



Workflow continuity ecosystem



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Abstract

The consolidation of hybrid work models, driven largely by the entry of Generation Z into the workforce, has fundamentally redefined the professional landscape. While current portable devices enable mobility, they often fail to address the operational friction inherent in the frequent transitions between domestic, corporate, and nomadic environments.

This Design & Engineering thesis investigates these ergonomic and functional gaps through a user-centric research approach, analyzing the specific needs of the 'digital nomad' regarding energy autonomy and workspace setup.

The proposed solution is a modular ecosystem designed to ensure seamless workflow continuity. The system comprises a stationary docking hub and a mobile power module, characterized by a refined kinetic interaction. A custom-engineered viscous damping mechanism allows for a controlled 'soft-landing'

connection, transforming a utilitarian action into a premium tactile experience.

To achieve the necessary compactness without compromising performance, the product architecture leverages cutting-edge enabling technologies. The integration of GaN (Gallium Nitride) semiconductors and Silicon-Carbon battery cells allows for drastic volumetric optimization and superior energy density. The result is a high-performance, pocketable device that enhances operational comfort while meeting the dynamic demands of contemporary work culture.

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Introduction

The hybrid work era

Remote working, telecommuting, Work From Home (WFH), smart working etc., are all synonyms for a practice that consists in carrying out your office job, away from the office.

And although it might seem like a recent invention, its original introduction dates back to 1973. Jack Nilles, a NASA engineer, coined the terms *telecommuting* and *telework*, and pioneered the first remote work experiments using telephone lines as a network.

50 years later, with the help of a global pandemic, remote work is as popular and as convenient as ever.

Together with a more flexible approach to where work is done, a revolution occurred also in how work is done.

In fact, in the latest years, productivity started to be measured in completed tasks, rather than spent time.

The entire concept revolves around empowering workers to manage their time.

According to Harvard Business Review, employees who feel empowered at work produce stronger job performance.

Thanks to technological innovations like powerful laptops and cloud networks that let us exchange files and communicate instantly via messages and video calls, the office has lost most of its advantages over a home desk setup.

But all that glitters is not gold, and although Gen Z employees would never give up remote work, they also would not be okay to only work remotely.

From sociality to in-person learning opportunities, time spent onsite is still vital, and that is why hybrid work setups are here to stay.

■ Hybrid work trends



Data from recent surveys conducted in Italy show some trends that prove how much a hybrid work culture is now radiated and expanding.

96% adoption rate in Italy: According to a study from 2024 by Politecnico di Milano's "Osservatorio Smart Working", years after the COVID-19 pandemic, the number of Italian remote workers was predicted to keep growing by 5% in the following year.

Though this growth is differentiated between different sized companies: in fact, whereas almost all big companies are adopting hybrid work policies, medium- and small-sized ones keep lagging behind.

Future growth: Not only most big companies have already put big efforts into moving to a hybrid workplace, but an intention to increase those efforts was also reported.

In fact, that same study from Osservatorio Smart Working shows that 1 in 3 Italian big companies are planning to strengthen their remote working policies, much to the delight of their employees.

Resistance to Return-to-Office: As a testament to how much hybrid work policies have become vital for employees' wellbeing on the workplace, according to surveys, only 14% of them say that a return-to-office would have no impact on them.

The remaining majority of workers say that remote working is now comparable to a fundamental right:

- 7% of Italian workers say they would leave their job immediately if remote work policies were shut down
- 68% of Italian workers say they would not leave their job immediately, but they would start looking for new opportunities elsewhere

Gen Z Preference: Recent data from Gallup shows a trend where 65% of remote-capable Gen Z workers were more likely to favor hybrid work environments than their millennial (60%), Gen X (58%), or Baby Boomer (56%) counterparts. Only 29% of Gen Z employees expressed a preference for an "exclusively remote" work arrangement, compared to the 33% of the older generations.

The reason Gen Z is least likely to prefer exclusively remote work is because they need time onsite to learn how to work effectively within their organization, build relationships, and feel like a part of the organization's culture. These younger workers value opportunities to learn and grow from those around them, and find it easier to navigate their career in-person.

Research & Analysis

Research strategy

The consolidation of hybrid work models has fundamentally shaped the professional landscape in recent years, redefining workers' priorities, expectations, and habits. Consequently, a deep dive into the specifics of individual experiences is crucial to precisely delineate the project's scope.

The research strategy leading to the design brief was structured along two main axes:

- **User Experience:** Analyzing target users' pain points and frictions within current hybrid working conditions to identify intervention opportunities.
- **Technological Enablers:** Investigating current and emerging technologies capable of supporting innovative and seamless workflows.

The user-centric phase of the study involved face-to-face interviews with Gen Z employees, focusing on their digital wellbeing and operational comfort across dif-

ferent scenarios and during transitions. Complementing this, the perspective of companies' IT System Admins was analyzed through a qualitative review of specialized online forums, highlighting maintenance and lifecycle concerns.

On the technology front, the research focused on the latest innovations in power and data transfer standards. Finally, a comprehensive market benchmark was conducted to assess the state of the art and identify gaps in current solutions.

■ Interviews with Gen Z

To give the design hypothesis a practical basis, the research phase entailed an in-depth study of a very typical environment for such a group: the offices of BTicino, a company I interned at.

BTicino's offices represented an optimal test bed for modern nomadic dynamics since all members of the sample operate based on a formal hybrid model: 2 days of remote working and 3 days of office-based working each week.

There were 10 individuals interviewed; 8 from Generation Z and 2 slightly older 'tech savvy' employees representing a senior version of the younger employees. By including these slightly older employees, it was possible to assess whether the requirements for continuous workflow and agile mobility are evolving from being just a function of generation to becoming a common attitude or mindset among professionals.

A number of semi-structured qualitative interviews were carried out to gather information about the daily rituals of these professionals beyond simply how well they worked.

In comparison to traditional survey formats which limit respondents to specific answers, this conversational style of interviewing allowed to capture unscripted responses related to what causes frustration in terms of working nomadically: the "stress" associated with setting up when returning to their desks, the "cognitive burden" created by cable clutter, and the "anxiety" caused by lack of control over their devices.

The comments received were extremely valuable. They transformed the nature of the project from developing a simple product to creating an ecosystem that would help restore order and clarity of mind.

What can't be missing on your desk when you work?

Do you ever try to work at a place that is not your desk?

How often do you move your laptop away from your desk?

Do you care about the tidiness of your desk setup?

Have you ever used DIY tricks to make your setup more comfortable?

Is it easy to pack your laptop bag for work travels?

...

What can't be missing on
your desk when you work?

“I love my extra monitor. At
the office I have one and, as
soon as we started hybrid
work, I had to get one also
for my home desk”

(Selene, 27y, Junior Marketing Manager)

“At my office desk I like using
an external keyboard and
mouse. I would use them at
home too, but then I'd have
to waste time plugging too
many cables”

(Matteo, 27y, Software Engineer)

How often do you move your laptop away from your desk?

“Two to three times a day I have meetings I have to attend in person. Most of the times I have to present something, so I bring my laptop and charger”

(Lucia, 27y, Product Marketing Manager)

“I like to sit on the couch to perform boring activities like writing emails. But I don’t do it that often because of my laptop’s unreliable battery”

(Gennaro, 25y, Electronics Engineer)

Do you care about the tidiness of your desk setup?

“Tidiness is vital for me. At home I have installed BTicino’s wall sockets with integrated USB-C ports so I don’t have to see my laptop’s bulky charger”

(Marco, 50y, B2C Product Manager)

Have you ever used DIY tricks to make your setup more comfortable?

“Too many times I forget my laptop’s charger at the office and the following day I can’t work. So I got two laptop chargers, one for home and one for the office”

(Alice, 28y, UX/UI Designer)

Is it easy to pack your laptop
bag for work travels?

“I travel often to meet our
teams around the world, and
packing is always stressful.
I never know if I got enough
chargers for my devices, or
the correct plug adapters”

(Milka, 55y, Vice President Art and Design)

■ Interviews with Gen Z

— Conclusions

The qualitative data extracted from the interview responses reveals an underlying paradox in the contemporary hybrid workflow: while there exists the technology for people to work remotely from any location, they are both physically and psychologically tied down by the equipment needed to support their use of it.

From the testimony of the participants in this study, three primary drivers of design have emerged:

- **Redundant infrastructure:** Users like Alice and Marco, purchase redundant charging systems, or install additional customized wall outlets because of the physical and visual obstructions caused by cable management.
- **Battery anxiety:** Gennaro's anxiety about working off-site due to "unreliable" battery performance illustrates that users lack energy confidence in terms of portability.

- **Transition friction:** Matteo's unwillingness to set up peripherals at his home workspace, indicates that when setting up takes longer than just a few seconds, it is a barrier to achieving an optimal ergonomically correct workflow.

The identified technical challenges illustrate the need for a balance of high power delivery and a seamless portable solution, within a compact size constraint.

This subsequent chapter will examine the viability of leveraging Wide Bandgap Semiconductors (GaN), and High-Density Silicon-Carbon Batteries to overcome these physical limitations, thus allowing for the necessary volumetric reduction to meet the design requirements expected by the users.



Enabling technologies

This portion of the report investigates the technological advancements necessary to provide users with a compact, high-power device that still does not compromise on performance.

These three technologies together represent the fundamental base needed to convert a simple 'brick' into a polished, seamless experience.

Three technological advancements are key in this regard:

- **Standardised connectivity** enables the integration of a single port capable of both fast data transfer rates and two-way energy transfer via USB-C, USB4 and PowerDelivery.
- **Wide bandgap semiconductors** (e.g., GaN) enable increased thermal efficiency, thus reducing the size and complexity of the AC/DC converter
- **Silicon-carbon anode batteries** increase the energy density per volume of lithium-ion battery significantly over current standards

■ Enabling technologies

— Standardised connectivity

After years of chaos, where every company had a proprietary charging standard, the electronics industry is finally converging on a single, universal interface.

This shift is now legally driven by the European Union's Radio Equipment Directive, which establishes USB-C as the mandatory "Common Charger" for all new product launches.

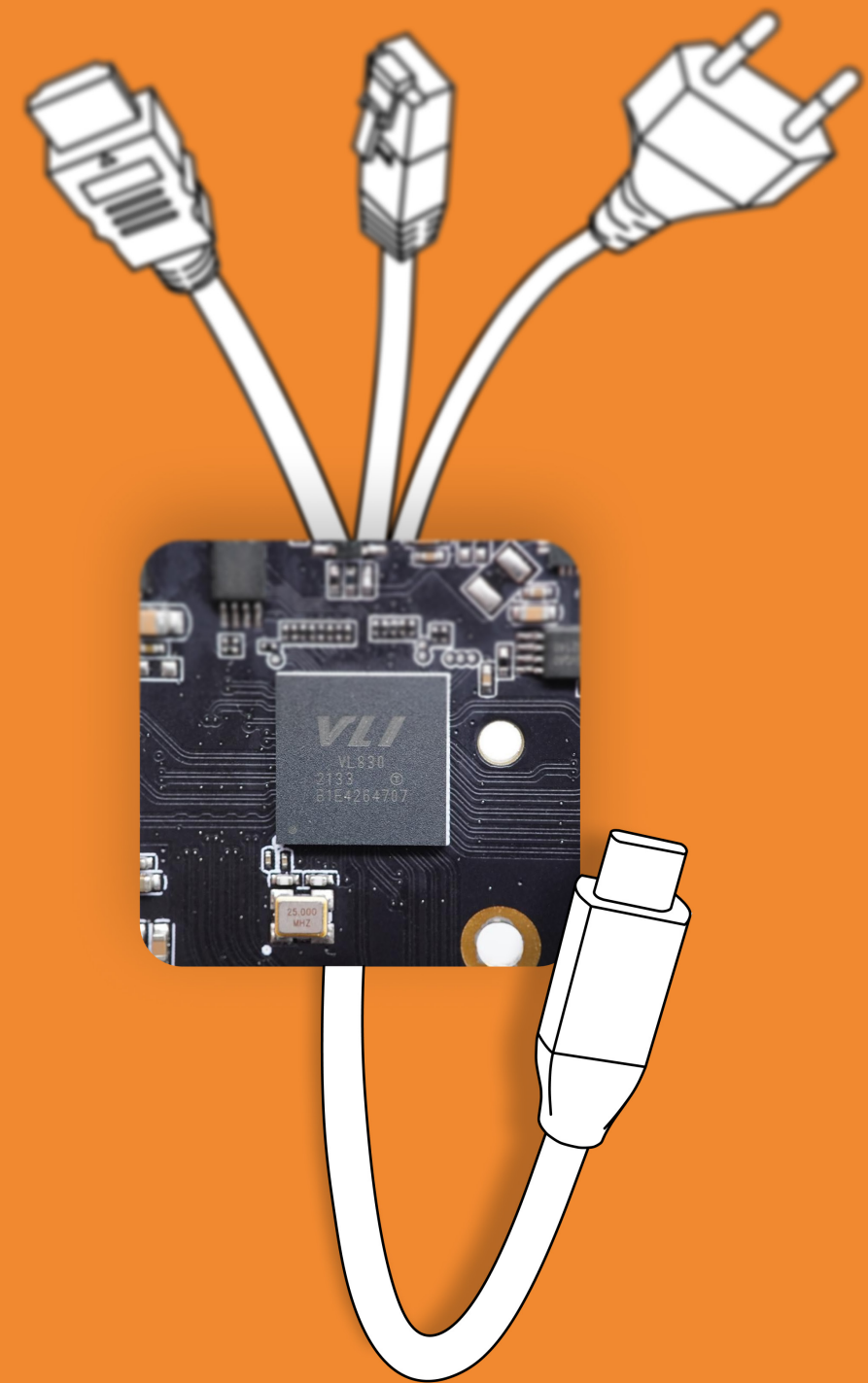
According to this European law, by the end of 2024, all mobile devices must be rechargeable via USB-C, a requirement that will extend to laptops by spring 2026.

However, "USB-C" merely describes the physical connector shape. Its true versatility lies in the underlying protocols it facilitates.

Through this single reversible plug, devices access USB Power Delivery (PD), a smart negotiation protocol capable of handling variable voltages to charge any device, from earbuds to workstations, up to 140W.

Simultaneously, USB-C supports USB4, the latest data standard built on Thunderbolt architecture, offering massive bandwidth for video and data transfer.

Managing these complex, simultaneous flows of energy and information requires advanced logic. This is made possible by specialized controllers like the ViaLabs VL830 (shown in the following page), an endpoint chip designed to manage USB4 speeds and PD requirements, ensuring the "one cable" ecosystem functions seamlessly.



USB controller chips, like ViaLabs VL380, enable HDMI, Ethernet and power signals through one single USB-C

■ Enabling technologies

- Wide bandgap semiconductors

The wide bandgap semiconductor Gallium Nitride (GaN) represents the long-awaited solution to the thermal and miniaturization challenges associated with Silicon (Si)-based components of the power electronics industry.

First introduced in 2018, the major differences are found in the atomic structure of the materials; specifically, GaN has a higher bandgap than Si.

The “bandgap” is essentially the amount of energy required for an electron to cross the energy barrier and pass from one side of the atom to the other to enable electrical conduction. This enables the material to support higher electric fields and temperatures before “breaking down”.

The effects of this increased stability can be illustrated by considering a transistor as simply a fast on/off electronic light switch. This switching action is the primary function of a transistor, which

is to turn the flow of current on and off in rapid succession to control the flow of power.

Due to its atomic properties, GaN enables the “light switch” to be turned on and off at rates that are many times faster than those possible using Silicon. Higher speed operation of transistors directly translates into smaller passive component sizes; i.e., smaller transformer, inductor and capacitor sizes.

In contrast to Silicon-based converters that generate large amounts of heat at high speeds, requiring large heat sinks and physically separate components, GaN-based converters maintain their high efficiency, but produce very little additional heat. As a result of this low-heat characteristic, GaN components can be placed closer together, resulting in an approximate 60% volumetric reduction in size when compared to equivalent Silicon components.



Size and power density comparison of GaN based power adapters and traditional Silicon based ones

■ Enabling technologies

— Silicon-carbon anode batteries

While power conversion efficiency has skyrocketed, battery chemistry has evolved at a slower pace.

The typical Lithium-Ion cells used in most of our portable devices contains a graphite anode, and graphite has very low ability to store lithium ions. But starting from around 2023, a huge breakthrough in battery technology came with the launch of the first devices equipped with Silicon-carbon (Si/C) anode batteries.

