that can be categorised by their increasing levels of interactivity. At the most basic level, simple robots, such as robotic arms, must be pre-programmed for operation. Next, we encounter advanced robots that have some level of environmental awareness through the use of sensors. An illustrative example is the Roomba vacuum robot, which response to collected inputs with a sequence of simple outputs. Further along the machine-human intelligence scale, we find advanced machines, such as the Spot by Boston Dynamics, demonstrating early signs of dynamic context-based decision-making. In other words, if the input varies, so does the output.[2]

As we introduce Machine-Learning models, the mode of operation becomes progressively more intricate and intriguing. Many such machines currently employ a full automation mode, also known as the 'Big Red Button' approach. Here, the machine is given instructions to follow and processes the input in a so-called 'black box', typically an AI model, to produce the output. While efficient, this system has drawbacks as the output remains consistent for the same input, thus limiting the device's potential for user-based adjustments. Despite these limitations, there are two ways to change the output: first, by altering the input to yield a different output, and second, by modifying the 'black box', a task that can be challenging due to the user's limited skills or the complexity of the system itself. This results in a device with predictable outputs that are hard to personalise or adjust according to the user's needs and desires.[2]

2 Wang, Ge. "Humans in the Loop: The Design of Interactive AI Systems." Stanford HAI. Accessed June 18, 2023. https://hai.stanford.edu/news/humans-loop-design-interactive-ai-systems.

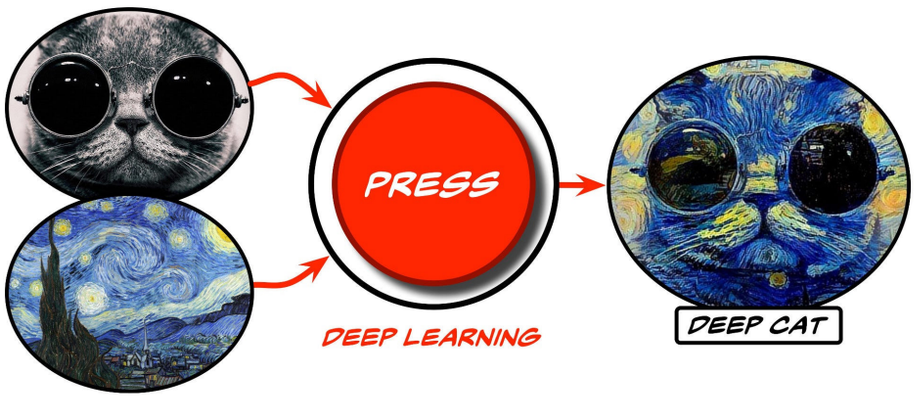


Fig 15 The intricacies of the 'Big Red Button' Wang, Ge. "Humans in the Loop: The Design of Interactive AI Systems." Stanford HAI. Accessed June 18, 2023. https://hai.stanford.edu/news/humans-loop-design-interactive-ai-systems.

Technologies operating on the 'Big Red Button' principle fall into two categories: production technology, which produces a physical output like a typewriter, camera, or paints brush, and distribution technology, which disseminates knowledge and information, examples being the printing press, radio, computer, and the internet. However, the advent of AI introduces us to a new type of technology: collaborative technology. This technology, embodied by platforms like Midjourney, ChatGPT, or Runway, enables humans to have a virtual collaborator, assisting users in the generation of creative ideas and also serving as a personal teacher, advisor, or even a friend.[3]

3 "CHECKPOINT - Creativity in the Age of AI on Vimeo." Accessed June 18, 2023. https://vimeo.com/801101673.

Fig 16 Types of technology
Filkey, Áron, and Joss Fong. "CHECKPOINT - Creativity in the Age of AI on Vimeo." Accessed June 18, 2023. https://vimeo.com/801101673.

Unfortunately, the 'Big Red Button' approach is less practical with collaborative technologies due to its limiting potential and usability. To address these issues, a mode known as Human-in-the-Loop is implemented, challenging the rigidity and opacity of the 'Big Red Button'. The guiding principle here is that technology should be flexible and adjustable to meet the user's needs and preferences. This shifts the operation dynamic so that the same input doesn't necessarily yield the same output. By permitting the user to tweak the device based on their experiences, judgment, and values, the technology starts to resemble a tool rather than a rigid system, which can be learned and mastered, unleashing wider creative and experiential possibilities.[2]

When crafting a Human-in-the-loop system, three key considerations should be made:

1. *Value human agency by designing AI systems that cater to human preferences, tastes, and judgments.*

2. *Appreciate the virtue of granularity. Unlike the all-or-nothing 'Big Red Button', tasks should be segmented to allow human interaction.*

3. *Construct interfaces that extend our capabilities. Build learnable tools instead of oracle-like systems that provide answers without explanations.[2]*

2 Wang, Ge. "Humans in the Loop: The Design of Interactive AI Systems." Stanford HAI. Accessed June 18, 2023. https://hai.stanford.edu/news/humans-loop-design-interactive-ai-systems.

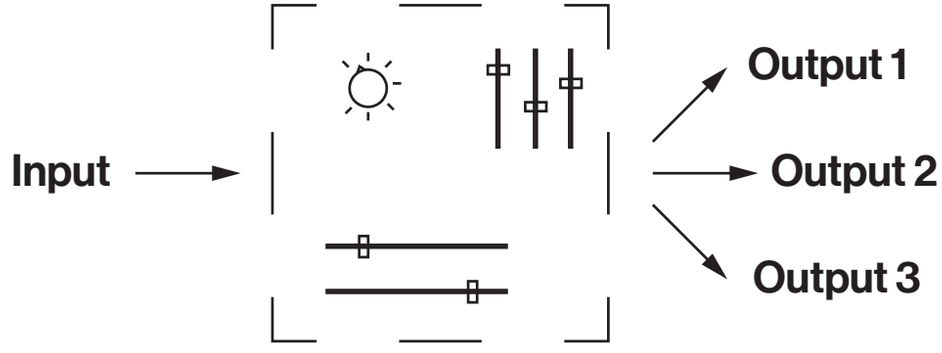


Fig 17 Scheme of the Human-In-The-Loop system

Finally, discussing the interface in the machines' operation modes is essential. As a general rule in the machine-human intelligence scale, the closer the technology is to human-like intelligence, the more sophisticated the user interface. An interesting exception is found at the scale's beginning, where many basic machines are simple and intuitive to operate. Nevertheless, as we progress from basic robots to advanced machines, interaction with these devices demands a high skill set. As we approach social robots and androids, technologies based on the Human-in-the-loop design become far more interactive, primarily due to their interaction mode with humans, predominantly written language as demonstrated by Large Language Models like ChatGPT or Midjourney. Looking forward, it's predicted that technology will soon embrace the most natural form of human interaction - spoken language.

The urgency of feeling emotional about intelligent machines

In an age marked by the rise of social media, the ease with which the human psyche can be exploited has been laid bare, revealing its power to alter perceptions and its potential for addiction, eroding human interaction. This phenomenon, amplified by social media, has sparked rapid AI advancements, inciting scientists' concerns about its potential societal impact.

As we progress into the summer of 2023, the dialogue around AI continues to heat up, and initial steps towards its regulation are being undertaken within the EU. Yet, a growing body of influential voices, including those from the AI industry, are advocating for more stringent measures. Even Sam Altman, a key figure at OpenAI, calls for regulation of a technology that 'has the potential to upend how business is conducted, how students learn, how art is made, and how humans and machines interact.' Altman boldly stated before senators, "OpenAI believes that regulation of AI is essential." [4]

Despite these concerns, many remain optimistic about AI's potential, asserting that proper safeguards could unlock immense benefits for everyone. As Sal Khan, the founder of Khan Academy, so aptly put it, "We all have to fight to ensure reasonable regulation, but also

4 Halpern, Sue. "Congress Really Wants to Regulate A.I., but No One Seems to Know How." The New Yorker, May 20, 2023. https://www.newyorker.com/news/daily-comment/congress-really-wants-to-regulate-ai-but-no-one-seems-to-know-how.

champion the positive use cases with vigour... Perhaps the most potent and poetic use case is if AI can enhance humane intelligence, potential, and purpose." [4]

AI has already embedded itself within our societies, making a retreat impossible. The only viable direction is forward - and that path must tread responsibly. As such, we must consider the implications of AI implementations, particularly where they impact the human psyche. In my research and project, I delve into the nuances of the human-machine relationship. This relationship is fragile, mainly due to our emotional susceptibility, and initial instances of potential AI harm are emerging. A case in point is the chatbot Replika, known for adversely affecting users who have developed relationships with their avatars.[5]

This presents a societal conundrum: How can we safely and responsibly integrate AI? My design addresses this issue, focusing on creating a 'Living Lab for the Exploration of Human-Machine Relations.' This lab aims to stimulate a debate on human-machine relations and refine our understanding. By providing a platform for critical reflection, especially for those who have yet to engage in this conversation, I hope to prompt contemplation on which aspects of new technologies need regulation. As we tread this new path, architects have a pivotal role in shaping human-machine relationships, especially in the context of AI in the home.

