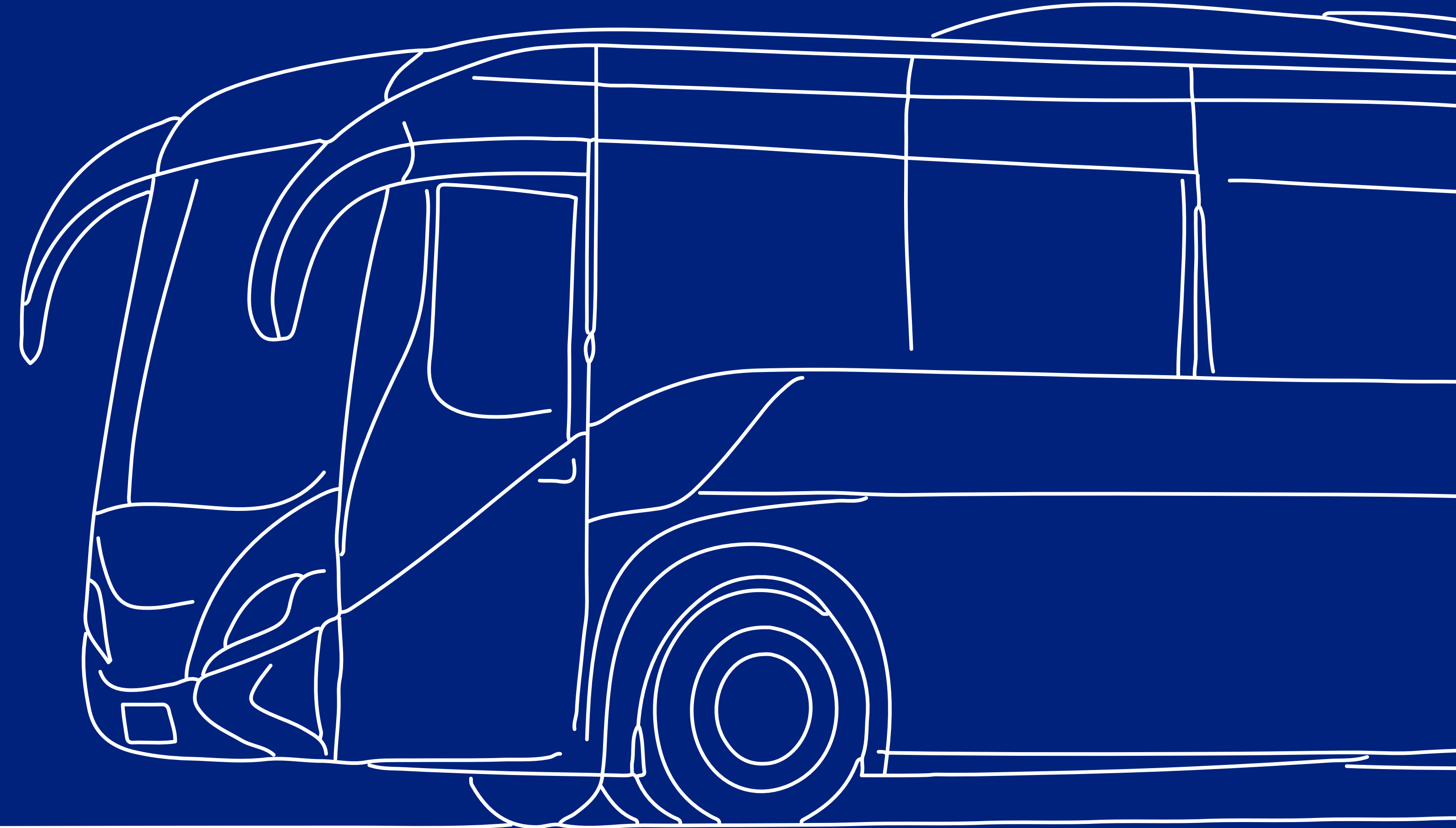




TED UNIVERSITY

Şehir Otobüsleri İçin Yenilikçi Kapı Tasarımı

Innovative Door Design for City Buses



TED Üniversitesi Endüstriyel Tasarım Bölümü
TED University Department of Industrial Design



MAN Türkiye A.Ş. işbirliğiyle
With the collaboration of MAN Türkiye Inc.