The main benefit is atomic: a silicon battery can hold about 10 times as much lithium as a graphite battery.

This leap is most evident in the 21700 form factor, the current industry standard for high-capacity power banks and electric vehicles. While a traditional high-end 21700 Li-Ion cell peaks at around 5,000 mAh, equivalent Silicon-Carbon cells are already breaking the 6,000 mAh barrier. This allows for

a substantial increase in energy density, meaning more capacity without increasing the physical volume of the battery.

However, the adoption of this technology faced a major physical obstacle: swelling. During charging, pure silicon can expand as much as 300%, causing cracking in the electrodes and decreasing the battery's lifespan. The solution involves a nanocomposite structure with silicon particles contained within a conductive carbon matrix that will accommodate the expansion of the silicon while providing structural support.

This technology has successfully moved from the lab to mass production. Industry leaders like Xiaomi, Honor, and OnePlus have already implemented Si/C batteries in flagship devices, proving their viability for high-performance consumer electronics



Battery capacity comparison of similar sized phones. Xiaomi 17 Pro Max, on the right, is the only one equipped with a SiC battery

Following the research on the target users' pain points and the available technologies, a market analysis was conducted to identify what's already available for users to purchase.

This benchmark analysis of existing products is useful to identify market gaps and help define a clear counterbrief and precise project scope.

The investigation categorized existing players' offerings into three main groups:

- devices for power
- devices for connectivity
- devices for mobility

Benchmark

— Devices for power

Name: 200W GaN Extension Box

Price: 159\$

What it does: This grey box sits on your desk and acts as an all-in-one charging station for USB-C devices. It has a built in power adapter and retractable USB-C cables, making it easier to keep your desk uncluttered.



Name: 65W Ultra-Slim GaN Charger

Price: 49,99€

What it does: This GaN charger from UGREEN provides up to 65W to three devices in one of the thinnest form factors available. Such thickness is achieved by mounting the tallest components (capacitors ecc.) to the PCB laying flat on their side.



Benchmark

Devices for connectivity —

Name: Microsoft USB-C Travel Hub

Price: 109,99\$

What it does: This USB-C hub comes with a built-in cable and no power brick, that makes it ideal for travel. Its strong point is portability rather than performance as it provides HDMI, ethernet, VGA and additional USB ports. It is powered by the host device, so it cannot provide charge to it.



Name: Dell Thunderbolt 4 Dock

Price: 336€

What it does: One of the highest performance docking stations. It is powered by the laptop's original charger and it is connected to the laptop via USB-C. Through one USB-C connection to the host laptop it can transfer power, screens, data ports, ethernet



Benchmark

— Devices for mobility

Name: Aukey MagFusion Ark

Price: - to be launched Q1 2026

What it does: This is a modular wireless charging system with a Qi2.2 multi-pad base and detachable spheres. Each sphere has a 6,700mAh battery and a bi-directional USB-C port, making it a fixed wireless charging station and a portable power bank.



Name: Anker 30W Fusion Power Bank

Price: 49,99\$

What it does: The Fusion line from Anker introduced a new product category to the market: power banks with integrated chargers. It can be used as a regular power bank, but when plugged in a wall socket it acts as a charger by passing power through to your devices.



Benchmark

Conclusions —

The benchmark analysis reveals a market characterized by saturation yet fragmentation. While there is an abundance of standalone accessories, ranging from high-power desktop bricks to pocketable but underpowered batteries, no single solution effectively bridges the gap between performance and mobility.

Currently, achieving a complete hybrid setup forces the user (or the IT procurement) to piece together a disjointed puzzle: a charger for power, a hub for connectivity, and a battery for travel. This results in functional redundancy, aesthetic incoherence, and a bumpy user experience where the devices compete for space in the bag rather than working in synergy.

This fragmentation identifies a clear market gap. There is a distinct lack of a unified ecosystem designed to dissolve the boundaries between the static office

and the nomadic lifestyle. To fully understand the operational impact of this void, the following chapter, 'Problematic Scenarios', will visualize the specific friction points that arise when these fragmented tools fail to support the fluid reality of modern work.

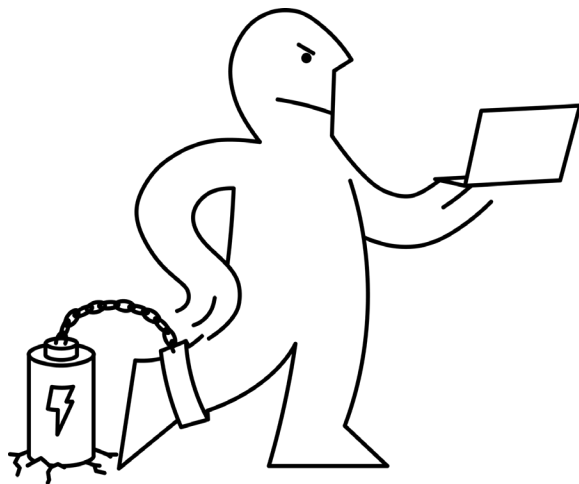
Problematic scenarios

From the reasearch on Gen Z workers' habits and, more specifically, from the interviews, it was possible to get a clearer idea of the most problematic scenarios these young professionals face on a day-to-day basis, linked to their company provided devices.

Whether when moving from their desk to a meeting room, or when packing their laptop bag for a work trip abroad, there is a myriad of daily small interactions with their work tools that, if not smooth and seamless, can cause unwanted additional stress.

Thus, in order to keep project development on the right track, 4 core problematic scenarios occurring in the users' routines were highlighted and analyzed, with the objective of addressing them directly.

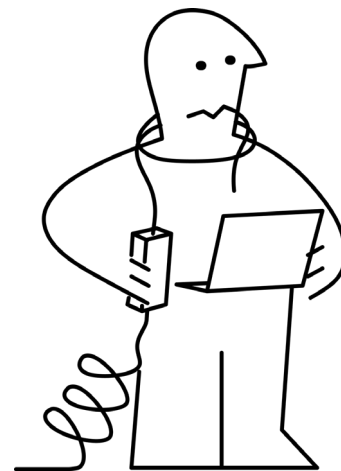
■ Problematic scenarios



Feeling locked to your desk because of laptop battery anxiety

While Low Battery Anxiety affects users across all demographics, younger generations, often dubbed “digital natives”, tend to exhibit more pronounced anxiety when battery levels drop.

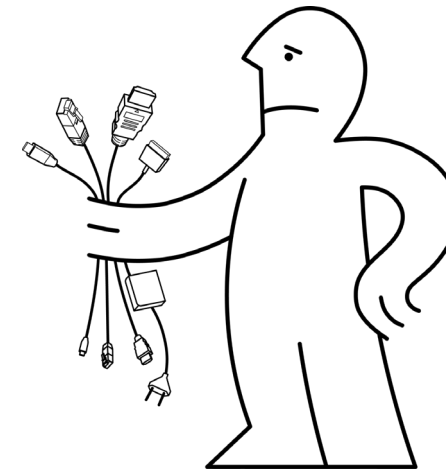
Also, from the interviews, Gennaro shared that sometimes he would like to do some of his work tasks from the couch at home, but his laptop’s battery unreliability prevents him from doing it comfortably.



Moving away from your desk with your laptop and charger

As shared by Lucia in her answers, bringing backup power for your laptop to meetings is essential.

But given the bulky chargers that are provided with most laptops, moving from one room to the other often becomes a challenge of balancing a laptop with one hand and trying not to get tangled in cables with the other.

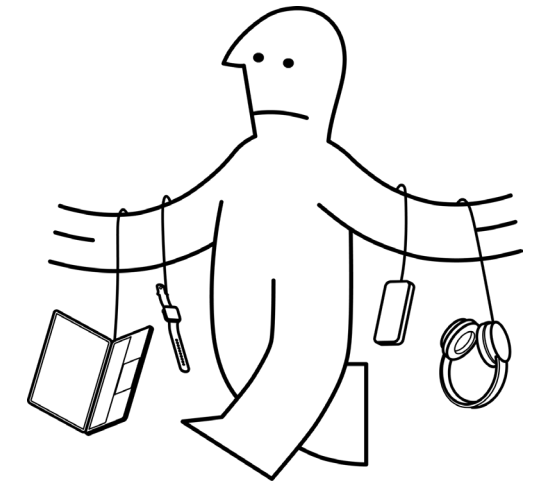


Plug and unplug cables each time you switch desks

Work laptops are almost never used bare.

Being tools that employees potentially use for 8 hours a day, they often come with attachments that make using them more comfortable: larger displays, fast ethernet networks, constant charging, wired mice and webcams etc.

Though each of these handy attachments comes with cables that have to be plugged and unplugged from your laptop, one at a time.



Carry multiple chargers for multiple devices when traveling for work

With the increasing number of personal devices that everyone carries around with them also comes an increasing number of chargers and cables.

The scenario can get problematic when traveling to countries with different wall socket standards, as you are then required to pack an adapter for each charger, or a bulky multiplug.

■ Counterbrief

The findings of the user research, technological evaluation, and market benchmarking were then synthesized into a definitive counterbrief that will serve as the basis for the project's strategic direction.

This counterbrief converts the identified friction points (cable clutter, battery anxiety, setup fragmentation) into actionable design opportunities with which the development process can be guided.

The objective shifts from developing an individual “accessory” to developing a cohesive ecosystem of seamless actions.

This counterbrief provides the general idea towards which the development is headed. Next, stricter requirements are defined to ground the solution into measurable parameters.

Design an ecosystem around users' work laptops capable of achieving a seamless transition between working from the office, from home and from everywhere in between.

Requirements

While a counterbrief defines a general idea to head towards, during the development of a project, clear and quantitative requirements are needed to enclose project parameters into desirable ranges.

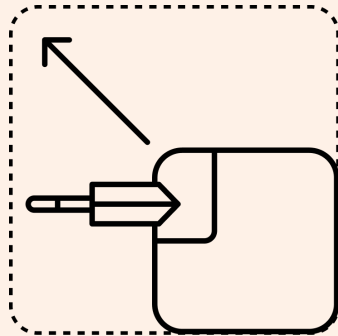
In the following pages, the data gathered via the user research, the enabling technologies and the benchmark analysis finally get crystallized into specific requirements capable of driving the design efforts towards an effective solution.

The way a user and a product interact, and the way a product impacts a user's experience are determined by three central aspects of how that product is designed:

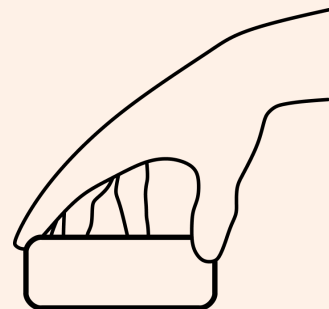
- Its physical dimensions and how they relate to the user's body and the environment it is used in
- The experience it is designed to provide to the user, and how different it would be without it
- The practical features the user can take advantage of

■ Requirements

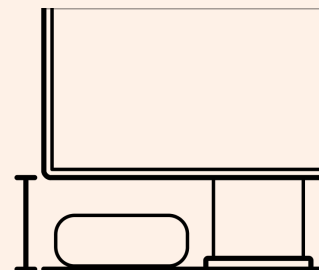
— Dimensions



Portability
Size comparable to average laptop chargers (<30% volume increase)



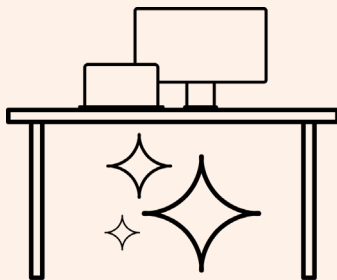
Handling
Size and ergonomics capable of one-handed use (< 120mm max width)



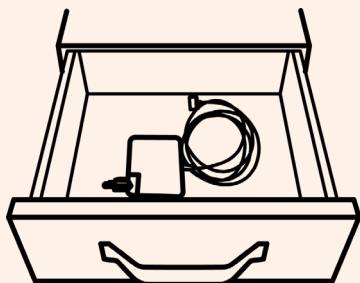
Desk compatibility
Fits usual desk setups (e.g. fits under most monitors, height < 80mm)

Requirements ■

Experience —



Clutter-free
Ease cable management for a tidy desk setup



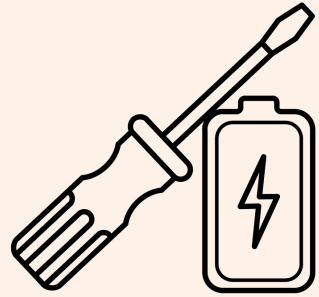
Error-proof
Ensure basic functions in most situations



Versatility
Ease of switching from desk use to on-the-move-use (< 5 seconds for switching)

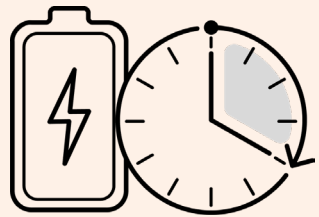
■ Requirements

■ Features



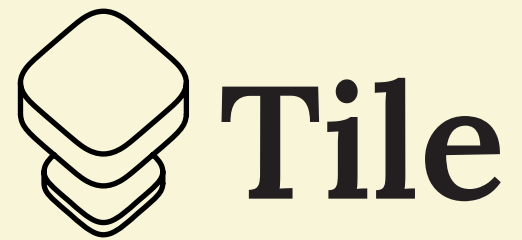
Repairability

Ease of access to consumable hardware
(integrated batteries)



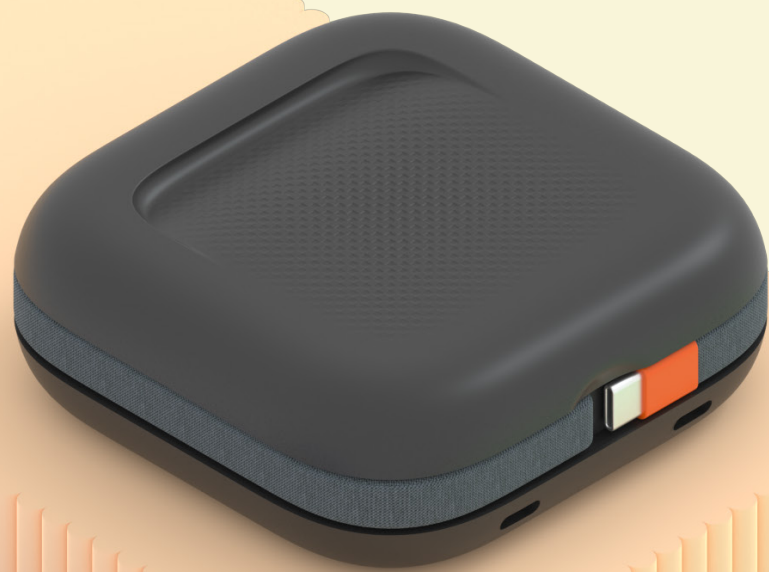
Stress-free laptop use

Provide battery support for 3-4 hours of laptop use away from a desk



Tile

Workflow continuity ecosystem



Executive design

Modules overview

In this chapter, Tile, a workflow continuity ecosystem, will be presented.

Tile is a modular ecosystem composed of 3 module types:

- the Core module
- the Base modules
- the Travel module

By combining them together, or working standalone, each one of the modules plays a role in providing users a seamless hybrid work experience.

The previous chapter was used to recount the research methods that were used (interviews, enabling technologies analysis, benchmarks etc.), how that data was interpreted, and the way it was translated into actionable design requirements.

In this “executive design” chapter, it is shown how the requirements were taken as guidelines throughout the development process of a solution capable of responding to the defined counterbrief.

■ Modules overview

■ Mobile module

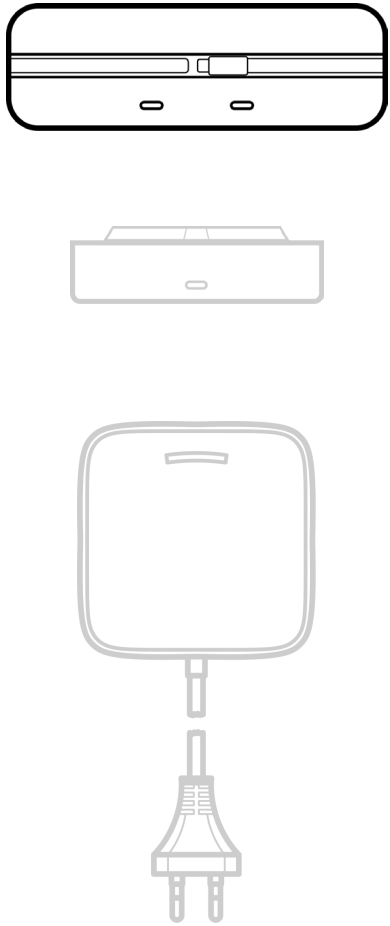
The **mobile module** is the core piece of the Tile ecosystem.