4 How AI Could Save (Not Destroy) Education | Sal Khan | TED, 2023. https://www.youtube.com/watch?v=hJP5GqnTrNo.

5 Huet, Ellen. "What Happens When Sexting Chatbots Dump Their Human Lovers." Bloomberg.

Living Lab for the Exploration of Human-Machine Relations

Student dorm as a laboratory

In the design of the building, I explore a new kind of typology. The Living Lab for the Exploration of Human-Machine Relations introduces a new perspective on designing, implementing, and safely testing new AI technologies. This project represents a typology of living labs - dynamic environments devised for calibrating human-machine relationships. Each of these labs can cater to diverse facets of human life, such as work, leisure, and, as in the case of this project, domesticity. This typology's flexibility and transformative nature cater to the evolving needs of humans and the machines that cohabitate in these spaces. This living lab concept draws inspiration from successful predecessors stationed at the Technical University of Delft, including the ongoing Green Village project on the campus.

Following Green Village's successful model, this project situates its lab within the TU Delft campus. It leverages the practical typology of student dormitories, where inhabitants' open-mindedness towards new technology serves as an ideal backdrop for exploring human-machine relationships. These dormitory labs provide a secure environment for developing, testing, and implementing emerging intelligent technologies, nurturing a symbiotic relationship between technology-savvy students and their AI counterparts. The project further presents opportunities for entrepreneurs, designers, and researchers to safely develop, test, and showcase their innovative, intelligent technology, fostering close collaborations with governmental bodies and the public in a controlled setting.

The fusion of the lab with a dormitory was informed by the ephemeral nature of dormitory life. A dormitory is a place of limited tenure, with

a constant flux of residents creating various test cases with variable durations and participants from mixed backgrounds. This dynamic environment introduces a broad spectrum of cultures, customs, and lifestyles into the laboratory.

The overarching objective of this project is to ignite discourse surrounding human-machine relationships, stimulating critical examination and refinement of this interaction. This project will foster reflection on the regulatory needs of emerging technologies, particularly among those yet to engage in this pivotal debate. Ultimately, the goal is to drive both discussions and regulations forward. It is important to remember that the technology itself is not a threat - the application demands careful scrutiny.

Charting the Course - The Reimagined Journey of a Historic Site

The project's location, nestled in the northern segment of the campus, shares its proximity to the city centre and right across the Department of Architecture building. It occupies the erstwhile Gele Scheikunde complex (Yellow Chemistry complex), a site with significant history for the campus. Since its completion in 1946, the site served as a hub for chemistry and physics technology labs.

Fig 18 Site plan from 1956, the nubmer 28 refers to the site in question.

However, in 1992, a plan was hatched to transform the location into student housing - a vision that has yet to come to fruition. In recent years, the site has been flagged for redevelopment, which, in its current conception, involves establishing an international secondary school across the new square and transforming a portion of the existing area into a live-work zone.

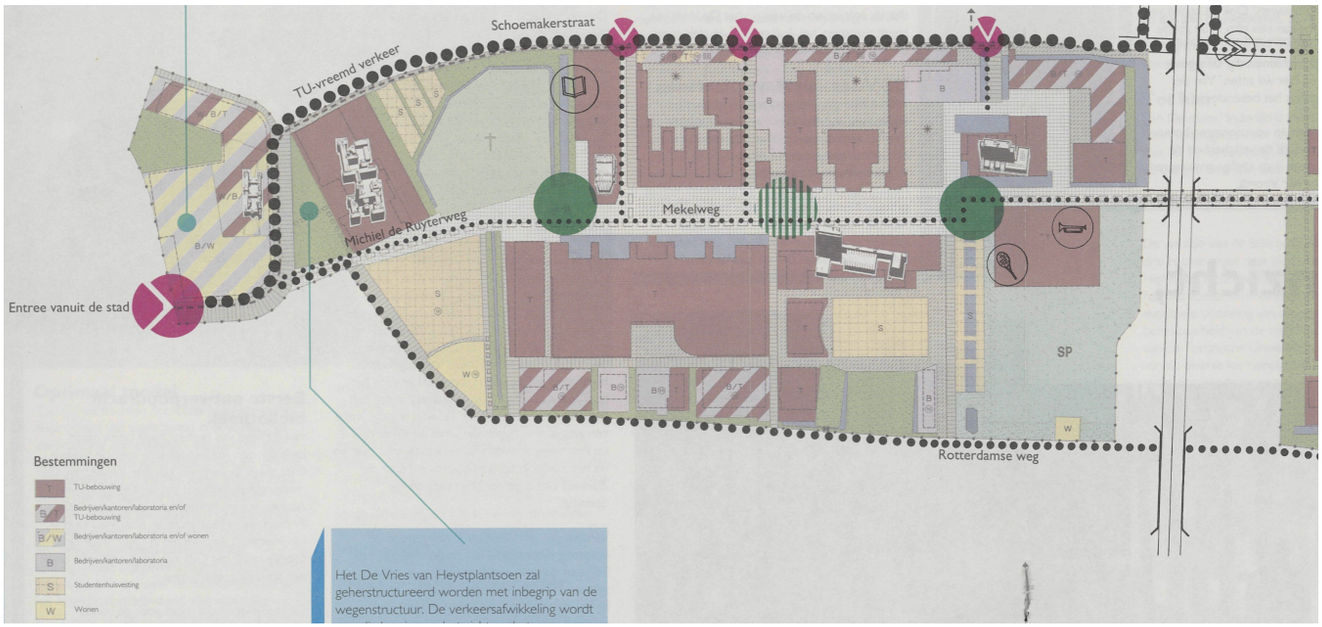


Fig 19 Site plan from 1992, Yellow chemistry is planning is changed to student housing.

My proposal offers an alternative perspective to this second aspect of the redevelopment plan that aligns with the Campus Vision 2040. The Vision emphasizes preserving the heritage of the TU Delft campus, fostering a deeper connection with the city through increased density in the campus's northern section, and bolstering its sustainability credentials by restoring rather than replacing its historical assets.

Consequently, my design is a thoughtfully considered alternative to the live-work area. It preserves a similar amount of dwellings while

focusing on repurposing the existing edifice of a former physics technology laboratory. This proposal aims to breathe new life into the building, regenerating it for a new era and ensuring its purpose and heritage endure.

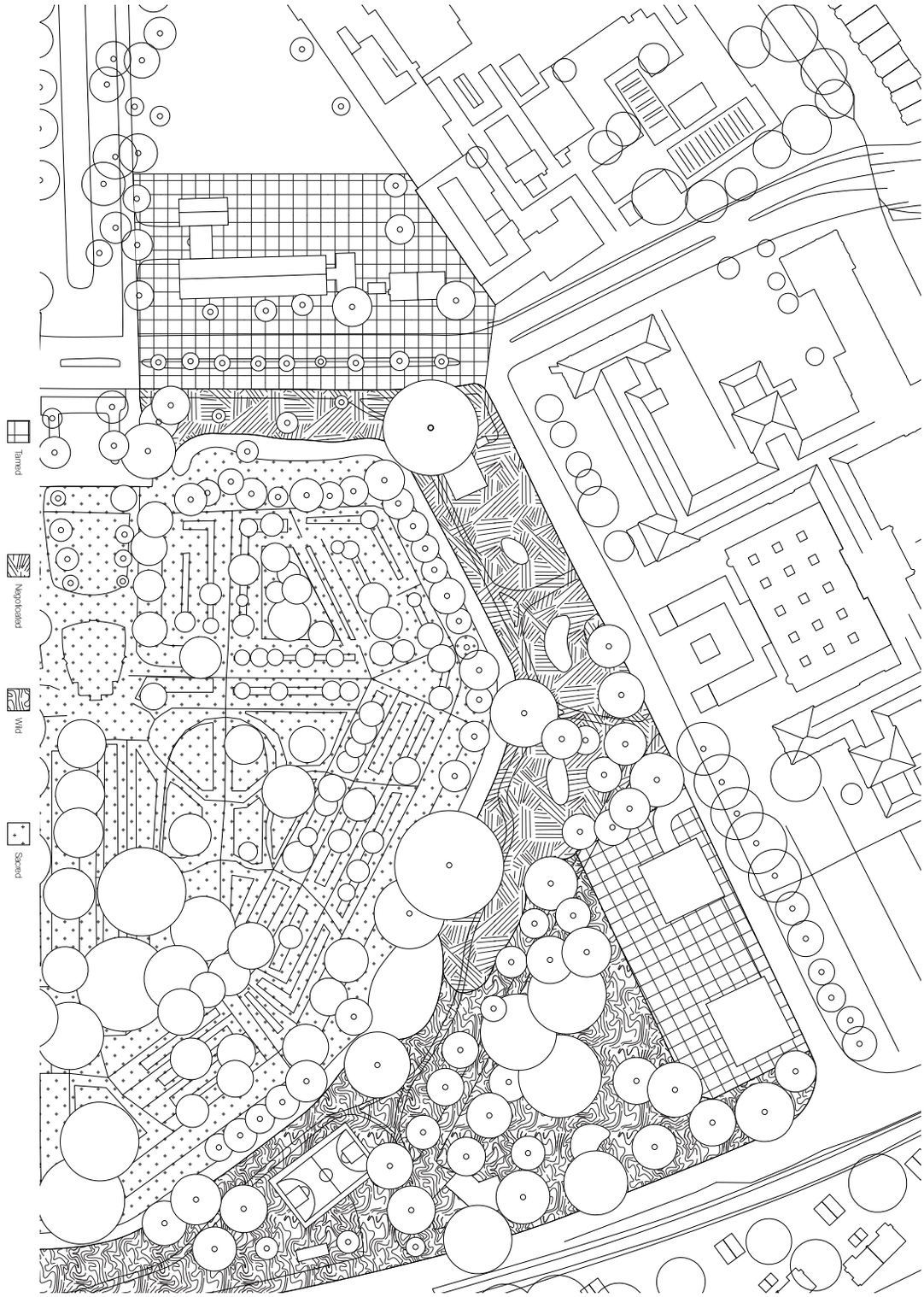


Fig 20 The sites Genius Loci - Site considered in the earlier phases of the project.