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Proje Hedefleri

“ID 420 Tasarımda Seçme Projeler” dersi kapsamında gerçekleştirilen bu projede, MAN Türkiye A.Ş. tarafından verilen tasarım problemi doğrultusunda alçak tabanlı şehir içi otobüsler için yenilikçi kapı tasarımları çalışıldı.

Firmanın mevcut kapı portfolyosuna eklenebilecek bu tasarımın farklı bir çalışma sistemi içermesi, kullanıcı deneyimini iyileştirmesi ve müşteriler tarafından tercih edilir olması ölçütleri ön planda tutuldu. Bu proje hedefleri doğrultusunda ders yürütücülerinin geliştirdiği masa başı araştırma, saha araştırması, fikir geliştirme ve detaylandırma aşamalarından oluşan yoğun bir süreç izlendi.

Dörder kişilik ekipler halinde çalışan öğrenciler, dört ay süren çalışmaların sonucunda toplam beş farklı kapı konsepti geliştirdiler. MAN Türkiye mühendislik ekibinin birebir desteği ile detaylandırılan konseptlerle ilgili fikri haklar ve buna bağlı gizlilik süreci devam etmekte olduğundan, bu katalogta yalnızca ara çıktılar ve proje aşamaları aktarılmaktadır.

Project Objectives

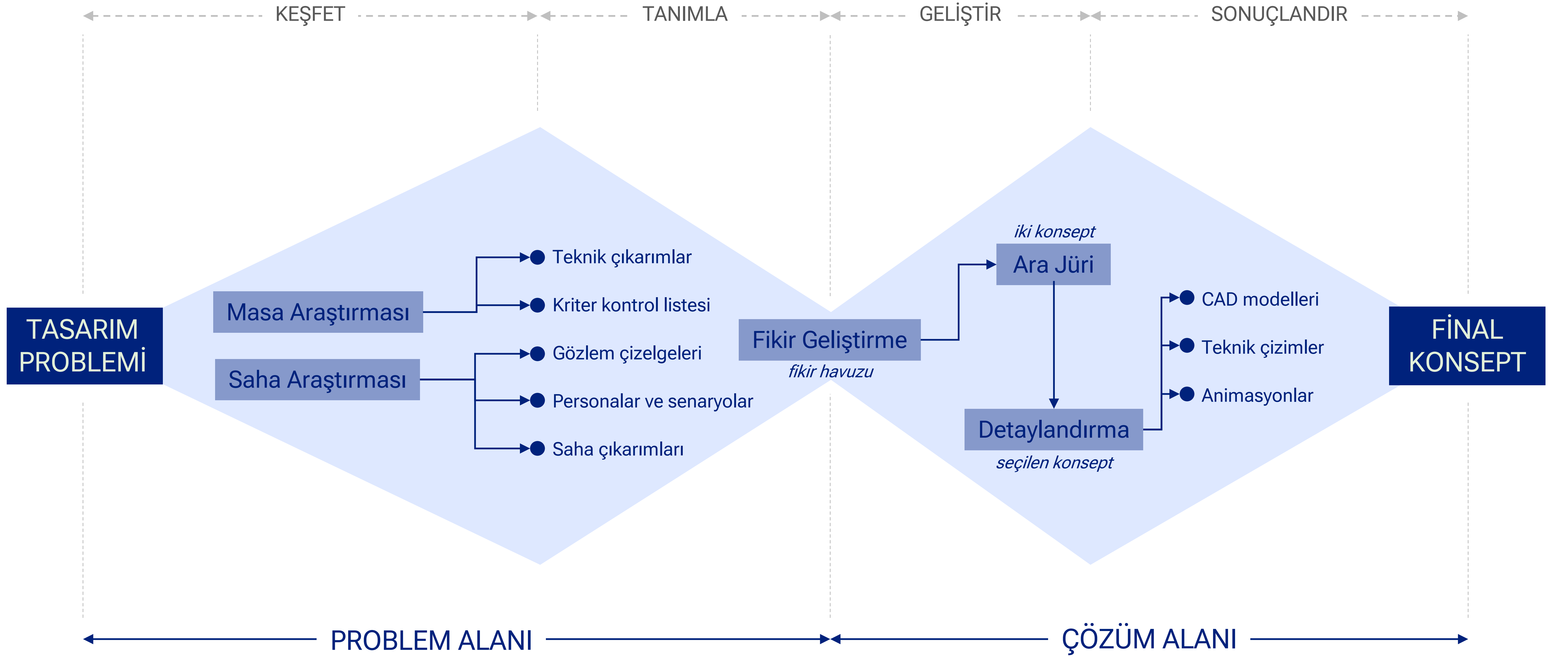
In this project carried out within the scope of “ID 420 Special Projects in Design” course, students worked on innovative door designs for low-floor city buses, based on a design brief provided by MAN Türkiye Inc.