Hybrid working professionals are always carrying their laptops around in their bags or backpacks; this module is designed to replace the laptop charger users are used to bring with them everywhere they go.

For this reason its main purpose is to provide a power backup to users' laptops, and it achieves it by being equipped with a 65Wh Silicon Carbon battery and an integrated USB-C cable, making it a power bank for away-from-desk use.

But it is when it gets combined with the two other modules of the ecosystem that its full potential is reached, as it unlocks two extra features:

- USB4 docking station with 100W laptop charging
- 65W charging station for up to 3 devices



Modules overview

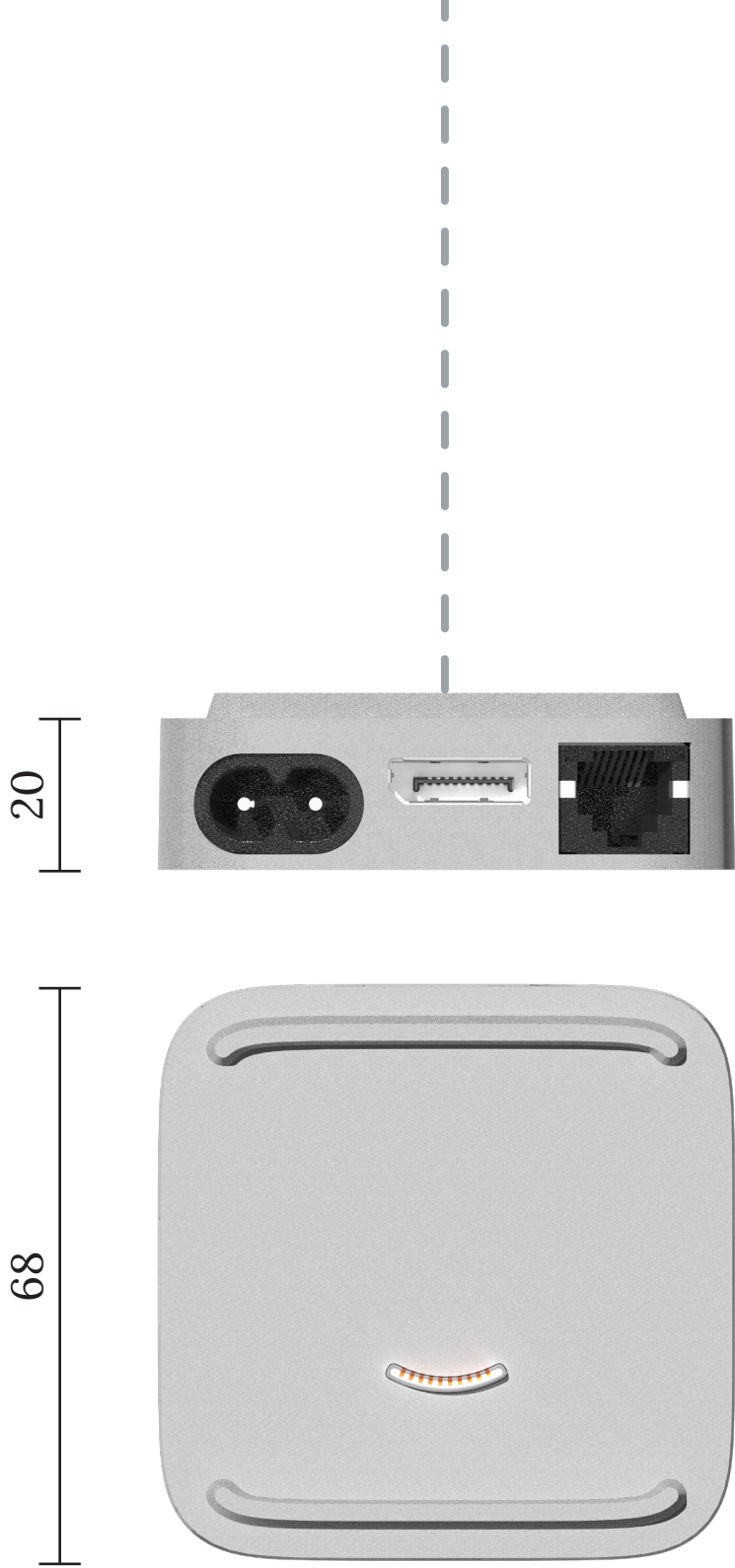
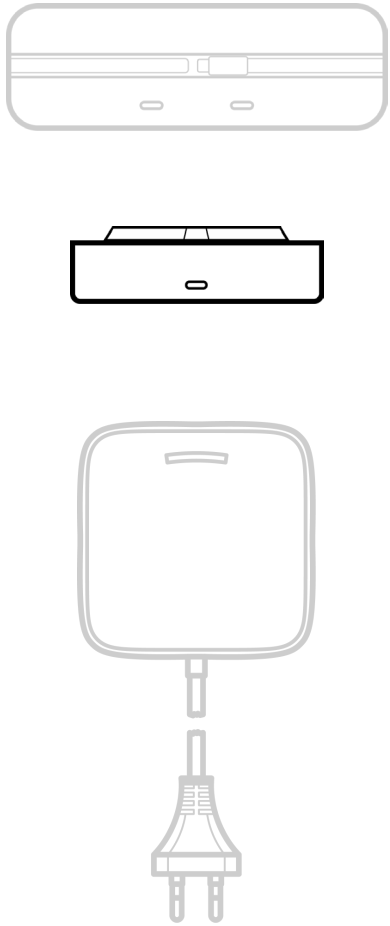
Base module

The **base module** is the most stationary device in the Tile ecosystem, as it permanently sits on a desk. When combined with the mobile module it enables scenarios where the most power and connectivity are needed.

Two identical units of the base module are provided with each Tile kit: one unit is for the office desk and another one for the home desk.

Each base module also comes with a separate power cord, and it adds 5 additional ports to connected user laptops (DisplayPort, Ethernet, 2 USB-C, 1 legacy USB-A).

When the mobile module is slotted on top of the base module it can provide 100W charging and USB4 connectivity to a host laptop. Instead, 30W charging and USB4 connectivity are also available with a USB-C cable straight to the base module's port.



■ Modules overview

■ Travel module

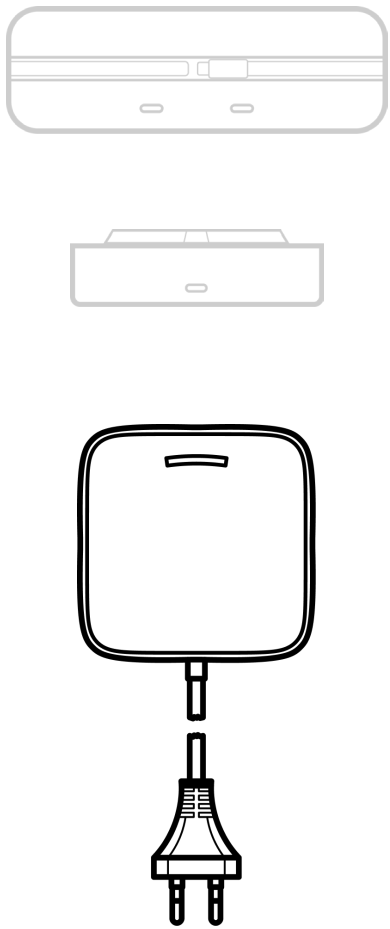
The **travel module** is the only non-standalone module of the Tile ecosystem, as it only activates when combined with the mobile module.

Stored away for the most time, the travel module only comes in the mix on the occasion of business trips.

It consists of a base and an integrated power cord, and its main function is to connect to the mobile module to power it up via a wall outlet.

The travel + mobile module combination, together with 2 additional USB-C cables, charges up the mobile module's batteries and acts as a 65W charging station for up to three of the user's devices.

This way, when traveling for work, Gen Z professionals can leave at home their laptop/phone/earbuds etc. chargers, and only pack these two Tile modules and two USB-C cables to satisfy all their battery charging needs.



Bring your work where your comfort is



Use scenarios ■

The improvements an ecosystem like Tile can bring to any user are strictly related to how dynamic their average work day is.

The way dynamism can be evaluated depends on two factors:

- **Day-to-day variability:** how often in a week they work from home or from the office (3+2 workweeks, like BTicino's, are the perfect example), and the occasional business trip
- **Hour-to-hour variability:** how often in a day they move their laptop away from, or to their desk (e.g. for in-person meetings, or the occasional email drafted from the couch at home)

Then it is evident that the more a professional moves around with their main tool, a laptop, the more a smooth transition from at-the-desk work to away-from-desk work, and viceversa, gains importance for them.

For this reason, it was essential for Tile

to provide the most seamless interaction in 3 key moments of the employee's routine:

- **Moving back to a desk,** reconnecting power and peripherals to your laptop
- **Moving away from a desk,** disconnecting power and peripherals
- **Packing for business trips** and charging multiple devices

These 3 fundamental ways to interact with the Tile ecosystem will be presented in this chapter via schematized storyboards.

■ Use scenarios

— Working at your desk

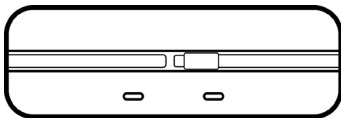
Finalizing a complex 3D render or inspecting a dense spreadsheet are tasks that require maximum focus and the biggest help from technology.

Max processing power, ethernet speeds and a big monitor are fundamental in these high-effort scenarios, and with the correct combination of Tile modules it is possible to achieve such peak performance in a seamless way.

When the base module and the mobile module are combined and connected to the host laptop, they add up the individual DC power from their integrated power adapters, to provide up to 100W charging to the host via the built-in USB-C cable.

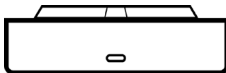
Also DisplayPort, ethernet and USB data feeds pass through the base module, to the mobile module, to the user's laptop, all via the convenient built-in USB-C cable.

Required modules



Mobile module

+

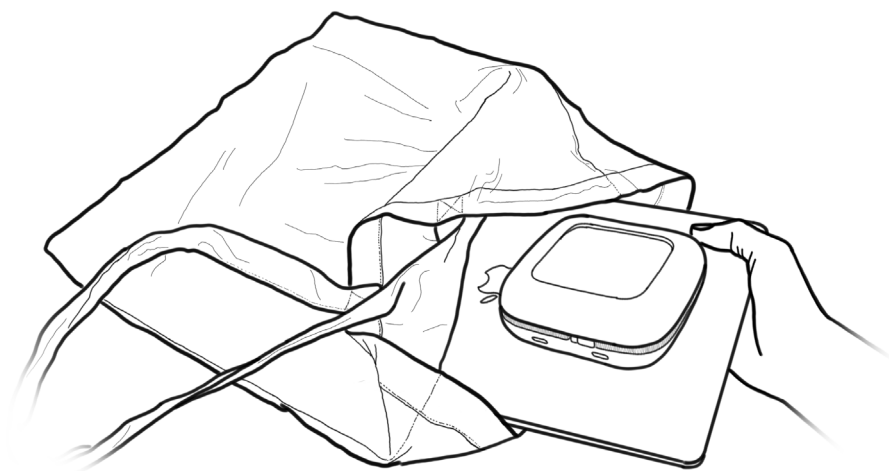


Base module



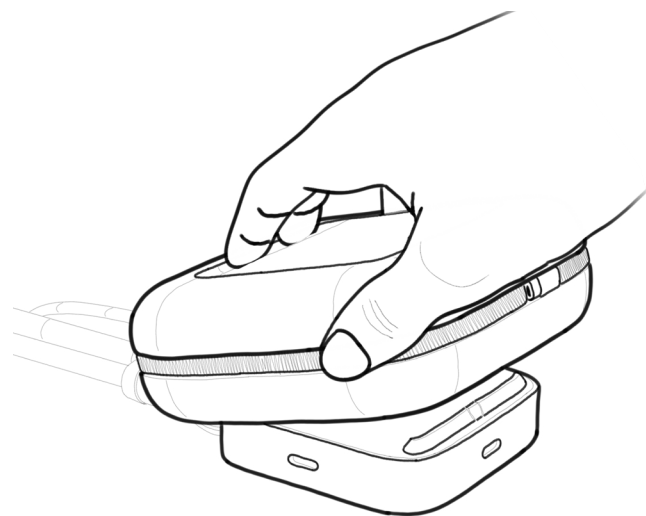
■ Use scenarios

— Working at your desk



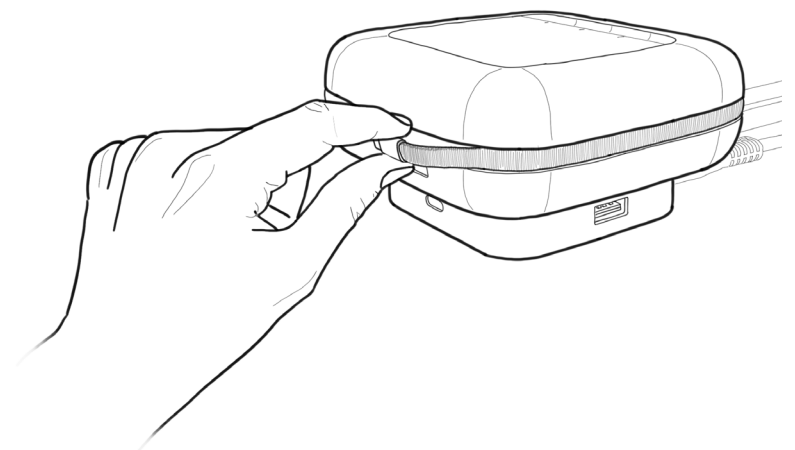
1. Carry your devices in a bag

All you need is your laptop and your Tile's mobile module



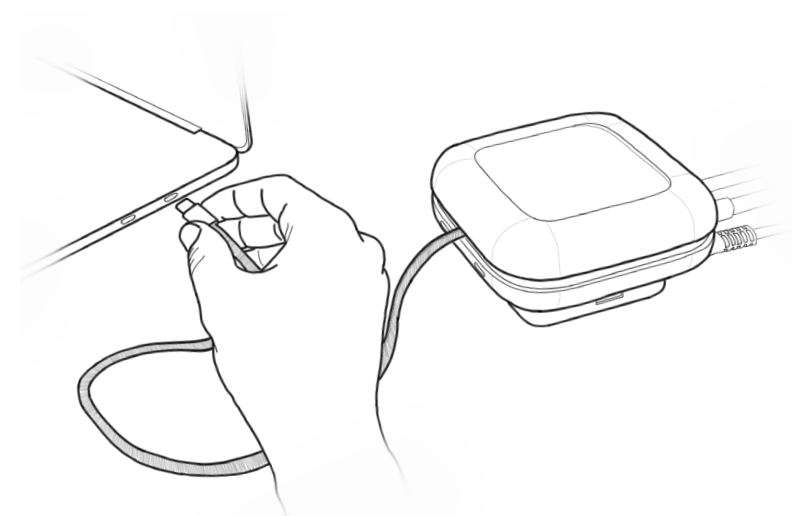
2. Place the mobile module on the base module

The mobile module will align perfectly with the base and it will slowly fall in place



3. Grab the integrated USB-C cable

The mobile module will extend the USB-C cable towards the user with a soft motion



4. Plug the combined modules into your laptop

No plugging into sockets, no reconnecting screens or ethernet. Just three simple motions to unlock your laptop's full potential

■ Use scenarios

— Working away from your desk

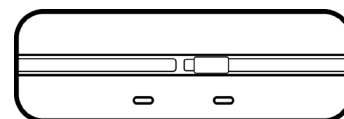
Peak laptop performance is not always the main requirement though. Sometimes, versatility and comfort are everything the Gen Z hybrid employee needs from their work setup.

Whether they need to attend a meeting in a conference room, or complete a more relaxing task on their home's balcony, users can detach their Tile's mobile module from its base and carry it around with their laptop.

When Wi-Fi connectivity and 65W of power are enough, Tile users can keep their laptops powered up for 3 to 4 additional hours, estimating a 15Wh average power consumption (with videocalls, web browsing, spreadsheets etc. on last-gen processors).