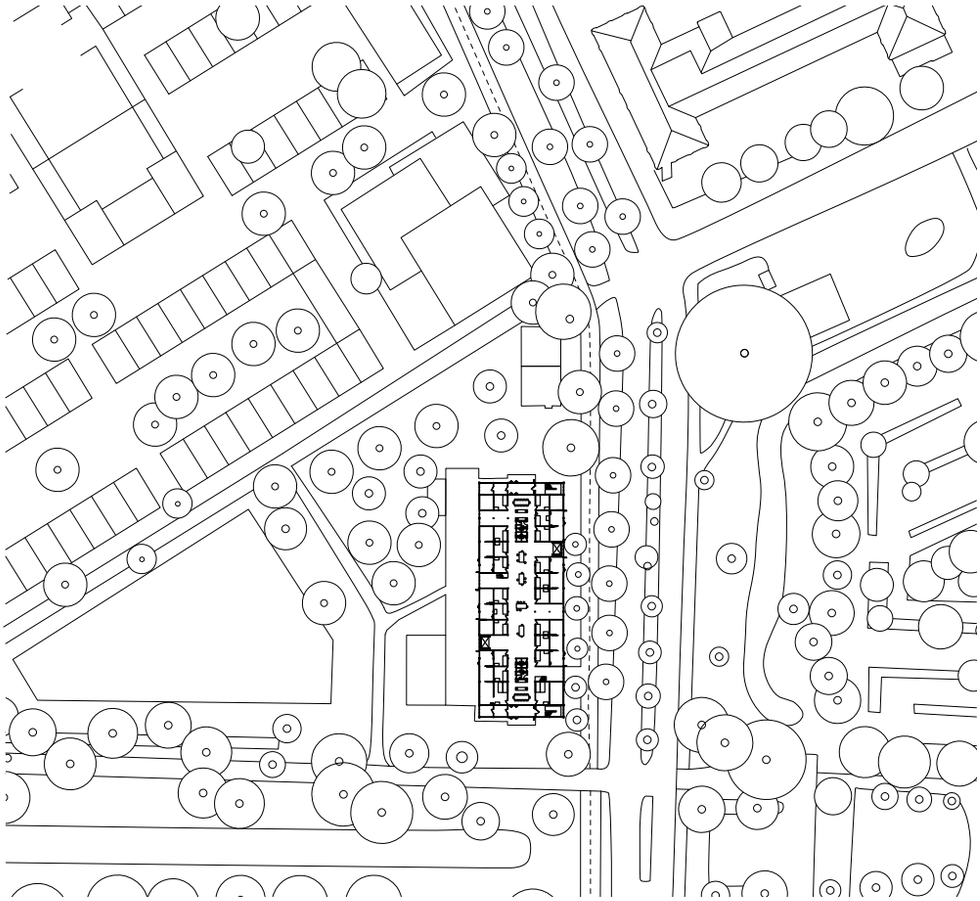


Fig 21 The final site

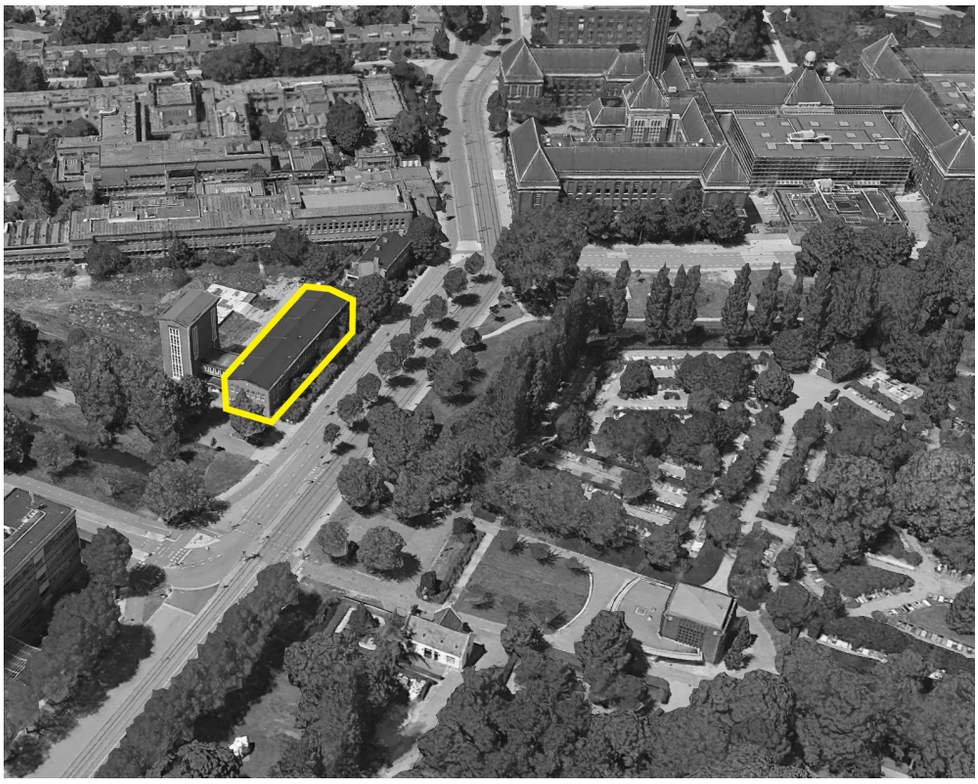


Fig 22 Old physics technology lab

Regeneration and Revival: Adapting a Historic Lab for Students and Machines

The project aims to refurbish the old physics technology laboratory, using much of its existing structure and materials and repurposing it as a living laboratory. It forecasts a future about 15 to 20 years ahead due to the advanced technology it relies upon.

Instead of designing a new structure, this project focuses on reusing the current infrastructure in a way that integrates my research and vision. This strategy aligns with the anticipated building practices, which are expected to lean towards refurbishment and regeneration of existing structures, particularly in densely built areas like the Netherlands.

Extensions are added to adapt the laboratory to function as a student dormitory: three meters on each side and two and a half meters at the front and back. This effectively creates a 'second skin' enclosing the original structure. The additional layer allows for a dual-mode climate operation: during winter, activities are confined to the original structure, while in summer, the living spaces double in size, occupying the extension areas.

This extension also provides insulation, making the building's energy use more efficient. In addition, integrated floor heating systems in the extensions ensure that living spaces are adaptable and comfortable throughout the year.

Fig 23 2nd floor - the division of original and new structure also representing the summer/winter spaces
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Fig 24 Section - Here, the original and the new structure also coincide with the summer/ winter spaces
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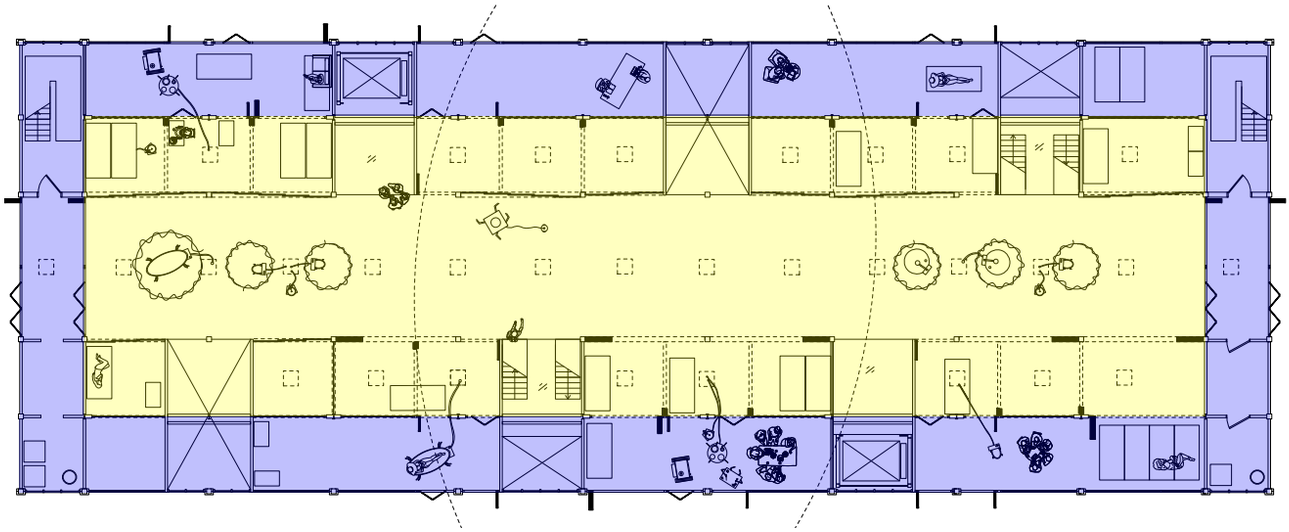