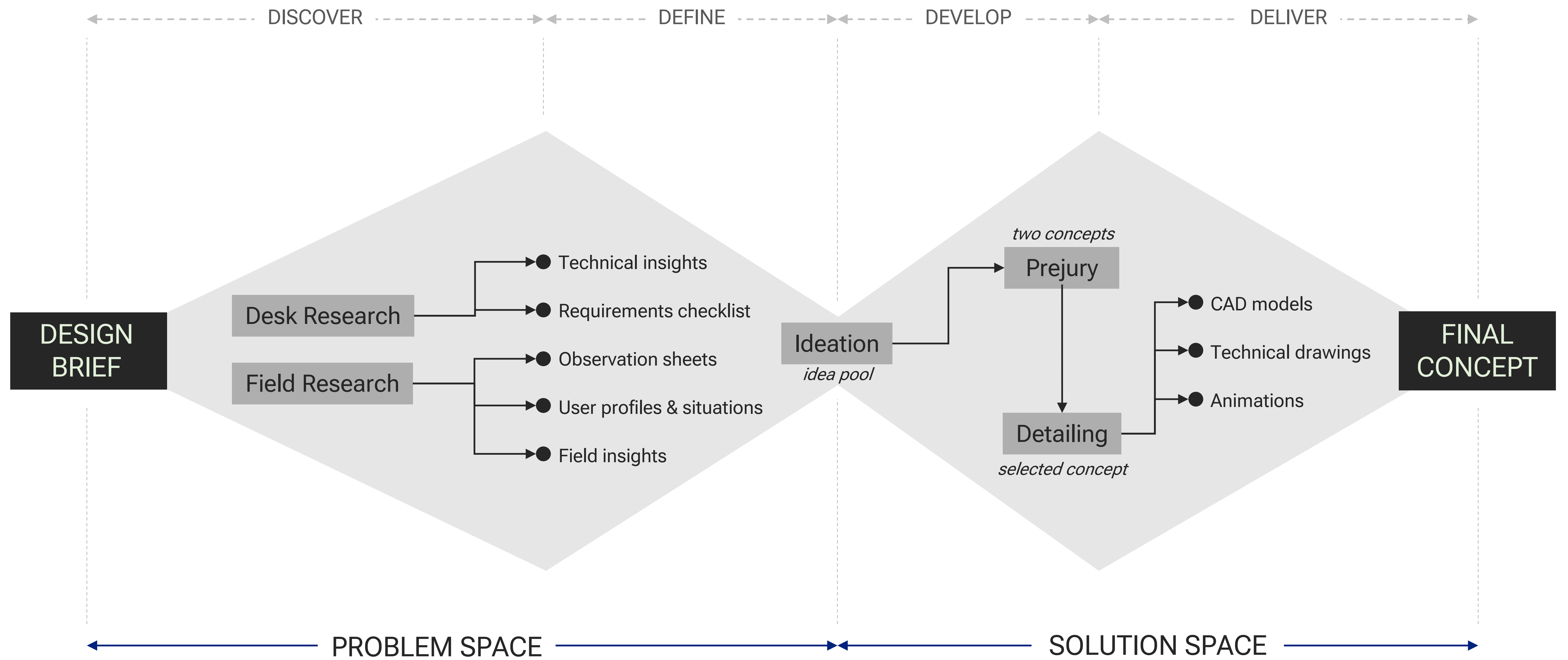
The design, which could be added to the company’s existing door portfolio, was expected to include a new way of operation, improve the user experience, and be preferable by customers. In line with these project goals, an intensive process was followed consisting of desk research, field research, idea generation, and detailing stages developed by the course instructors.