With no additional cables or bulky chargers, Gen Z professionals who use Tile can take their work where they feel more comfortable doing it.

Required modules

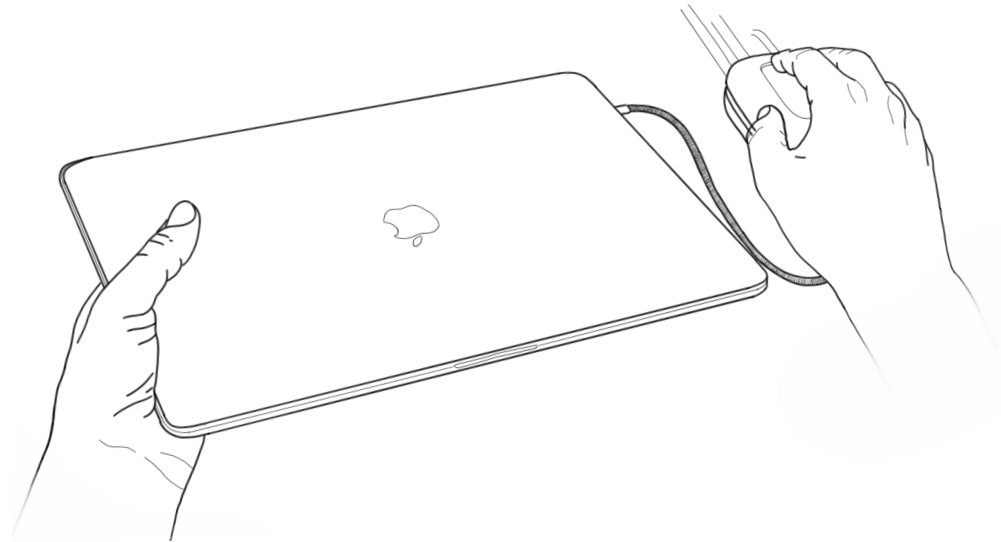


Mobile module



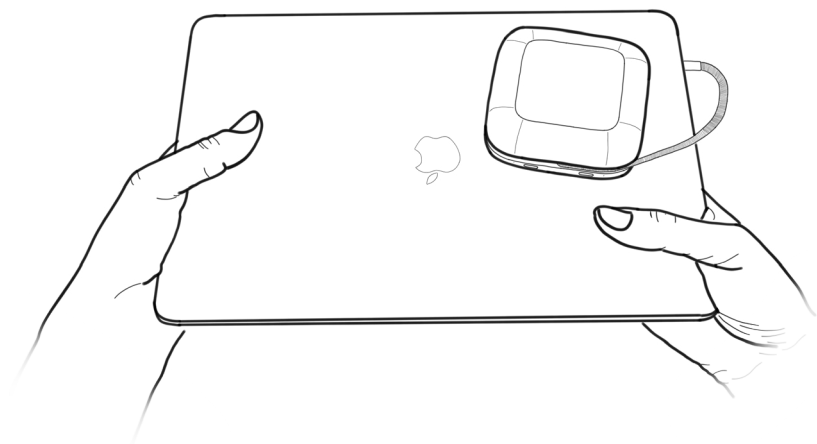
■ Use scenarios

— Working away from your desk



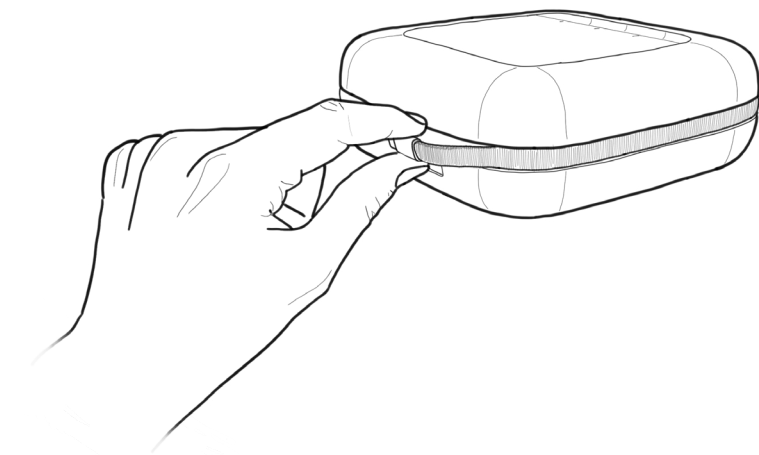
1. Lift your laptop and mobile module

The built-in USB-C cable can stay plugged into the laptop



2. Walk to where you want to bring your work

Walk to your destination. No long cables, no power adapters, no balance challenges



3. When you're done, wrap the cable

Wrap the built-in cable around the mobile module following its rail. Its head will latch magnetically on the front of the module

■ Use scenarios

— Business trips

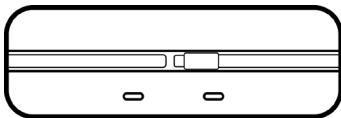
Sometimes modern work necessities take Gen Z employees *really* far away from their desks. In today’s international commercial landscape, with global markets and de-localized supply chains, specialized professionals often need to go on business trips.

And it is in such unfamiliar contexts that comfort and versatility, on and off their work hours, become even more vital.

For these occasions, users only need to add the travel module and two additional USB-C cables to their everyday setup, along with the mobile module.

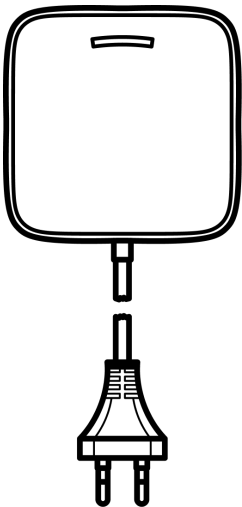
Thus, they can leave behind their phone/watch/earbuds chargers, and rely on Tile’s ecosystem to charge 3 of their devices at the same time. All with the added advantage of only needing one single plug travel adapter.

Required modules



Mobile module

+

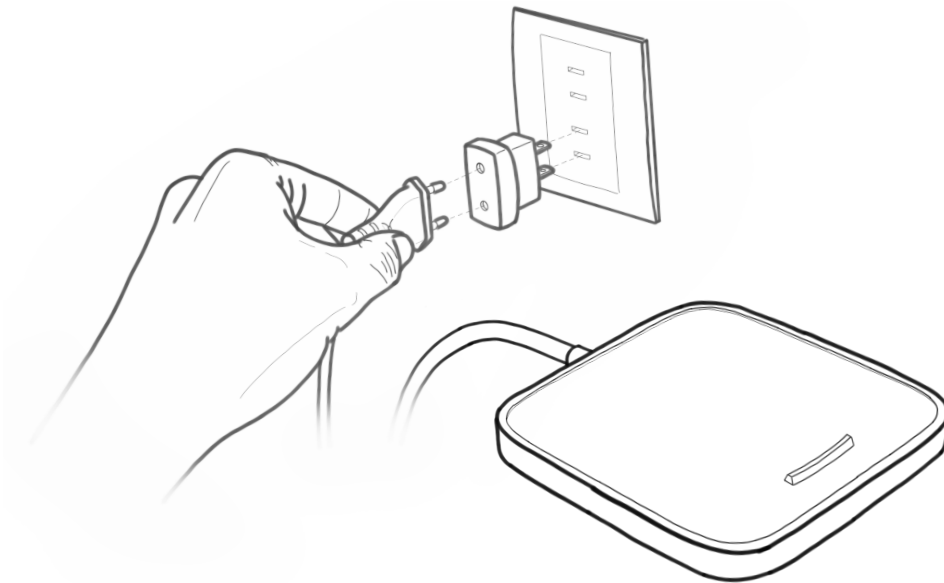


Travel module



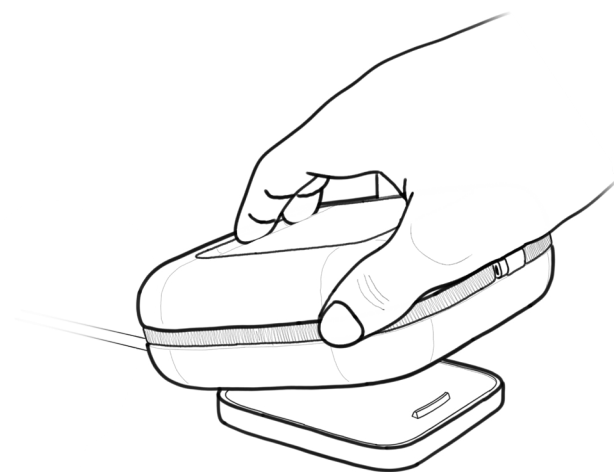
■ Use scenarios

■ Business trips



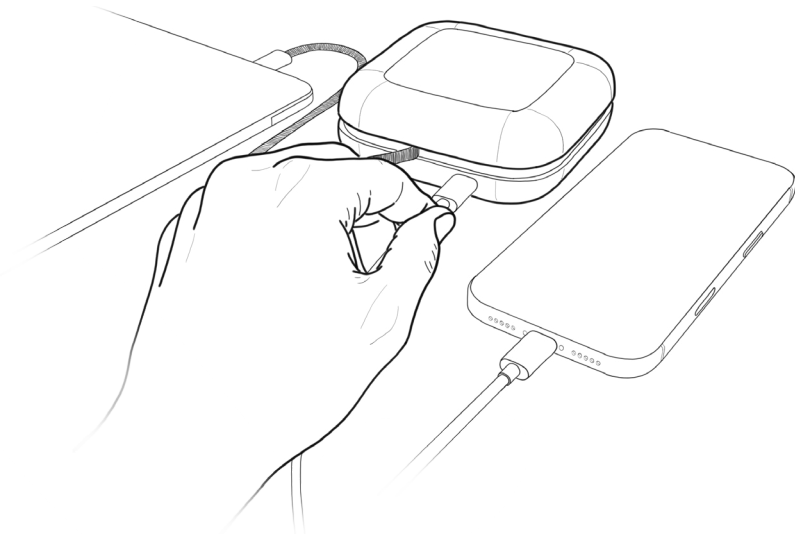
1. Plug the travel module into a wall socket

You only need one travel adapter for up to three devices



2. Place the mobile module on the travel module

The same interaction you are already used to.
The travel module will power the mobile module



3. Plug your devices into the mobile module

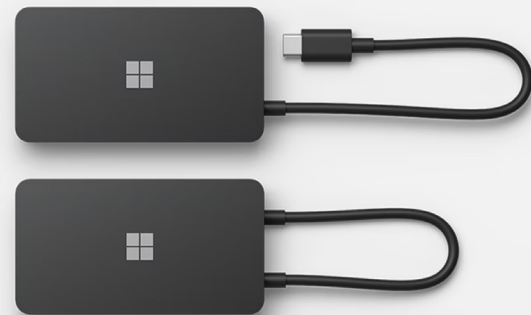
You can plug up to three devices using the built-in USB-C cable and 2 additional ones

Moodboard

Tile is catered towards premium OEMs like Apple or Microsoft



Rounded edges



Built-in cable



Hidden thickness



Textured surface



Stackable



Surface detail

■ Shape and proportions

— Ecosystem overall layout

Translating the visual language defined in the moodboard into a physical product requires a rigorous study of volume, geometry, and spatial relationships.

The first critical geometric decision was defining the overall layout of the ecosystem.

As shown by the sketches, two main overall layouts were initially analysed:

- a vertical layout, with the mobile module placed vertically on its base
- a stacked layout, with the mobile module laying flat on top of the base

Desk space is a premium commodity for the modern hybrid worker. In order to minimize the product's footprint, it felt logical to arrange the mobile module vertically.

But as much as the product's footprint could be reduced, it still could be clashing vertically with a monitor's lower edge, making this layout conflict with one of the

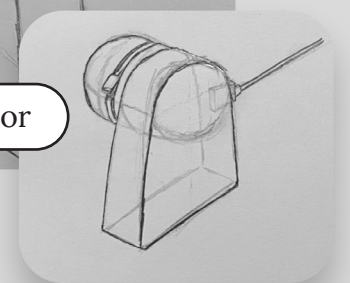
dimensions requirement that were defined.

Thus such vertical layout was discarded in favor of a horizontally stacked layout, achieving two purposes: visually, it merges the distinct parts into a single, monolithic entity when resting on the desk, reducing visual noise. Functionally, it enables a gravity-assisted, 'drop-to-dock' interaction, allowing the user to seamlessly align and connect the modules blindly with one hand.

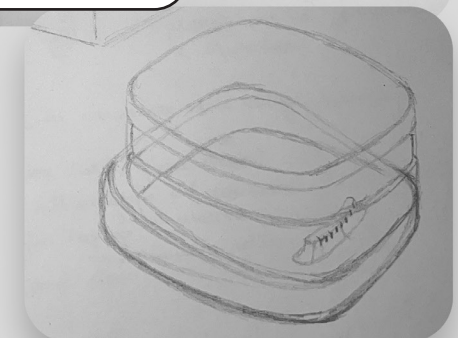
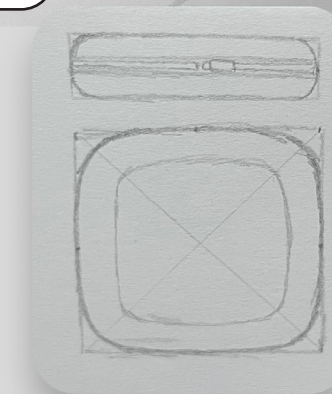
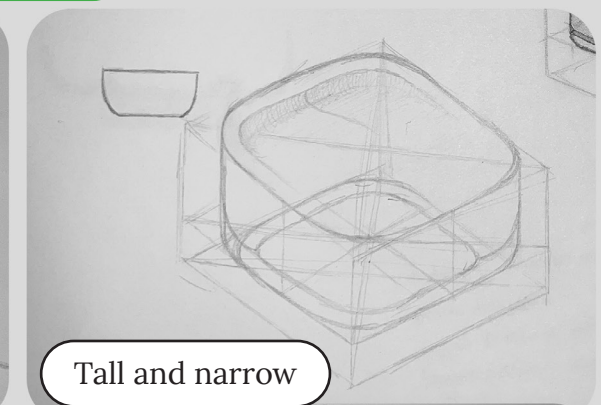
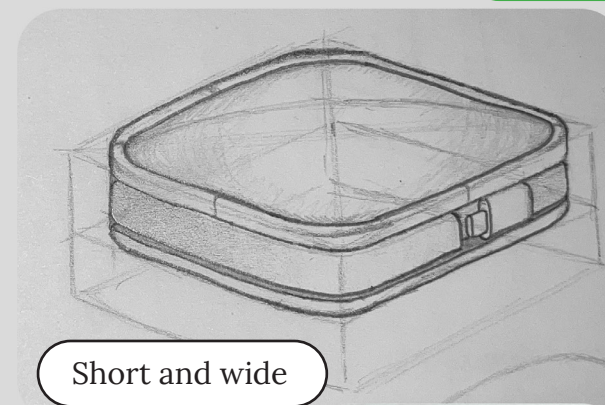
After the overall layout was decided, shape and proportions of the modules were left to be defined, ranging from wide to narrow and from short to tall.

Such decision depends also on the internal functional components, as described in the next chapter.

Vertical layout



Stacked layout



Shape and proportions

Mobile module internal layout

The layout of the internal components of the mobile module not only influenced its functionality, but also its shape and proportions.

The mobile module's functions revolve around batteries and PCBs for power, and I/O ports for connectivity. Also its weight balance is vital for comfort when carrying it.

Thus the criteria the proposed layouts were evaluated against were:

- number and position of SiC batteries
- availability of room for ports around the internal perimeter
- ease of cells installation during assembly

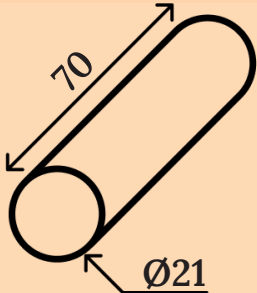
At this stage of the project, also the type and size of battery cells had to be defined to be able to design the shells and the other components around them.