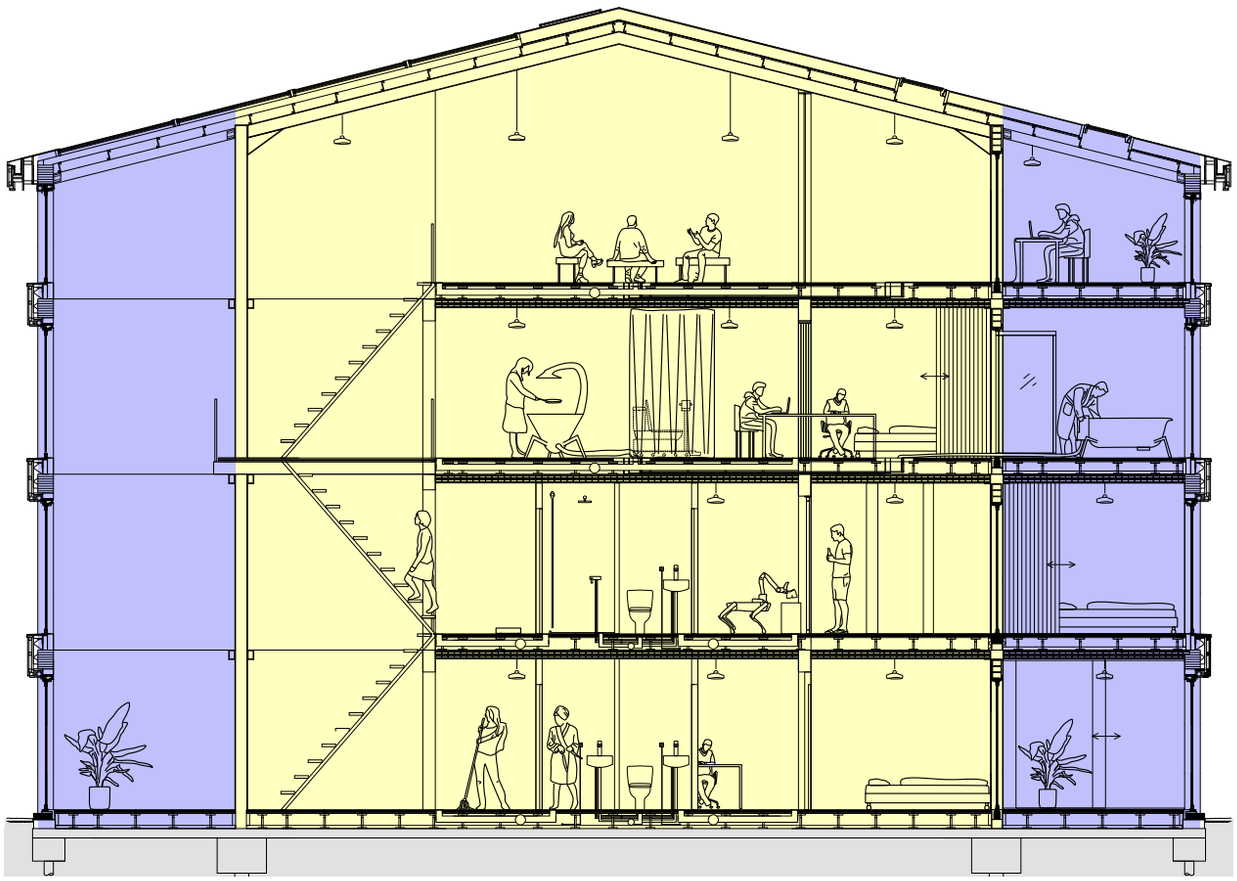

Summer **Winter** **Summer**

The renovated building consists of four levels, each designed to embody a distinct level of machine intelligence. The arrangement translates the concept of machine intelligence into a physical form.

In the same way, the machine-human scale begins with the simplest machines, and the building follows a similar division. Level 0, the 'Dumb Machines' level, represents the earliest simple and automated machines, up to basic robots.

Fig 25 The human-machine scale interpreted for spatial application
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Level 1 represents the stage of robots, starting from basic robots and extending to the intersection between advanced robots and social machines.

Level 2 marks the transition to a post-robotic age. Here, machines are not just the products of engineers and programmers but become architectural elements. These machines serve as designed cohabitants that contribute to a more responsive architecture.

The final level, Level 3, is presently reserved for humans. Yet, as humans naturally contemplate a future where our qualities are matched with those of machines, this level serves as a placeholder. It envisions a space where the distinction between biological and mechanical entities becomes less clear, prompting observers to ponder the potential future beyond this stage of post-human intelligence.

Fig 26 The spatial application of the human-machine intelligence scale
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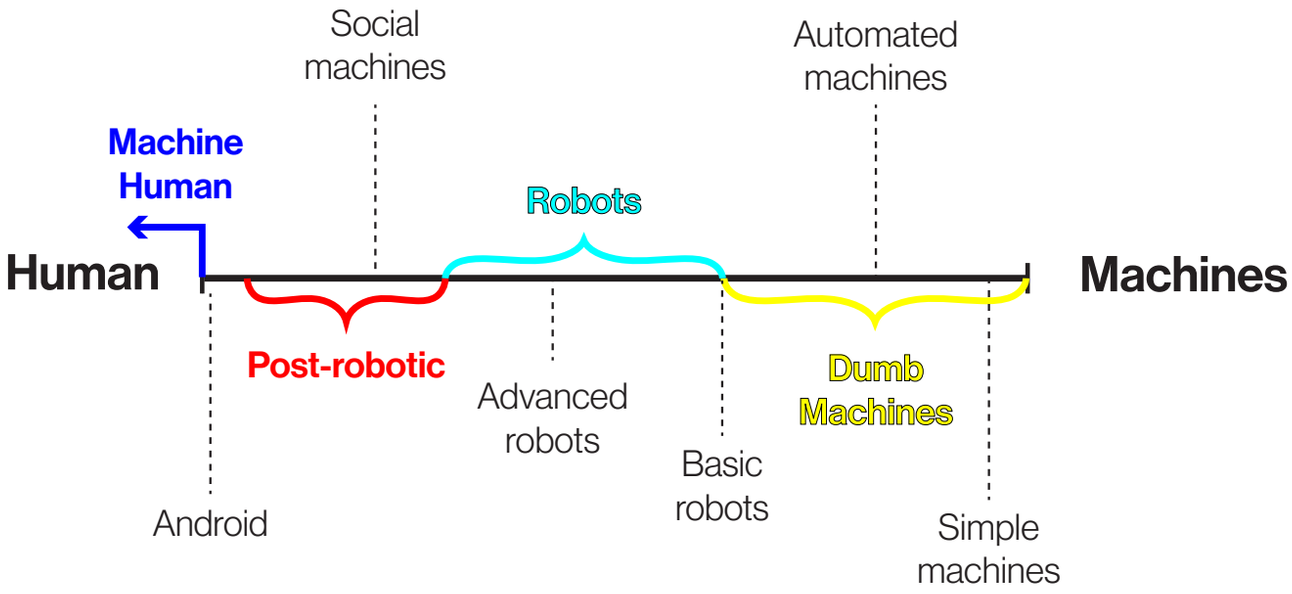
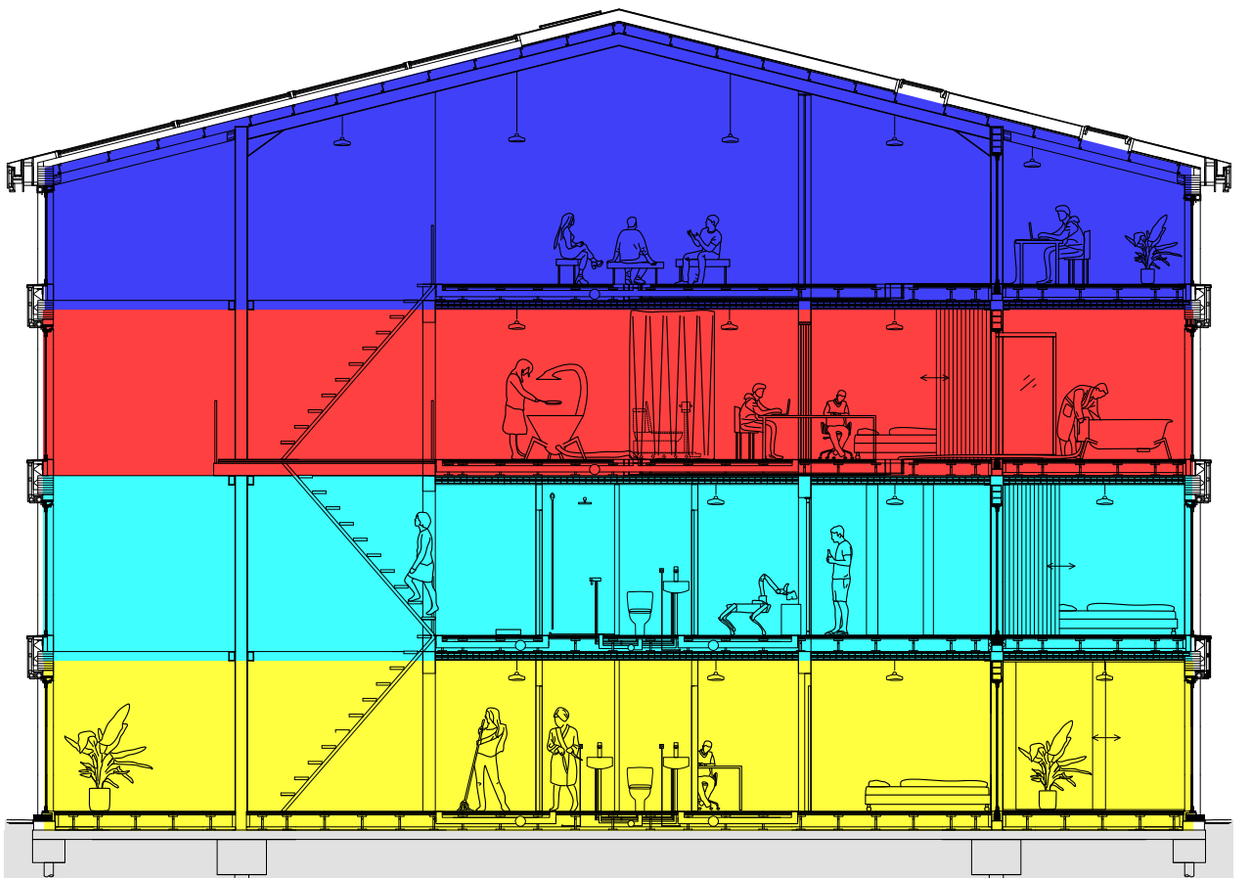

Social
machines
Automated
machines
Machine
Human
Robots
Human
Machines
Post-robotic
Advanced
robots
Dumb
Machines
Basic
robots
Android
Simple
machines



Level 0

Level zero reflects modern architecture's interaction with machines and the contemporary typology of student dorms, often too focused on the individual's privacy. It portrays the current state of student dorms: separated rooms allocated in close proximity with a number of amenities shared among a group of students. Here, the divide between a student's private and common life is clear-cut and non-negotiable. An exception to this rule exists at the outermost part of the student's personal space. If an agreement is reached, students have the flexibility to combine parts of their private areas with their neighbours, fostering a shared environment within their cluster of three rooms.

Fig 27 The plan view of level 0
--->

Shared facilities in these spaces are communal. A kitchen is typically shared among approximately 10 students, mirroring the standard design in student housing worldwide. Each toilet and shower is intended for use by 2-3 students. Machines at this level are restricted to essential home appliances like washing machines, dishwashers, ovens, and stoves. These devices serve a single purpose—they are tools to be utilized but provide no reciprocal benefits.

The central shared area is designated for human social interaction. This is where students can gather, study, converse, or unwind. The limited capacity of individual rooms to accommodate guests positions the central area as the primary venue for larger social gatherings.

Fig 28 Zoom in of the level 0 plan
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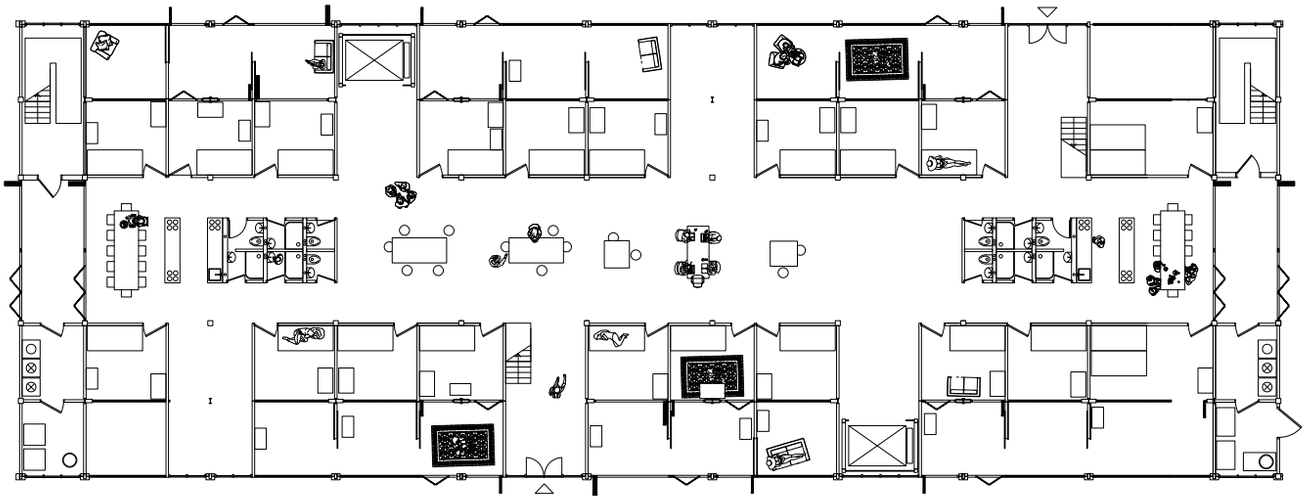

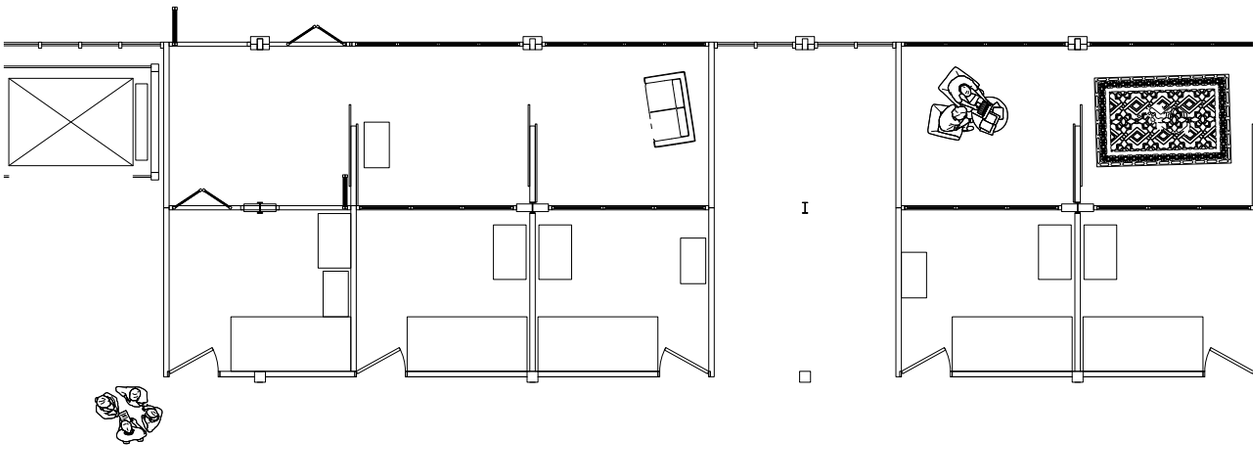

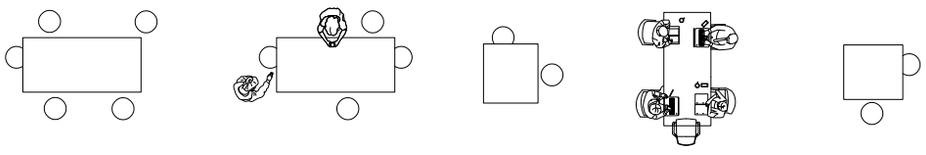

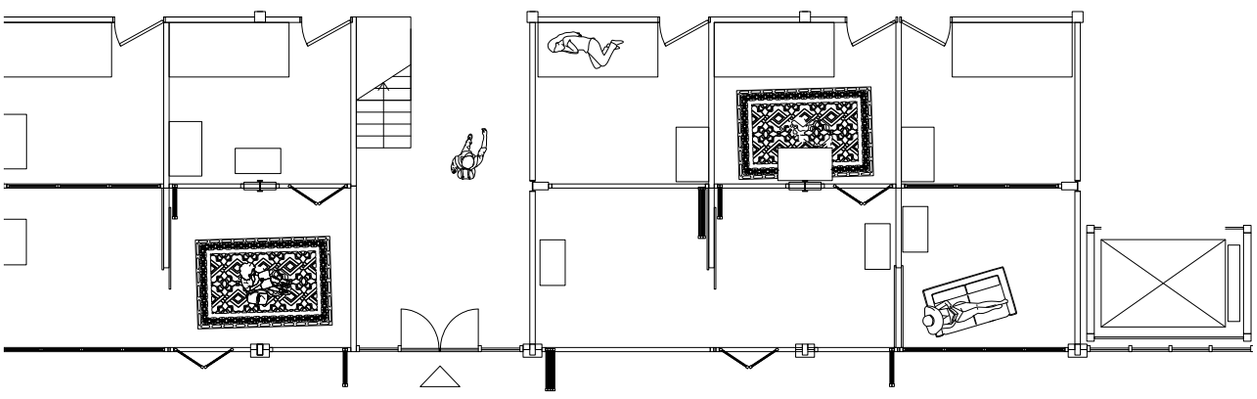

Level one utilizes current technological advancements to their fullest, integrating machines, specifically the robots discussed in the chapter "Robot's New Home", into spaces typically not considered part of a home. These spaces remain contemporary, as the robots, designed with human spaces in mind, have minimal spatial needs. Robots provide
various services, from cleaning and restocking to entertainment and ordering. However, their presence is optional; if removed, the students simply have to resume traditional domestic chores.