Battery of choice:



Amprius 21700 SiCore
3.6V - 6300mAh - 22Wh

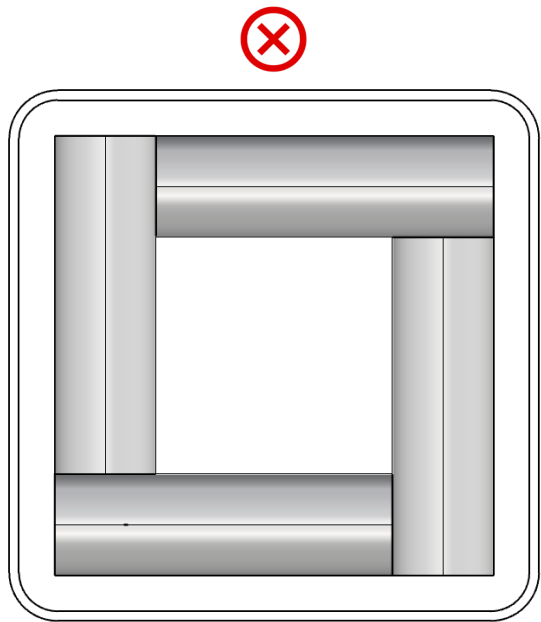
Dimensions:



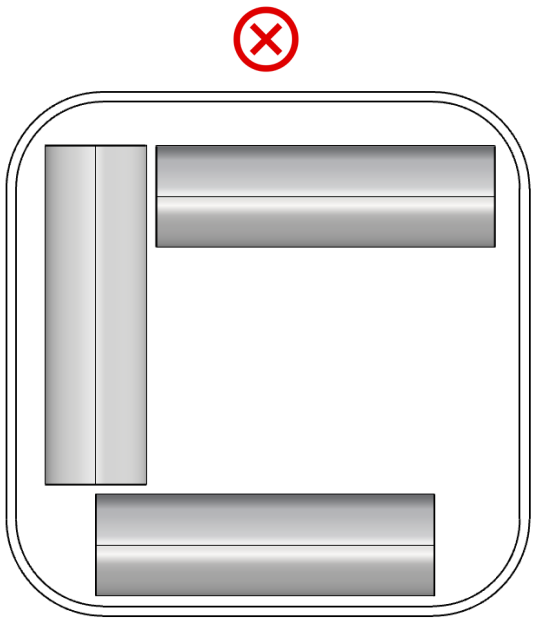
Capacity:

1 x  ↔ ~1h 

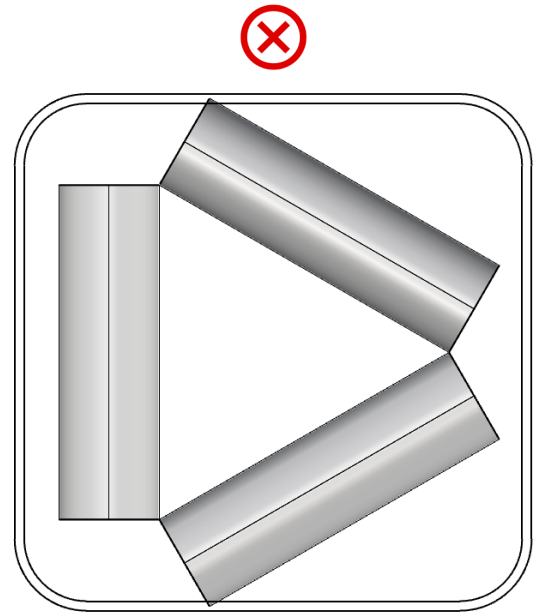
Each battery cell equates to roughly one additional hour of laptop use



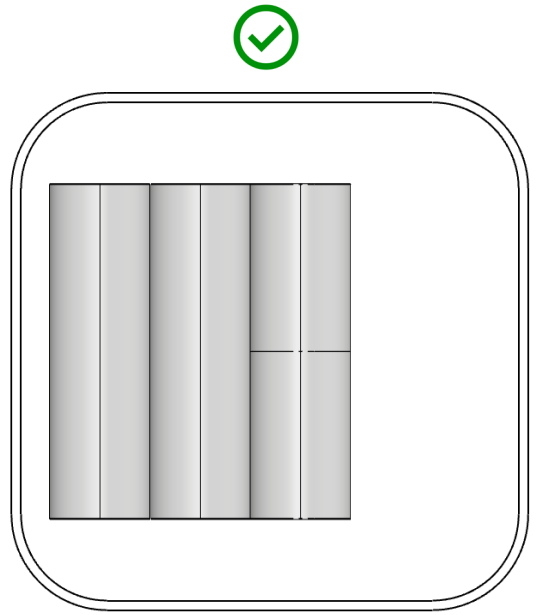
- ✓ 4 cells can provide more power
- ✗ Side walls are inaccessible for ports
- ✗ Cells assembled individually



- ✓ 3 cells provide enough power
- ✓ Ports on wall on the right
- ✗ Cells assembled individually



- ✓ 3 cells provide enough power
- ✗ Side walls are inaccessible for ports
- ✗ Cells assembled individually



- ✓ 3 cells provide enough power
- ✓ Ports on wall on the right
- ✓ Cells assembled as a pack

■ Shape and proportions

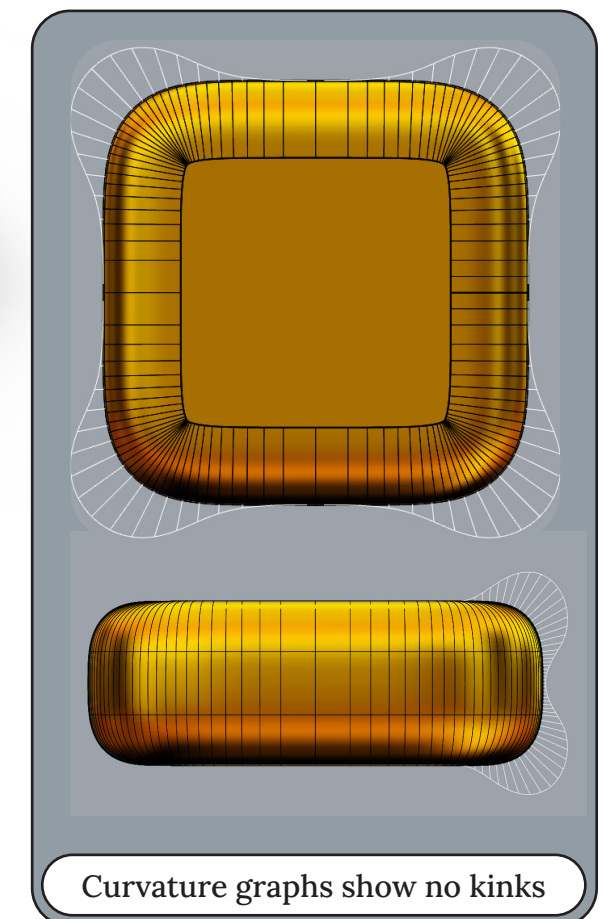
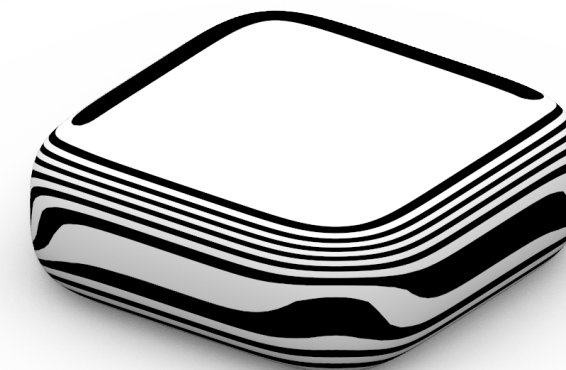
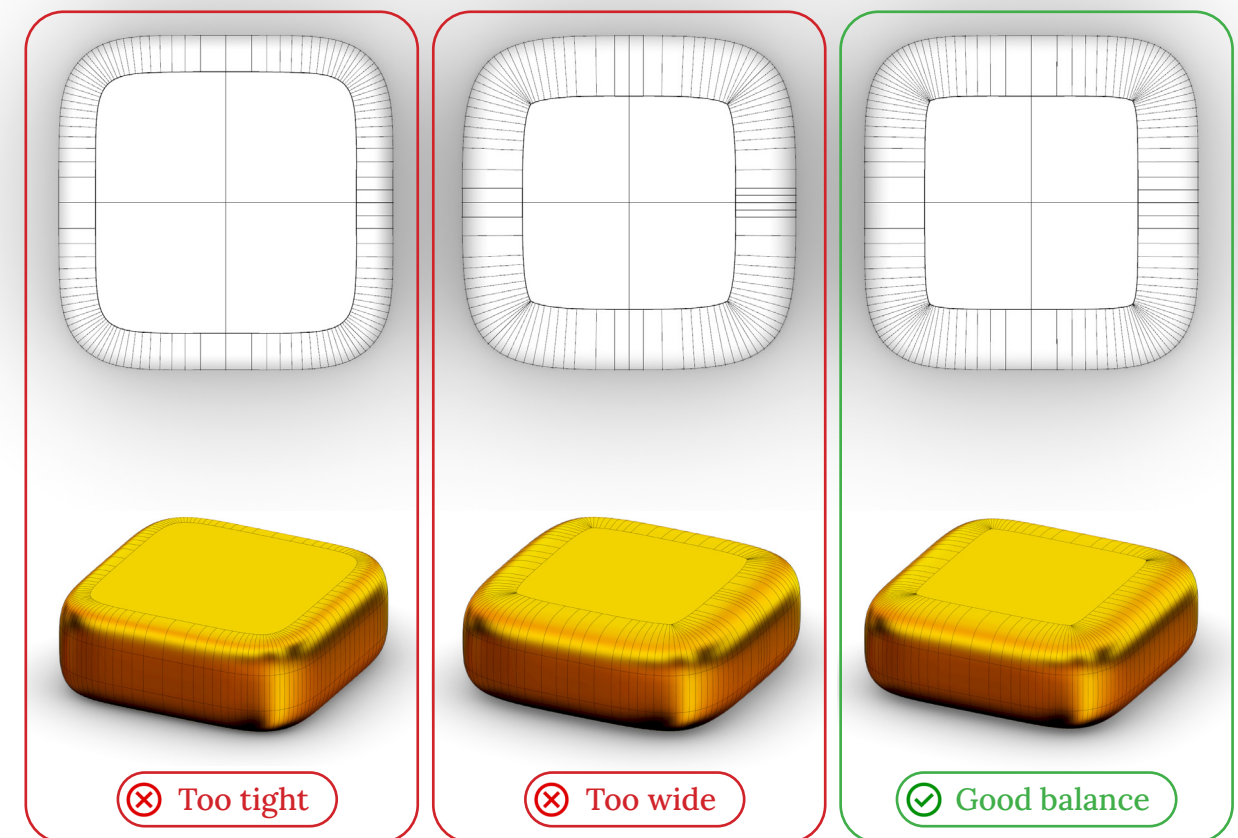
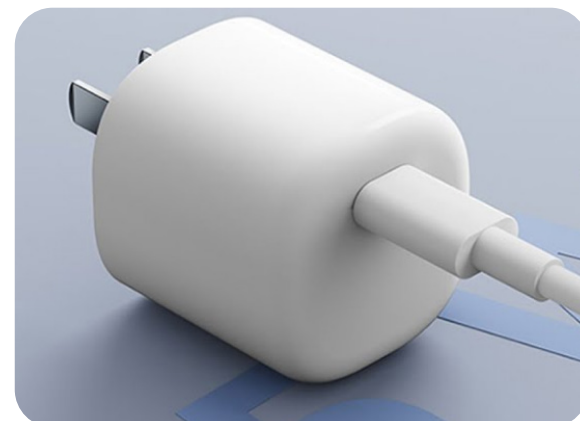
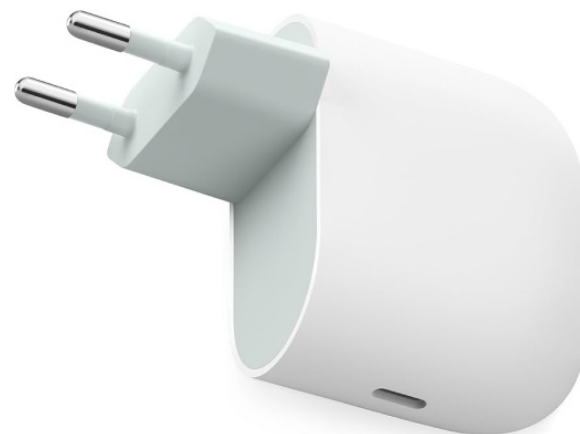
— Mobile module shape definition

Following the definition of the overall proportions of the mobile module, it was necessary to refine its look and aesthetic.

The strategy that was adopted when designing the external plastic shells of the mobile module was that of total, although subtle, minimization of flat surfaces. This strategy lets the product achieve:

- a premium plastic look, as molding defects are reduced and reflections flow more organically
- ideal sliding in bags, thanks to the absence of hard edges
- natural injection moldability, thanks to a properly placed parting line
- alignment with industry recognized premium looks, as shown by the two examples on the right

As shown by the examples on the following page, isocurves, curvature graphs and reflective surfaces were used to evaluate different designs.



■ Shape and proportions

— Mobile module parametric texturing

In premium consumer electronics, surface finishes are critical touchpoints that bridge the gap between mechanical engineering and user experience. For the top face of the Mobile Module, a simple flat finish was discarded in favor of a gradually-changing, parametric texture.

This decision fulfills both functional and aesthetic requirements. Functionally, the micro-pattern provides essential tactile feedback and enhances grip when the user undocks the module.

Furthermore, confining the pattern within a clearly defined area, both with the carved detail at the top, and with the noticeable fade towards the edges of the surface, creates a subtle split in the surface.

To achieve absolute control over this geometry, the pattern was generated algorithmically using Grasshopper. Rather than relying on standard post-processing maps, the algorithmic approach ensures a mathematically precise mani-

pulation of the surface detail.

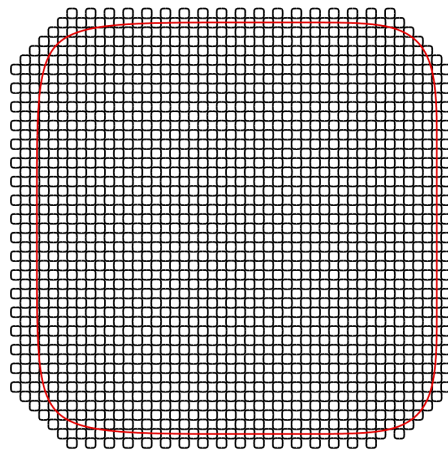
Through Grasshopper it is possible to use the mathematical relations among points to define the depth and the curvature of each dimple in the pattern matrix.

Particularly, in this case, the depth of the dimples gradually decreases the further they are from the center.

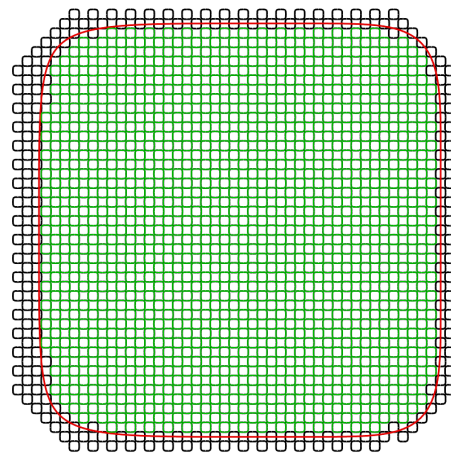
This pattern gives the surface it is applied to the feeling of it being curved, even though it is completely flat, in accordance to the approach adopted for the whole object.

In the following pages, the step-by-step process for achieving such surface control is described.