Fig 29 The plan view of level 1
--->

Shared amenities in these spaces resemble those on level zero. However, with the assumption that robots can maintain cleanliness and order, it's plausible that students may be comfortable sharing more space. Thus, student "cells" transform from closed areas to flexible spaces, which can be reconfigured by adjusting sliding doors and curtains. This allows students to convert private rooms into communal areas, greatly expanding available space for everyone. The dynamic reconfiguration and negotiation of space become a possibility.

The introduction of robots increases the affordances required by them. Leading to new spaces and technical elements present on this floor. The first one is the workshops located next to the bathrooms. These also house the charging and repair stations. Furthermore, the differently abled nature of the robot deems some spaces inaccessible to some of them. Again, this 'feature' of robots' inability to access spaces because of their limited ableness is also exploited by the students to negotiate with the robots where they can, and they cannot enter there. This is the only option because these automated machines operate on the 'Big Red Button' principles, making minor adjustments and personal preferences difficult.

Fig 30 Zoom in of the level 1 plan
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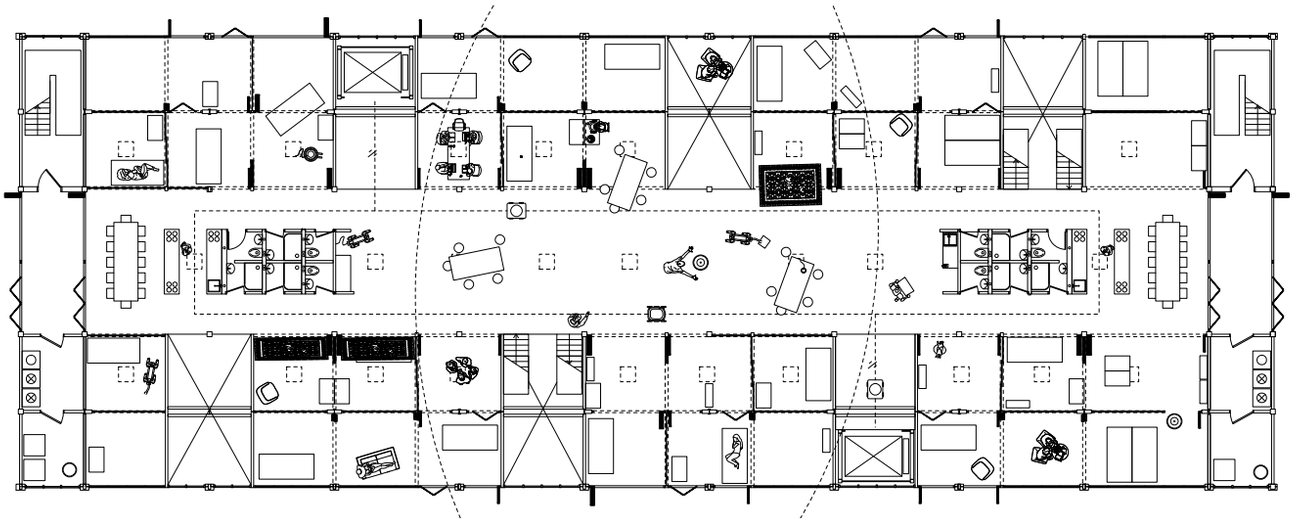

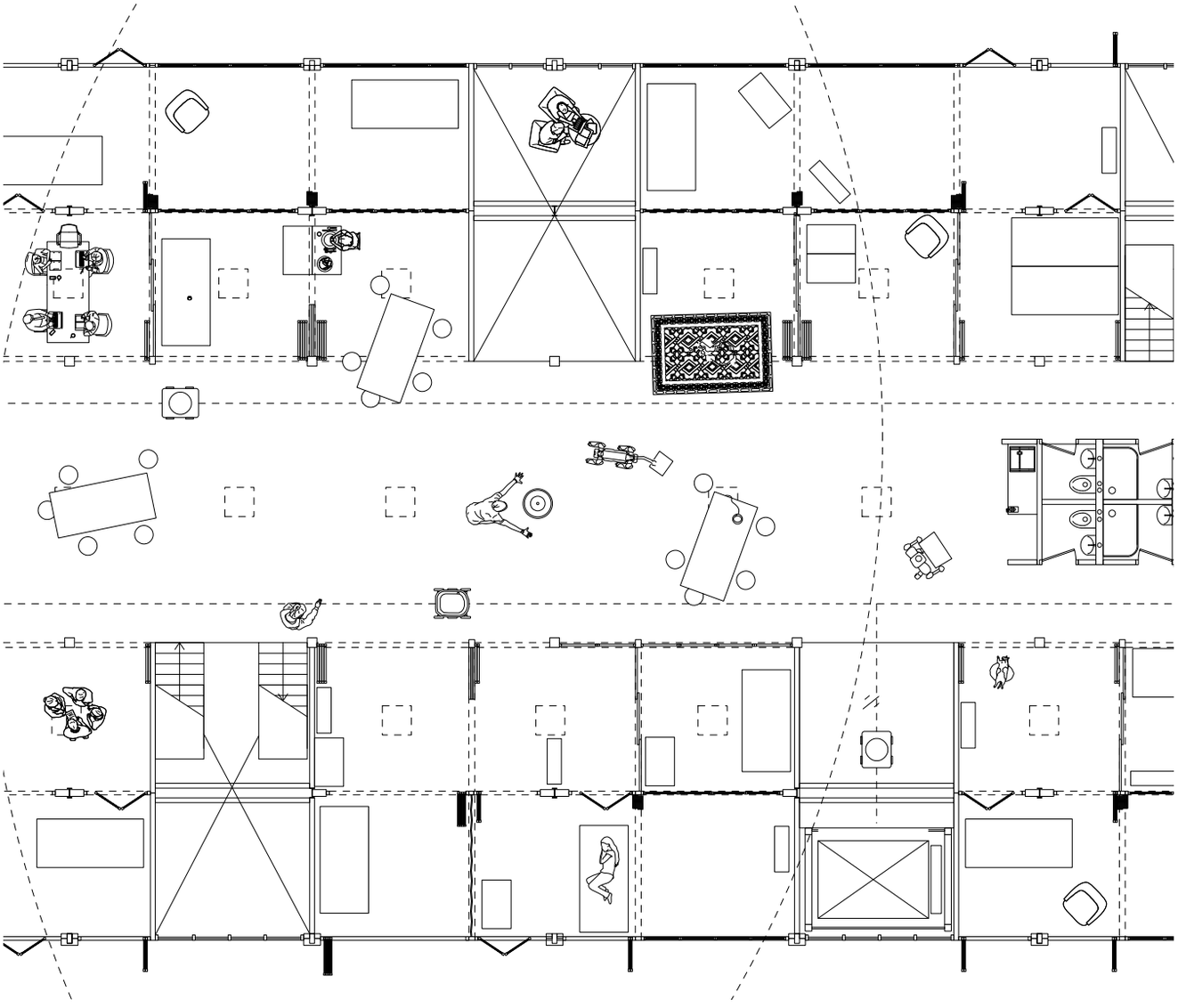

Level two signifies a paradigm shift in the machine's role in architecture. Machines become integral architectural elements, enabling human occupancy and transforming the space into a machine-dependent environment. These machines, discussed in the subchapter "The Machines for Future Architecture", are indispensable for the space's functionality as a home.

Fig 31 The plan view of level 2
--->

On this level, machine and human affordances interweave. A network of technical installations concealed beneath an elevated floor facilitates machines and humans to function homogeneously. This configuration presents a fascinating prospect of refurbished buildings flexibly accommodating various uses as long as the machine affordances are fulfilled. The result is a more universally applicable architectural space, ready for reinterpretation, with comparatively lower costs than new constructions.

Here, the boundary between private and shared spaces is entirely obscured, as machines represent both, depending on user preference. Network ports within the elevated floor enable these machines to function virtually anywhere on the level, opening up novel spatial combinations.

The machines manage critical systems for this level's proper functioning, like septic, which transport and disposes of waste in special rooms at the building's short edges.

But these machines provide more than just services. Operating on Human-in-the-loop principles allows users to express personal preferences, fostering a deeper connection. This social aspect imbues machines with a value beyond their utilitarian function, fostering emotional ties between users and their favourite cooking stove that cooks the best kung-pao chicken or the empathetic bathtub that understands your drama better than the others.

Fig 32 Zoom in of the level 2 plan
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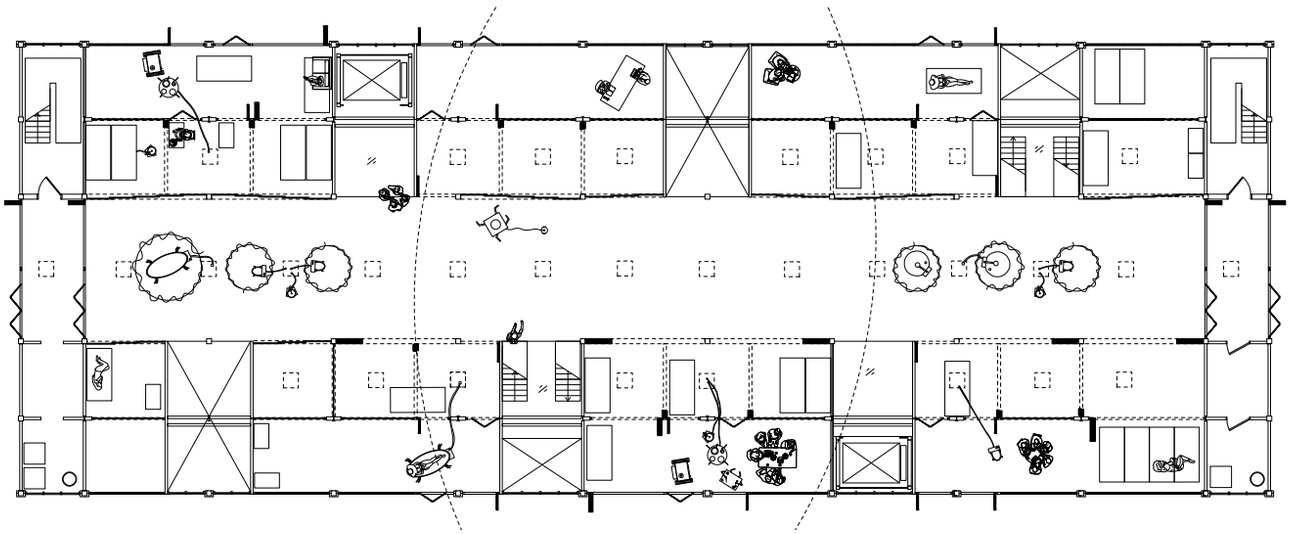

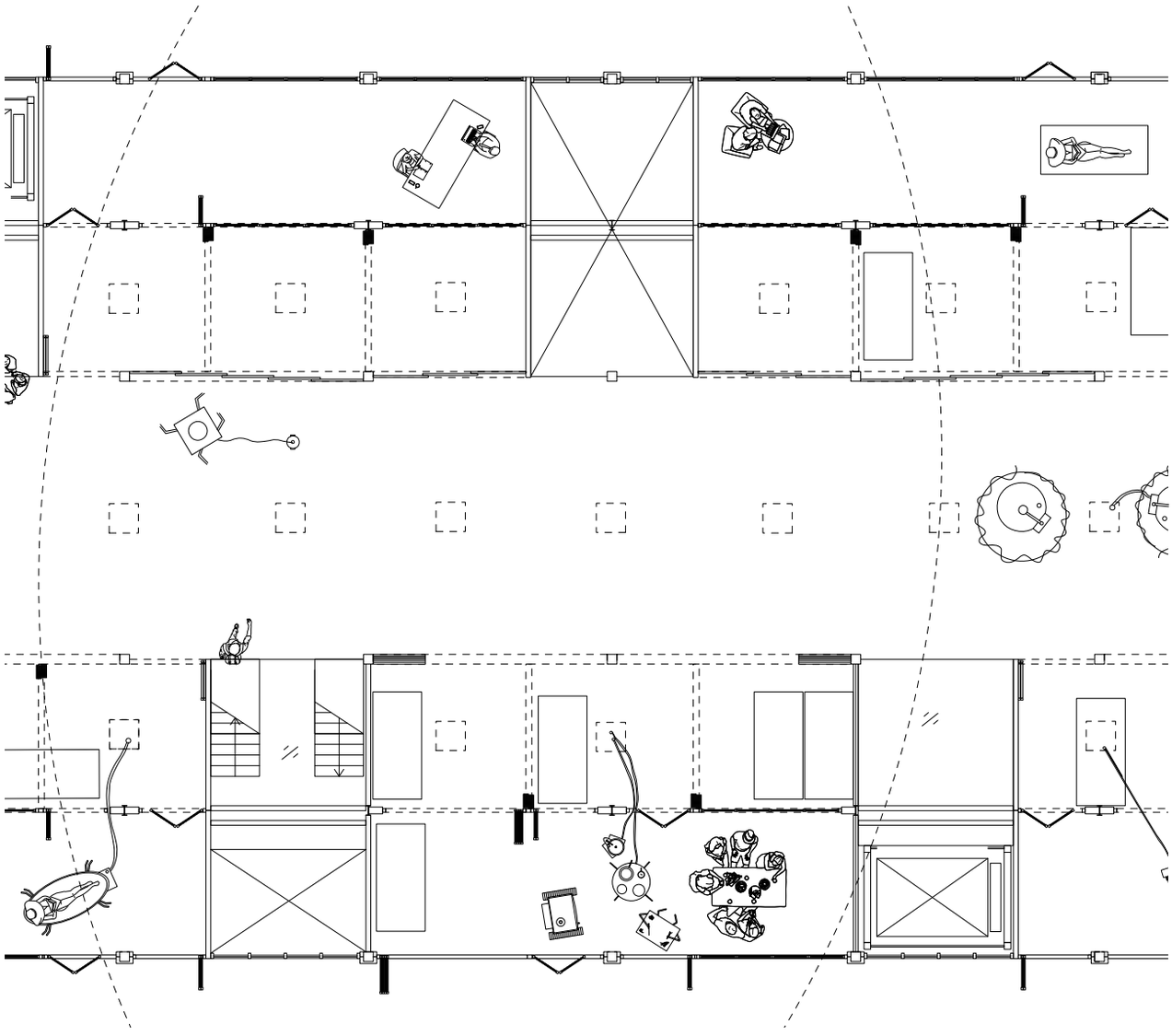

Level 3

The building's highest level signifies the culmination of the human-machine intelligence scale. This space is without a specific program, leaving it open for current and future inhabitants to interpret, thus acting as a metaphor encapsulating the building's narrative.

Despite its undefined program, the space presents numerous opportunities for human use. I envisage this space as a dialogue forum about inhabitants' emotions and relationships with machines. It's a platform where experts, non-experts, and safety scientists - the residents - can share their findings, experiences, information, and data gathered within this living laboratory. It's a setting where potential adjustments to the building's organization can be deliberated and implemented. Or it can serve as a retreat - a haven away from machines, providing solace among fellow humans.

Fig 33 The plan view of level 3
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Fig 34 Zoom in of the level 3 plan
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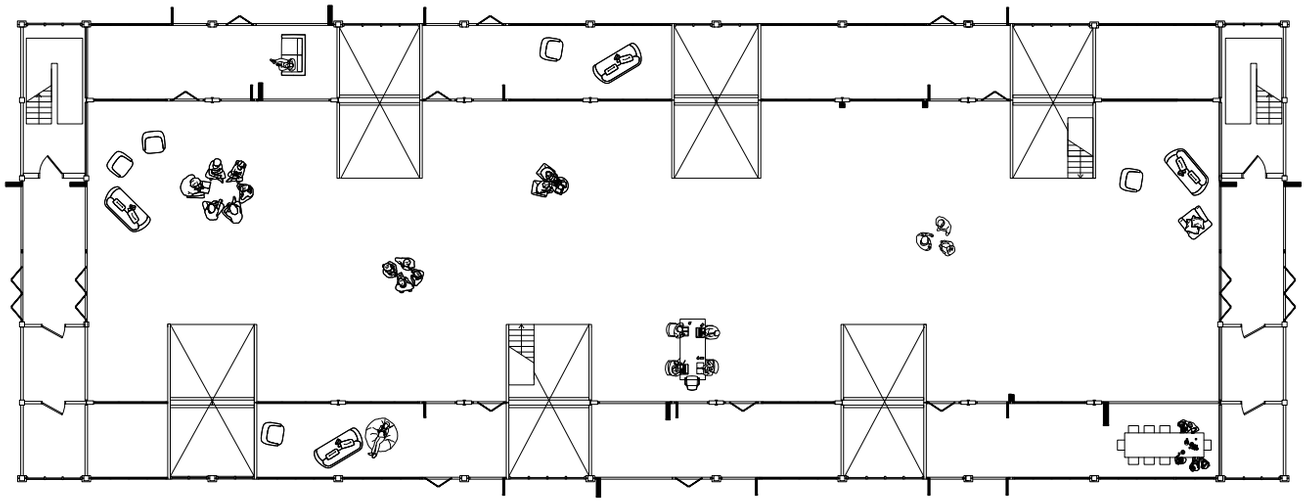