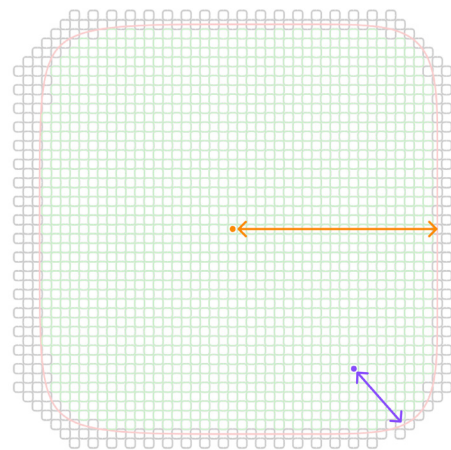




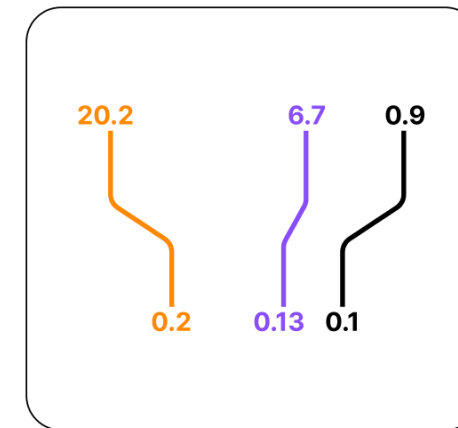
First, a matrix of rounded squares is defined



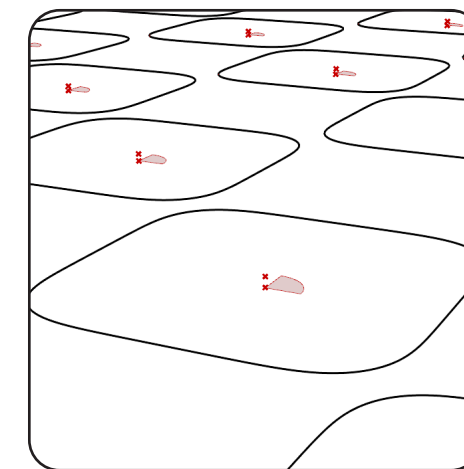
Then, the cells outside, or touching, a desired boundary curve are culled



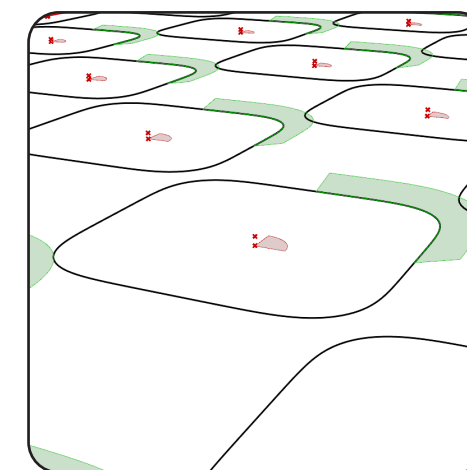
The distance of each cell from its closest point on the boundary curve is measured



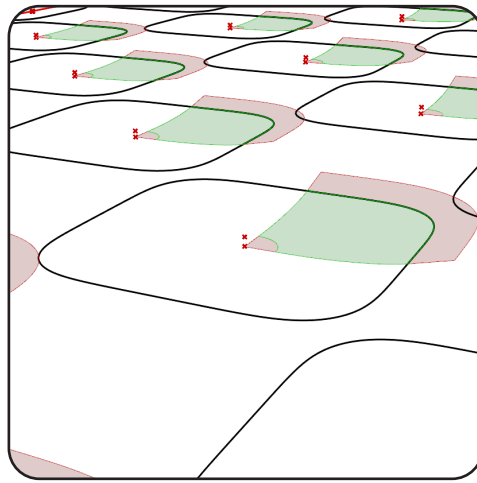
These length values are then proportionally remapped to a set ranging from 0.2 to 0.1



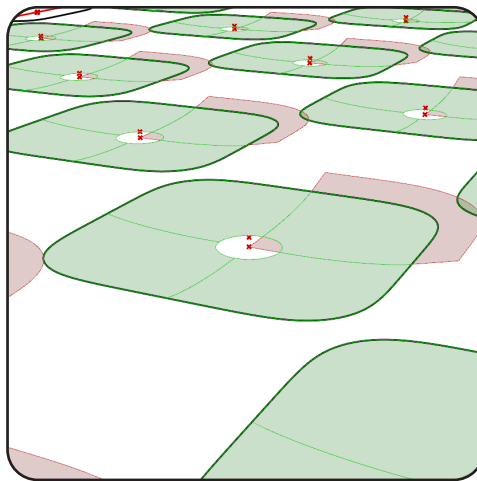
Each remapped value becomes the depth at which a quarter-circle sweep is created



A 90° sweep is also created on each cell of the matrix. The angle of the surface depends on the depth of the point, too



The two swept surfaces are then used as guides to obtain a blend surface that is curvature continuous to both inputs



The blends are then mirrored twice to obtain the whole surface of the dimple



Then, the dimples' edges are used to trim the base surface and are joined together

■ Shape and proportions

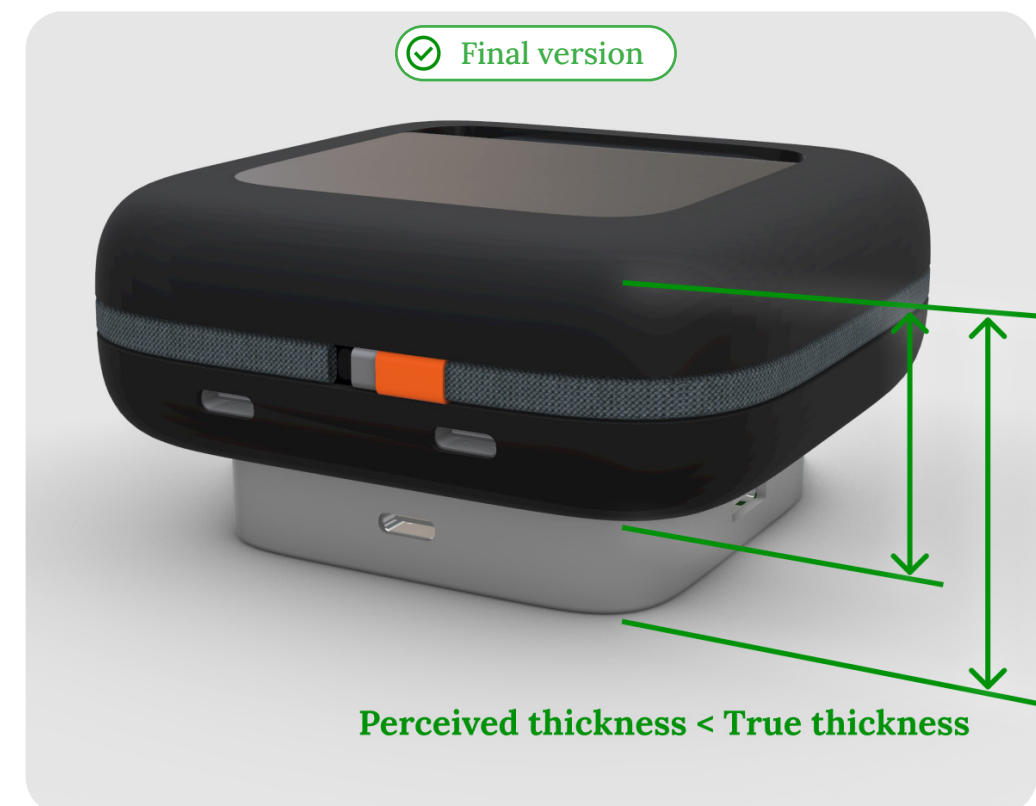
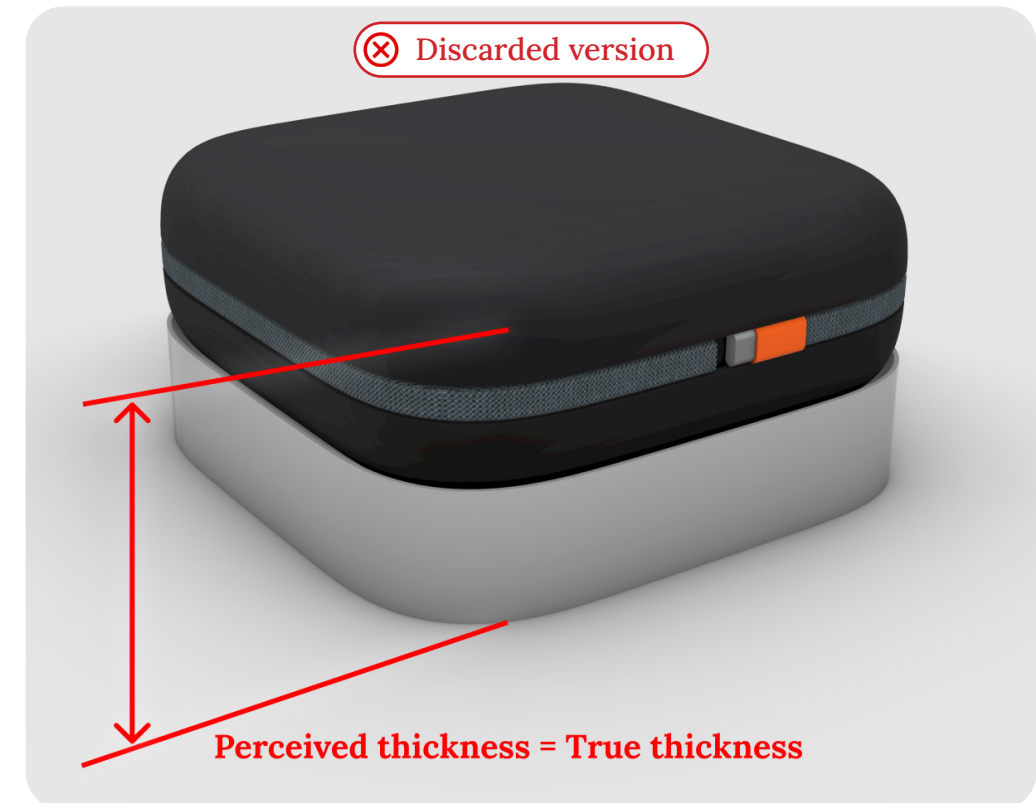
— Base module hidden thickness

Besides the mobile module's own shape, also its shape and proportions when docked on top of the base module play a big role on the ecosystem's overall look.

Thickness, and especially its reduction, is one of the main parameters that premium OEMs leverage to be recognizable over the market.

But when internal components impose a minimum thickness to the overall volume of the product, some visual tricks can be used to reduce the perceived size of the object.

Microsoft's Surface Laptop Studio 2 is a recent example of this design strategy's application: taking advantage of the users' elevated point of view, the main bulk of the laptop's body is hidden in the shadow of a thinner "visible layer".



■ Technical details

— Alignment feedforwards

The most iconic action when using Tile happens when users dock their mobile module onto the base module.

That is the moment when the switch from mobility and versatility to focus and power, happens.

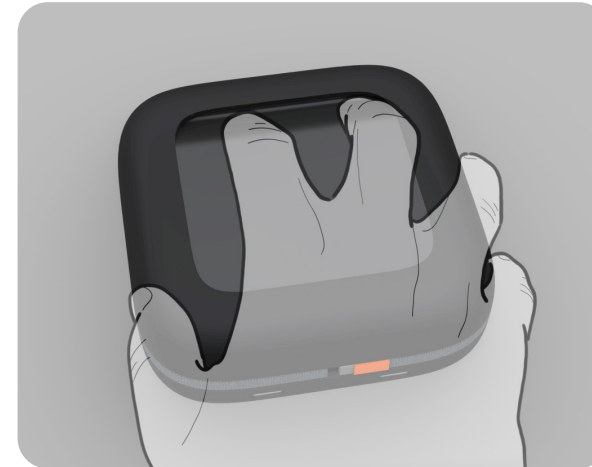
That moment should make users feel capable of doing their best work in the most comfortable way, so it has to come easy.

For this reason the visual and practical communication between the base module and the mobile module was studied with great attention to making it feel seamless.

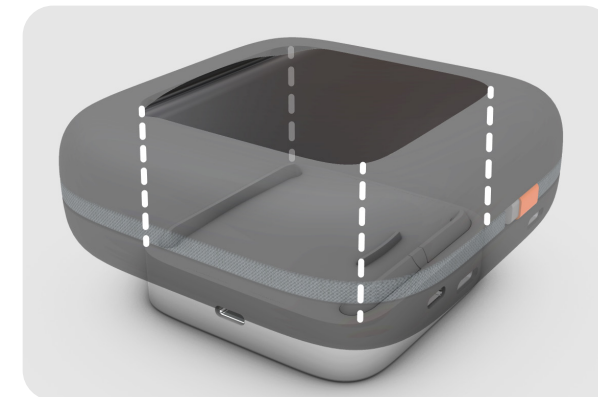
It was observed that, when handling the mobile module, there are three moments when the interaction is “blind”:

- When users handle the mobile module they are not immediately aware of its orientation, due to its overall simmetricity
- When hovering the mobile module over the base module to dock it, the base is hidden to their sight by their own hand
- When trying to precisely align the mobile module to the base, the latter is even less visible, and this poses the risk of hitting the delicate power connector on the base

On the basis of these observations, the mobile and the base modules were designed in a way that includes feedforwards, that is shapes and finishes that quietly guide users in handling the modules correctly.



A **carved detail** acts as a natural resting spot for users' fingers, and doubles as an indication of the module's orientation in space

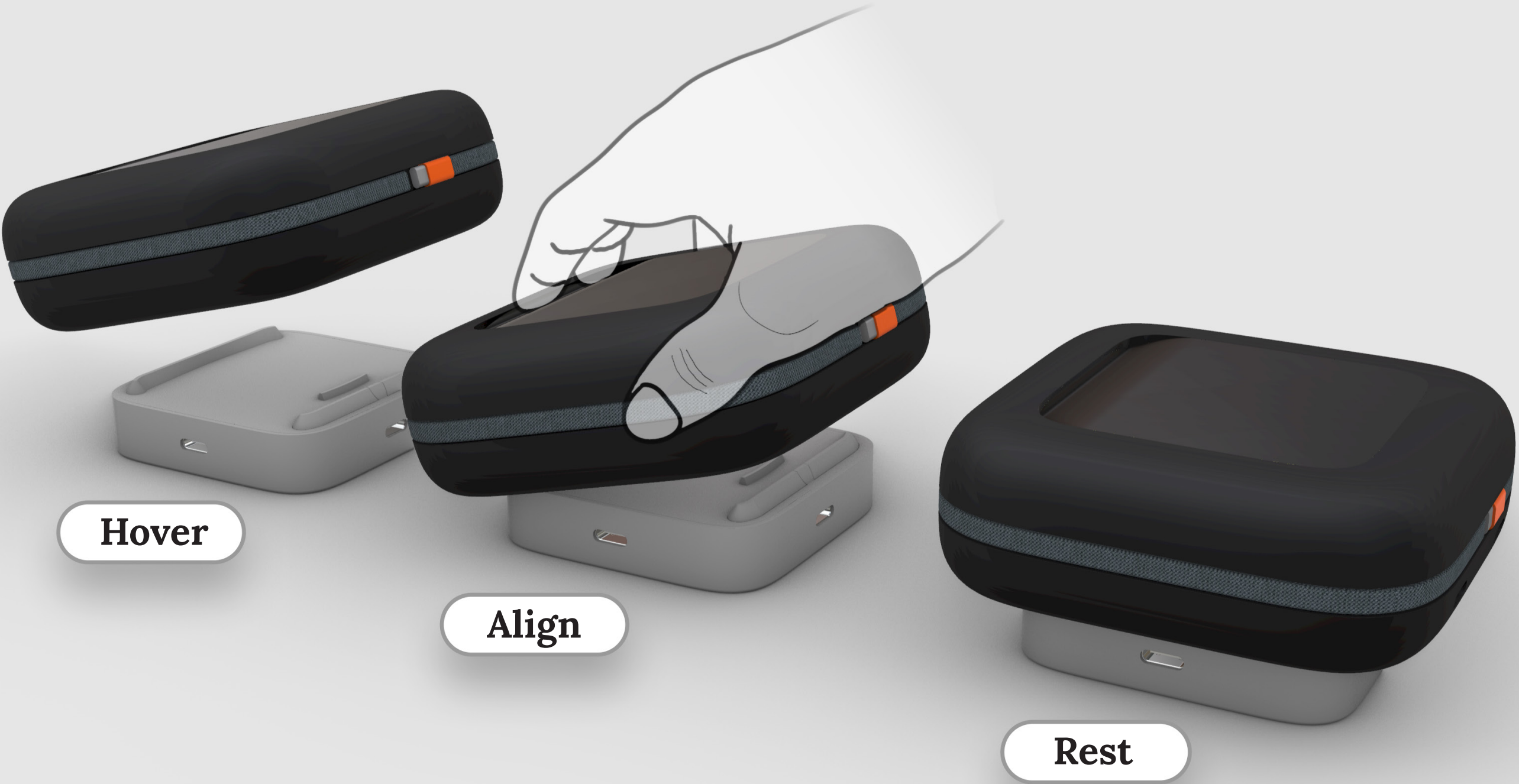


The mobile module's **textured area** aligns in shape and position to the base's footprint, suggesting the correct alignment



A **carved slot** in the mobile module's bottom surface and a **ridge** on the base guide users towards an easy initial alignment

- Technical details
- Alignment feedforwards



■ Technical details

— Soft fall mechanism

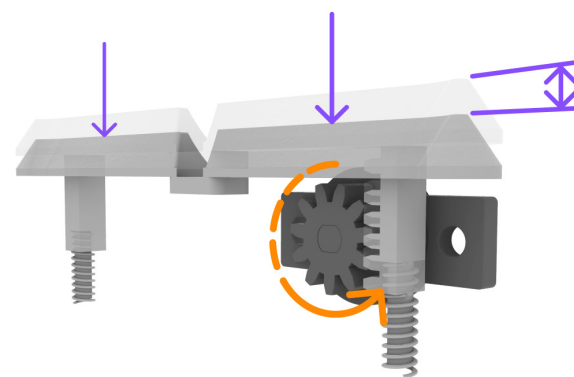
To give the impression of a product that is lively and dynamic, and enhance the feeling of continuity between one work scenario and the other, a mechanism that softly guides the mobile module down to the base module was designed.