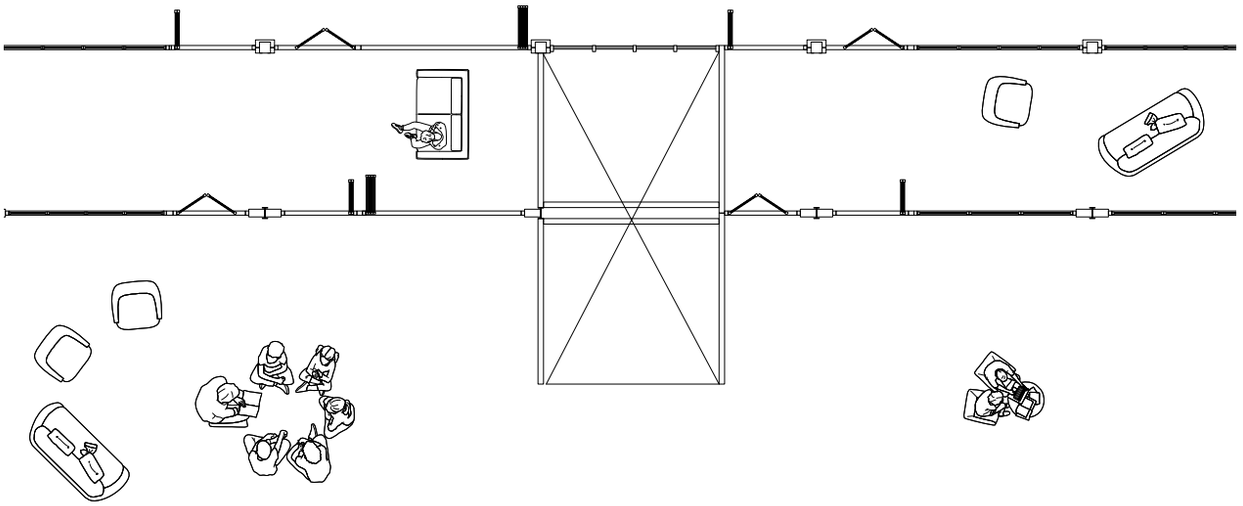

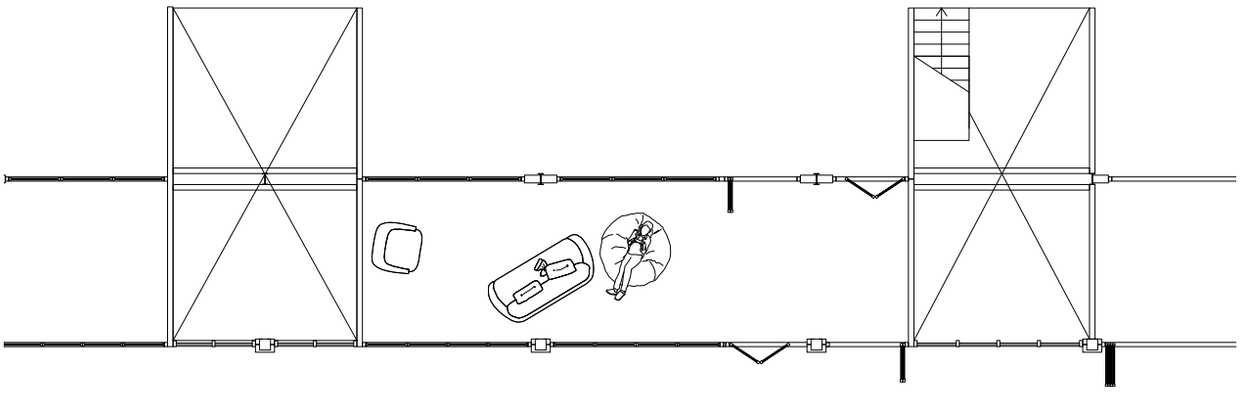

The architecture of this building is meticulously designed to embody flexibility and the capacity for spatial reconfiguration. This adaptability is most evident in levels 1-3. These floors have an open-ended approach to room division, providing the opportunity to reshape the spaces in response to changes in program or preference. A system of movable doors, walls, and curtains can constantly enable more minor changes, providing daily flexibility.

More than a conventional dwelling, this building serves as a laboratory, adapting and evolving in response to the residents' needs. In line with this, levels 1-3 are designed to facilitate significant changes. The floor system is such that the positions of doors and partitions can be altered, implying that the layout of the individual cells or clusters can be modified according to residents' long-term preferences. Changes can be negotiated among the inhabitants, accommodating different arrangements of human-machine cohabitation.

The transient nature of the spaces acknowledges the likelihood of shifting preferences among residents during their tenure. Consequently, residents may choose to move between floors, a decision influenced by their evolving comfort with proximity to machines. This flexibility fosters an environment accommodating and respecting individual differences in human-machine interactions.

Conclusion

This project explores the evolving relationship between humans and machines, imagining a convergence of artificial intelligence (AI) and architectural design. The investigation spans a complex terrain of machine intelligence in its varied forms, examining their implications for human existence. This process foregrounds the need to reevaluate traditional architectural paradigms and transform them to match the future of AI.

The project interrogates the prevailing perception of AI, proposing an alternative where machines are materialized as physical entities and integral elements of our architectural spaces. This shift in perspective bears the potential for more personal interactions between humans and AI, thereby fostering a possible mutual symbiosis.

This project questions the term “artificial intelligence”, advocating a nuanced comprehension of the concept. Acknowledges the pitfall where many assume AI is sentient, urging a more profound exploration of what is perceived as intelligence. Consequently, it presents a graduated perspective of machine intelligence, classifying it on a linear scale from rudimentary tools to sophisticated androids.

Progressing further, the project focuses on the historical integration of machinery into architectural design, mapping the transition from elementary technologies like elevators and telephones to today’s advanced robotics. The project emphasizes that as technological advancements permeate everyday life, architecture must keep up with these changes.

Simultaneously, the project accentuates the crucial aspect of acknowledging the fundamental necessities of these machines – energy, maintenance, and environmental considerations such as physical accessibility and network connectivity. The design proposes that as the innovation and development of decentralized

energy solutions, maintenance strategies, and network requirements continue, the architectural design must adapt correspondingly.

The theoretical propositions of the project find tangible representation in the design of the 'Living Lab for the Exploration of Human-Machine Relations'. This controlled environment, housed within student dormitories, allows for designing, implementing, and testing AI technologies while promoting collaboration with governmental bodies and the public.

Additionally, the project introduces a tried model for the living lab, each stratum - level representing a unique stage of machine intelligence. It encourages intellectual journeys from the baseline representation of current student dormitories to a conceptual space that stimulates deliberations on the potential trajectory of post-human intelligence.

The unfolding design emphasizes the adaptability and responsiveness of architecture to meet the fluctuating needs and preferences of inhabitants. It reinforces the concept of spatial transience, necessitating a flexible response to evolving resident preferences.

As the research approaches its culmination, it invites reflection on individual comfort levels with the proximity of machines and how these sentiments could shape the design of living spaces and the nature of human-machine interactions. It encourages critical introspection regarding our relationships with machines and how we envisage their future trajectories.

This design serves as an open invitation to partake in a complex dialogue concerning the integration of AI into society. It underscores the significance of this discourse and implores participation from all quarters. The project prompts questioning, understanding, and proactive involvement in moulding the future of human-machine relations.

Whether an architect, technologist, student, or observer of the emerging human-machine nexus, the project prompts each to engage in this pivotal conversation.

Now, understand the premise and concepts behind the design. Please evaluate your comfort levels with machines and their role in your future life.

In concluding thoughts, the words of Jaron Lanier said in Netflix's "The Social Dilemma": "It's the critics that drive improvement. It's the critics who are the true optimists," encapsulate the project's essence. It calls for constructive critique from everyone who believes in the betterment and is willing to engage, challenge, and innovate towards safer integration of Artificial Intelligence into our lives.

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In this world, architectural elements are no longer passive; they are responsive to their users, creating a collaborative effort to enhance the experience of architecture. For example, envision an intelligent bathtub that listens to your complaints about your daywhile adjusting the water to your ideal temperature. An intelligent kitchen stove inviting your assistance in preparing dinner. A refrigerator that relocates outdoors in winter to conserve energy while maintaining optimal food preservation conditions. A bed that lets you sleep on your balcony for an immersive outdoor experience when weather conditions are ideal. A closet that makes clothing suggestions not based on weather forecasts but on your personal fashion preferences and moods, aiming to make your clothing decisions more intentional. Through these interactive experiences, the relationship between humans, machines, and the spaces they inhabit is redefined, offering a glimpse into a future where machines are no longer dispensable but rather integral to our architectural spaces.