In a sense, when users rest their mobile module to sit down and work at their desk, also their Tile ecosystem is slowly “sitting down” and getting ready for focused work.

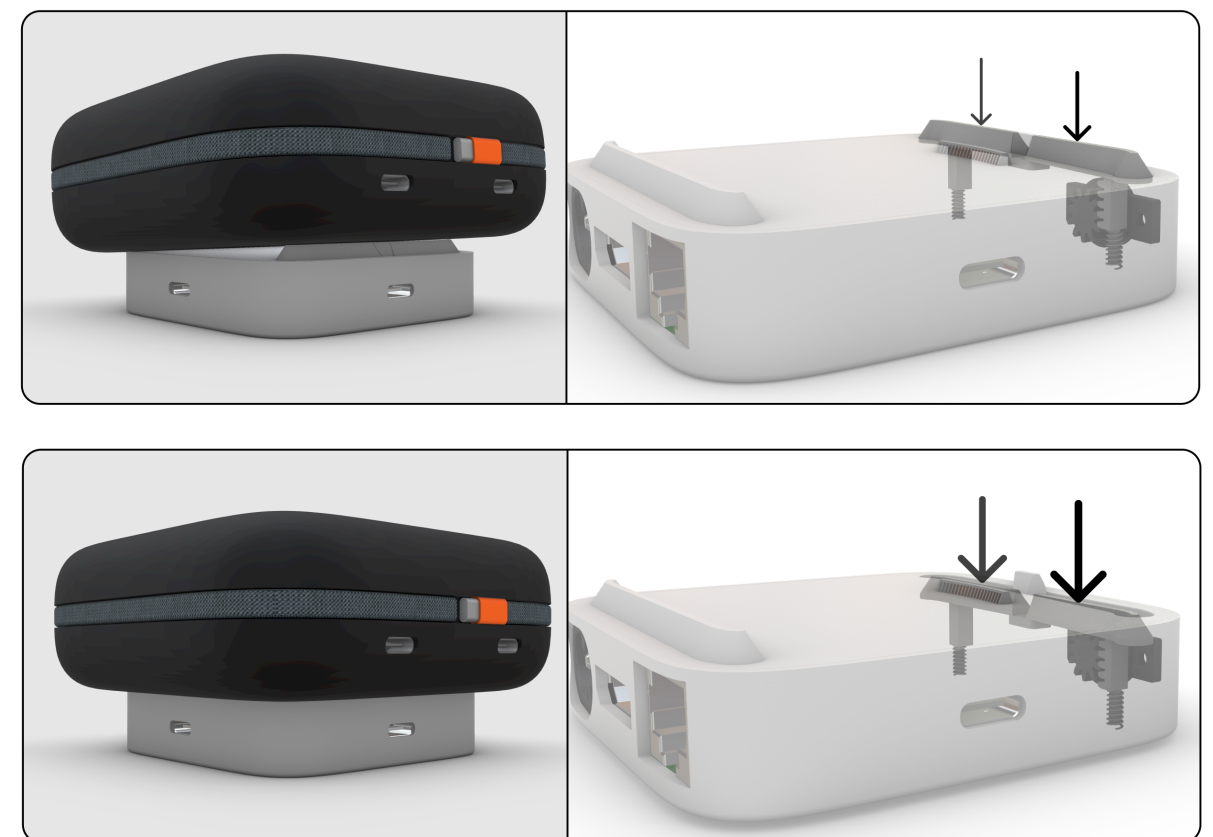
To achieve such a smoothly controlled descent, the base module was designed to hold a rotary damper inside it. This hidden dampening mechanism is connected, via rack-and-pinion to a translating platform that the mobile module rests on.

As the mobile module’s weight pushes down on the platform, the rotary damper is engaged and opposes the linear movement with an opposing torque, slowing down the descent.

The mobile module’s weight pushes down on a vertically translating platform



The rotary damper opposes the motion with a torque, slowing down the fall



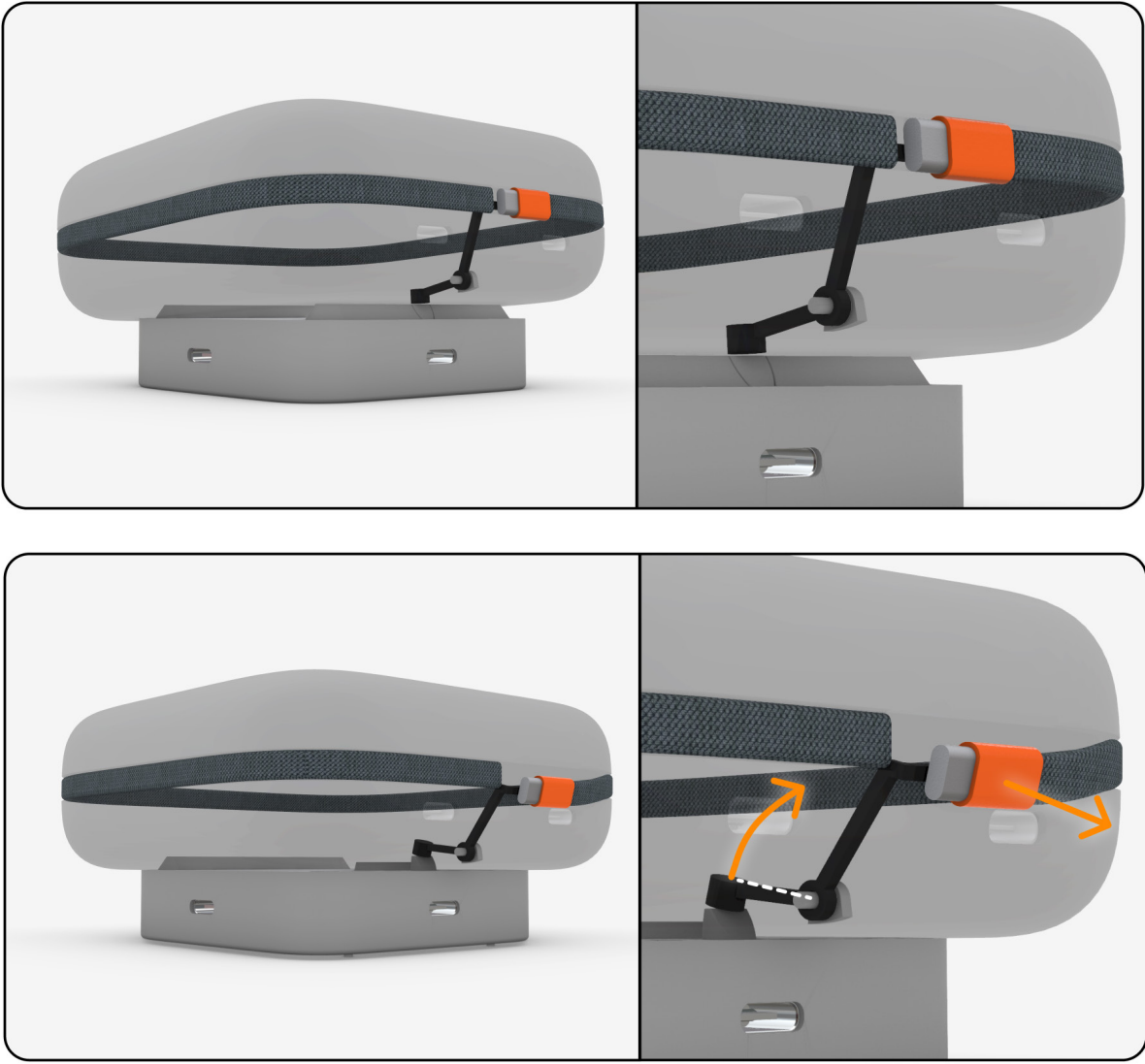
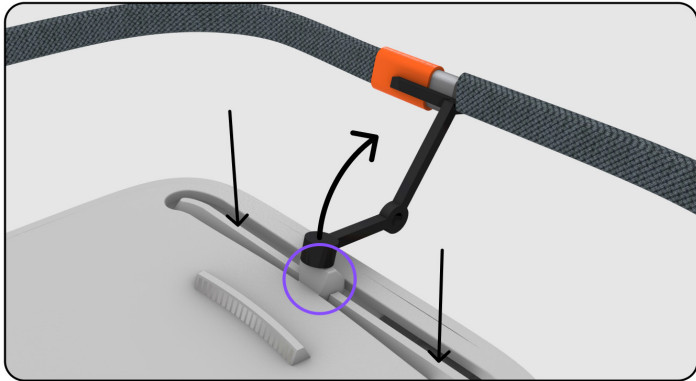
■ Technical details

— Cable extraction mechanism

As shown throughout the storyboards, when users get back to their desks, the first thing they do is dock the mobile module on the base module and then plug their laptop into their peripherals through the built-in USB-C cable. One requirement for Tile was to reduce cable clutter and their tendency to tangling. For this reason, Tile’s built-in USBC cable was designed to blend into the module’s overall bulk by tightly adhering to a recessed slot all around the module.

This solution makes the cable’s volume and tangling a non-problem, but it would make it hard to pull the cable out of its slot. So, a lever mechanism to link the mobile module’s slow fall to a soft extraction of the USB-C cable, that Tile figuratively “hands” to the user, was designed.

When the platform gets pushed down, a rigid post in the center of it pushes up on a lever located inside the mobile device. The lever then pushes out the USB-C cable



Design engineering

This chapter outlines the engineering framework applied to the ecosystem's development. While not an exhaustive documentation of every technical specification, it presents a representative selection of the engineering considerations addressed to validate the project's industrial feasibility.

Through these sub-chapters, the text illustrates the physical and mechanical resolution of the product, translating the design concept into a manufacturable architecture.

The section is structured around three specific focuses:

- **Product architecture and assembly process:** describes the internal layout of the components and the planned assembly steps for the modules
- **Calculations for soft fall mechanism springs sizing:** details the physical parameters and kinematic equations used to dimension the mechanical components of the docking system
- **Materials selection:** analyzes the criteria adopted for choosing the polymer for the outer shells, evaluating structural, thermal, and manufacturing requirements

■ Architecture and assembly

— Base module

The overall architecture of Tile's modules is rather straightforward, as they essentially are shells that contain the electronics required to achieve the functions they promise, and the mechanisms needed to deliver those functions as seamlessly as possible.

The real challenge lies in the miniaturization needed to achieve such portable and attractive form factors.

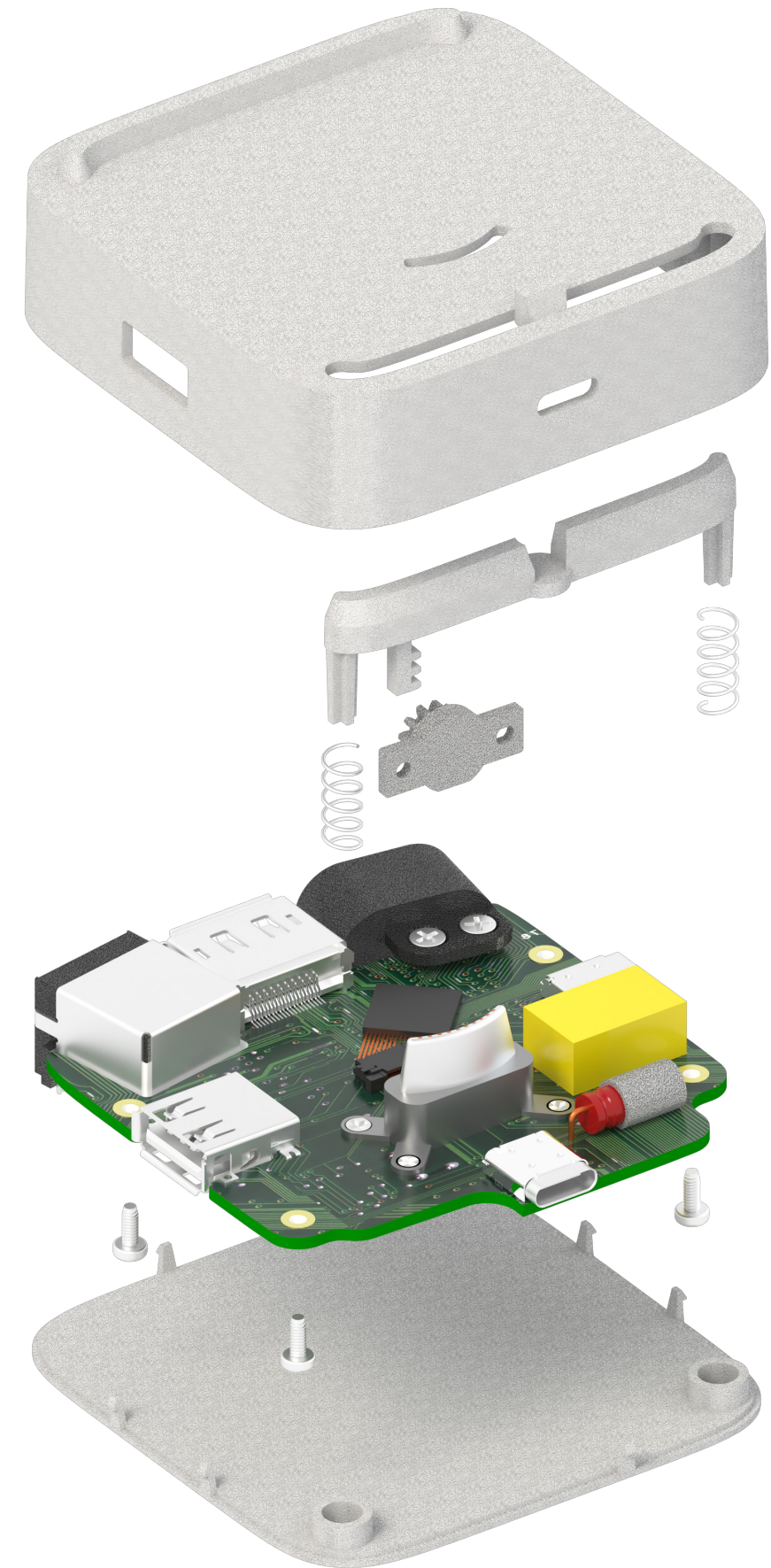
But the companies taken as example during Tile's development are not ones who easily sacrifice the final product's polish and premium look in favor of reduced costs or complexity.

Apple TV 4K comes to mind as an example: it is a continuous plastic box with straight edges and no interruptions around ports, nor visible parting lines. Also the internal snap fits have no undercut reliefs.

Thus, such a product requires a complex and rather expensive mold, but that is

justified by Apple's standards and production volumes.

Tile's base module adopts a similar architecture to Apple TV 4K.



■ Architecture and assembly

■ Base module



1. The process starts with the top shell sitting upside-down



2. The soft fall mechanism platform is inserted in its slot



3. Two springs are placed around the soft fall mechanism platform's poles



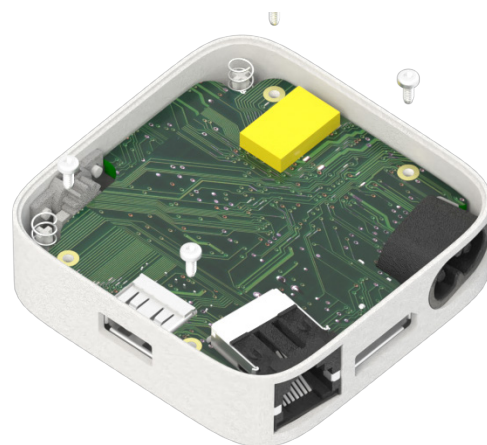
4. A rotary damper is inserted on the internal wall's surface

■ Architecture and assembly

■ Base module



5. The PCB is inserted in place by first aligning the ports to their respective openings in the walls



6. Four M2 screws are used to secure the PCB to the shells, via the injection molded bosses on the top surface



7. The bottom shell is aligned to the soft fall mechanism's platform's guide poles and snap-fit to the top shell



8. The base module is assembled and it can now be rotated back up

■ Architecture and assembly

— Mobile module

The base module's architecture is slightly more complex, due to the fact that, in order to hold the built-in cable flush to the external surface, a recessed area is needed.

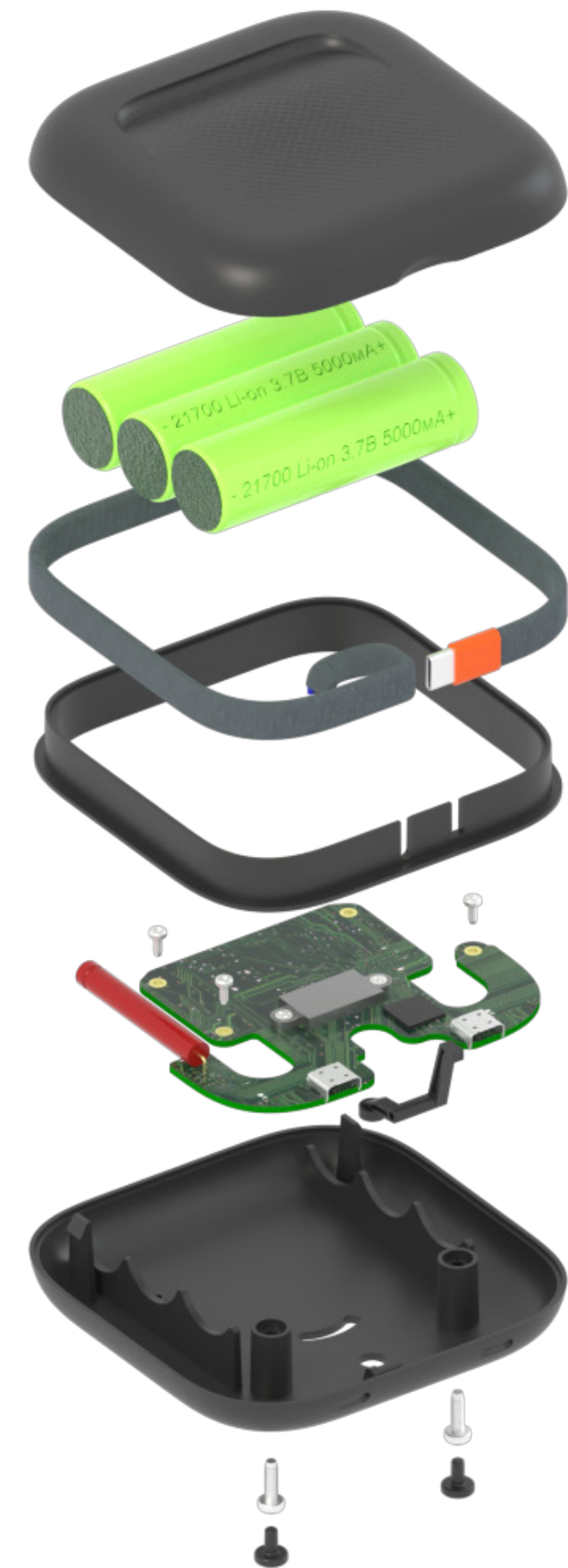
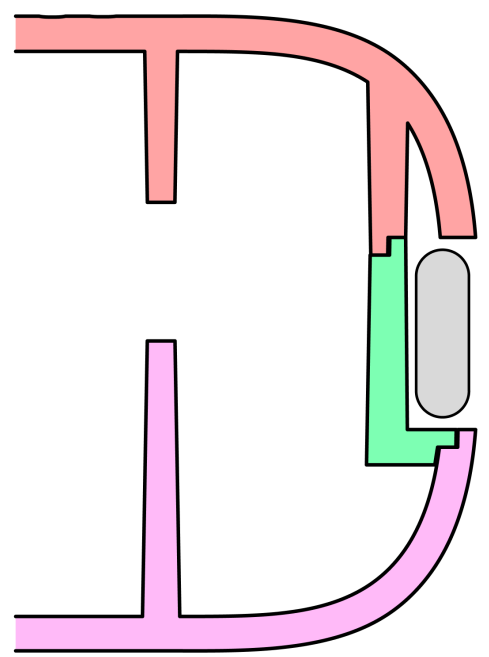
This makes it so that just two shells, were not enough to hold everything in place without resorting to complex in-mold mechanisms.

This was solved by designing a third polymeric part that mates to the top and bottom shells and keeps them apart (as shown in the schematic on the right).

Also, the presence of the cable extraction mechanism requires the design of a hinge so that the lever that pushes the cable out can rotate around it. And designing a built-in hinge, without sacrificing external appearance, necessarily requires the introduction of an undercut.

The mobile module also contains batteries that need to be constrained to their

housing: in order to do that, a double guide system was used, with two thin walls protruding from the top and bottom shell, holding the battery still in the horizontal and vertical direction.



Architecture and assembly

Mobile module



1. The assembly process starts with the bottom shell right-side up



2. The cable extraction mechanism lever is slid onto the hinge built into the shell



3. The PCBA is aligned to the screw bosses and the openings for the USB-C ports in the front



4. Four M2 screws are used to fix the PCBA to the bottom shell

■ Architecture and assembly

■ Mobile module



5. The spacer is rested onto the bottom shell by using the lip and groove features on their respective outer edges



6. The cable is plugged into the board, passed through the opening in the spacer and rested around the sides of the module



7. The 3-cell pack of batteries is rested onto its guide and plugged into the PCB



8. The top shell is aligned and rested on top of the spacer. The whole assembly is rotated while holding it together and then held in place by two screws

Components sizing

Soft fall spring sizing calculations

When the 350g mobile module is docked, its weight initiates a downward stroke. Instead of a harsh mechanical bottom-out, this kinetic energy is managed by a custom-engineered ‘soft-fall’ mechanism.

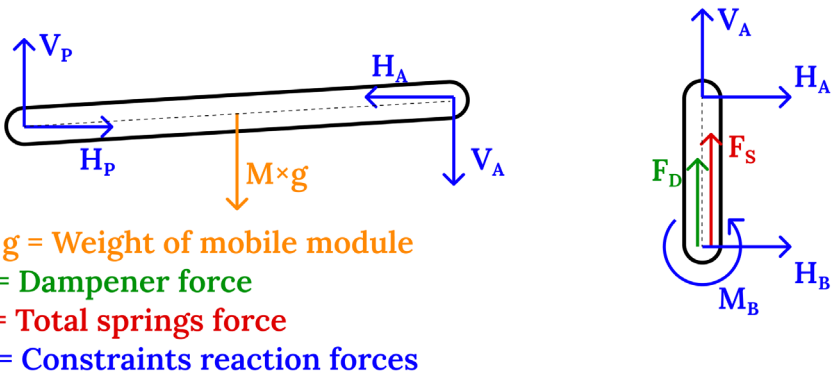
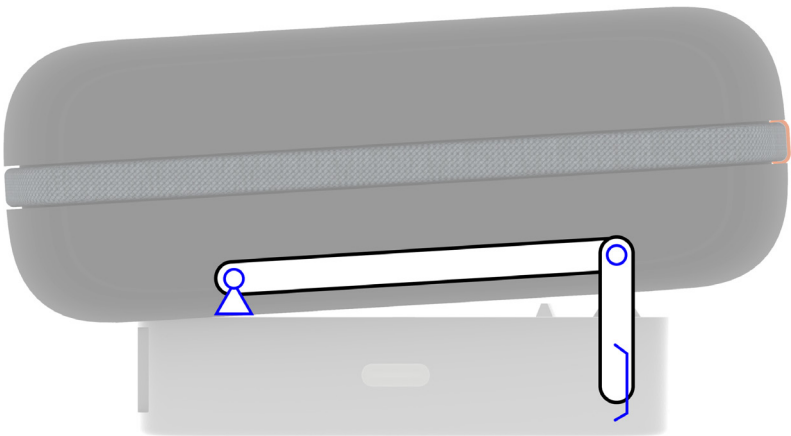
The linear motion of the docking platform is converted into rotation via a micro rack-and-pinion system, which engages a precision rotary damper. The viscous fluid within the damper provides controlled resistance against the 3.43N gravitational force, resulting in a smooth, cinematic descent

Upon undocking, the mechanism must reset seamlessly. A precisely calibrated compression spring acts exclusively on the lightweight docking platform. Without the heavy mobile module’s mass, the platform is gently pushed back to its initial zero-position. This decoupling of forces ensures that the return spring operates invisibly, adding zero noticeable resistance to the user’s downward

placement.

In the page on the right are represented the free body diagrams and the kinematics calculations that were carried out to estimate the total force of the springs, F_s , that is:

- not too high that it opposes the descent of the soft fall platform under the mobile module’s weight
- not too low that it cannot push the soft fall platform back up when the mobile module is removed



Equilibrium equations of mobile module:

- $V_p - M \times g - V_a = 0$
- $H_p - H_a = 0$
- $-M \times g \times R / 2 \times \sin(a) - V_a \times R \times \sin(a) + H_a \times R \times \cos(a) = 0$

Equilibrium equations of soft fall platform:

- $V_a + F_s + F_d = 0$
- $H_a + H_b = 0$
- $M_b - H_a \times L = 0$

Final equation of total spring force

- $F_s = (M \times g \times \sin(a)) / 2 - F_d$

With this known value, and knowing the springs’ compression (3mm) it is possible to estimate acceptable spring constants (k).

Factor of Safety	1,15	
Mobile module mass	0,35	kg
Mobile module mass (with safety factor)	0,40	kg
Gravity acceleration	9,81	m/s^2
Dampener active radius	5,00	mm
Dampener torque	1,50	Nmm
Dampener force (to surpass slightly)	0,30	N
Engage angle (a)	20,00	°
Forza totale molle (Fs)	0,38	N

■ Materials selection

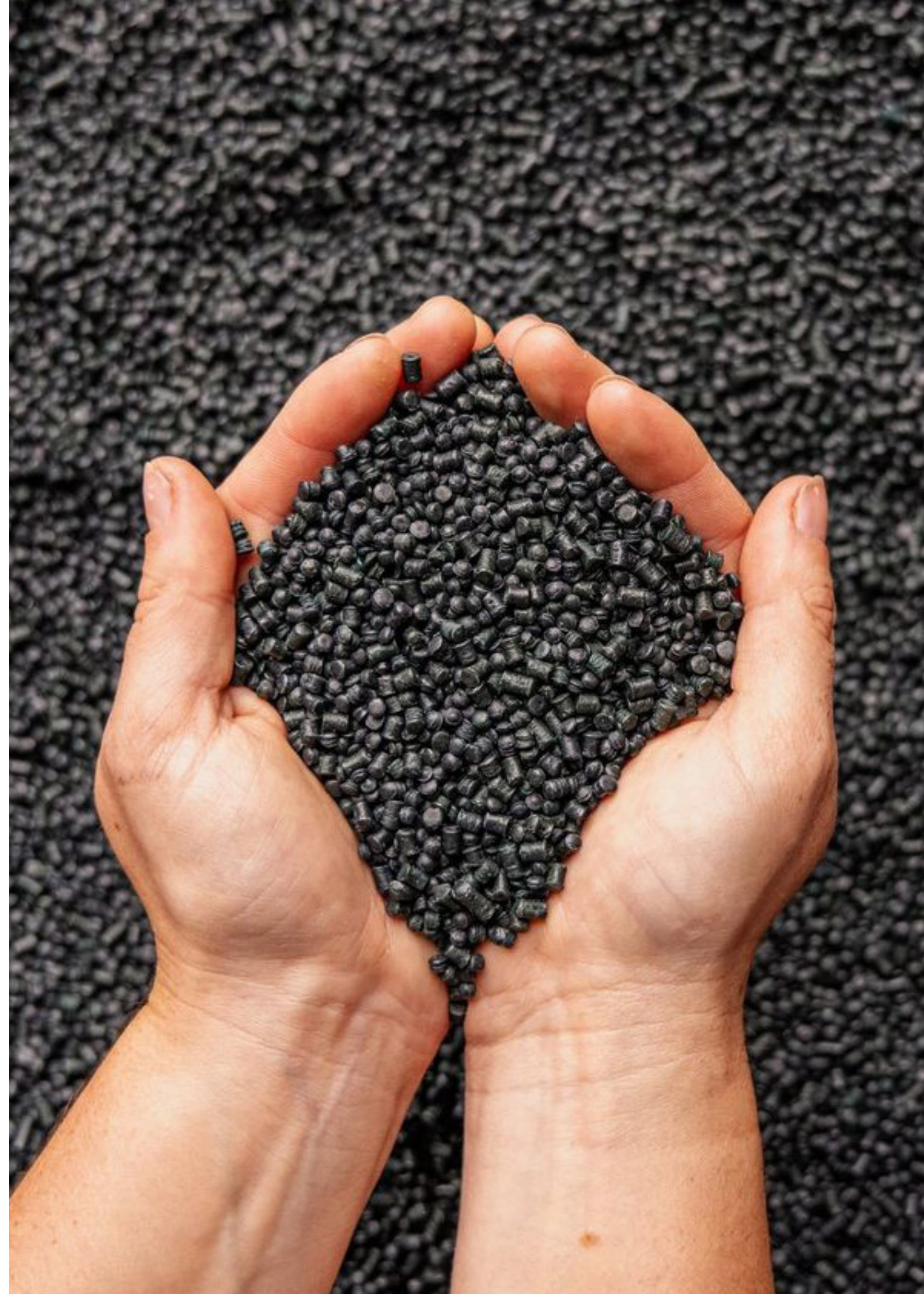
To ensure the Tile ecosystem meets the standards of premium consumer electronics, the material selection process required balancing structural integrity, thermal management, and manufacturability.

Initially, the extreme ends of the polymer spectrum were evaluated and discarded. Polypropylene (PP), while cost-effective, lacks the dimensional stability needed for the precise tolerances of the soft-fall mechanism and fails to deliver a premium tactile feel. Conversely, high-performance polymers like PEEK represent severe over-engineering; their prohibitive cost and extreme processing temperatures make them unviable for high-volume consumer production.

Narrowing the focus, pure ABS and pure Polycarbonate (PC) both presented critical limitations. ABS offers excellent moldability but features a low Heat Deflection Temperature (HDT). This creates a severe warping risk when put in close proximity

to heat-generating GaN semiconductors. Pure PC resolves the thermal issues and provides great impact resistance, yet its high melt viscosity makes it difficult to injection-mold thin walls or accurately replicate the micro-detailed parametric texture of the mobile module.

Therefore, a PC-ABS blend was selected as the definitive solution. This polymer alloy merges the high-impact resistance and thermal stability of PC with the superior flowability of ABS. This synergy ensures proper mold filling for complex surface geometries while delivering the dense, and monolithic aesthetic expected from flagship devices.





Conclusions

This project originated from an analysis of contemporary hybrid work models and the nomadic dynamics of modern professionals. User research highlighted that employees frequently experience friction during work transitions, primarily driven by the cognitive burden of cable clutter, setup inefficiencies, and off-site battery anxiety. The current market offers a fragmented array of standalone accessories, like chargers, hubs, and power banks, that fail to provide a cohesive experience, forcing users to manage redundant infrastructure across different workspaces.

To address this gap, the thesis introduced Tile, a modular workflow continuity ecosystem designed to unify stationary and portable power delivery. The architecture centers around a core Mobile module, complemented by stationary Base modules for desk setups and a Travel module for business trips. By transitioning from disjointed accessories to an

integrated system, Tile allows users to adapt their power and connectivity needs dynamically, ensuring a seamless experience when moving to and from the desk.

The final design was grounded through targeted engineering evaluations, leveraging high-density power technologies to achieve the necessary volumetric reduction without compromising the user experience. Ultimately, this project translates observed user behaviors into a highly feasible product architecture. Furthermore, the modular nature of the Tile ecosystem establishes a scalable platform; this foundation not only resolves current operational frictions but is positioned to accommodate future technological upgrades and the integration of additional modules, ensuring long-term adaptability to the evolving landscape of hybrid work.

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