Working in teams of four, the students developed a total of five different door concepts as a result of four months of work. The concepts were detailed with one-on-one support from MAN Türkiye’s engineering team. Since the intellectual property rights and the related confidentiality process are still ongoing, only the interim deliverables and project stages are presented in this catalogue.



MAN Ankara fabrikası gezisi *Visit to MAN Ankara factory*





Masa Arařtırması *Desk Research*

Masa Arařtırması

Proje, ilgili yönetmelikler, teknik şartnameler ve mevcut çözümler üzerine masa başı arařtırmayla başladı. Bunun nedeni, otomotiv alanının güvenlik ve erişilebilirlik konularında ulusal ve uluslararası yüksek standartlara ve sıkı düzenlemelere tabi olan bir sektör olması.

İncelenen belgeler arasında MAN'ın komponent gereksinim şartnameleri, ilgili araç sınıfları için AB ve BM yönetmelikleri, farklı kapı tipleri, patent veritabanı taramaları, otobüs tasarımında ödüllü projeler ve diğer sektörel kaynaklar yer aldı.

Her ekip bu belgeleri ayrıntılı bir biçimde analiz ederek tasarım boyutlarını haritaladı ve bunları projeye ilişkilendirerek bir tasarım gereksinimleri havuzu oluşturdu. Bu havuz daha sonra tasarım ve geliştirme aşamalarında kullanılmak üzere ortak bir kontrol listesi hâline getirildi.

Desk Research

The project began with desk research on relevant regulations, technical specifications, and existing solutions. This was deemed necessary due to the automotive sector's strict national and international standards, particularly regarding safety and accessibility.

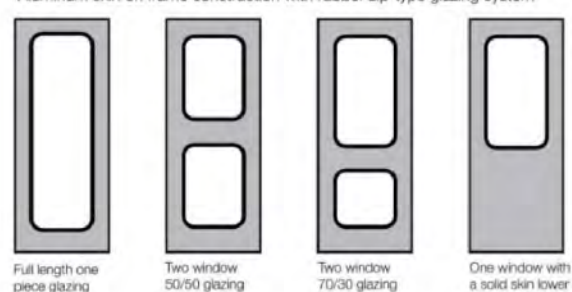
The reviewed materials included MAN's component requirement specifications, EU and UN regulations for relevant vehicle categories, various door types, patent database searches, award-winning projects in bus design, and other industry-specific sources.

Each team conducted a detailed analysis of these materials, mapping design dimensions and linking them to the project context to form a pool of design requirements. This pool was later consolidated into a shared checklist to be used in design and development phases.

Door Configurations

Classic

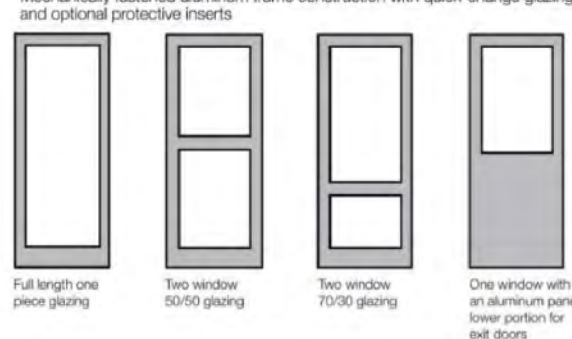
Aluminum skin on frame construction with rubber zip-type glazing system



Full length one piece glazing Two window 50/50 glazing Two window 70/30 glazing One window with a solid skin lower portion for exit doors

AmeriView

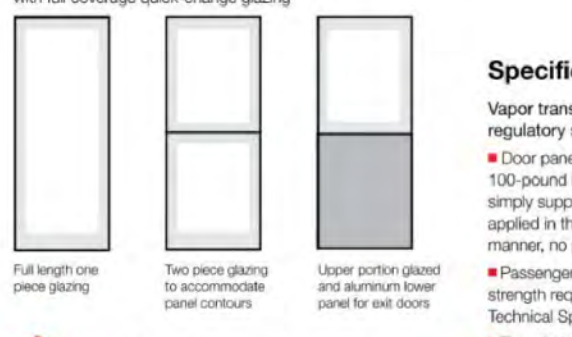
Mechanically fastened aluminum frame construction with quick-change glazing and optional protective inserts



Full length one piece glazing Two window 50/50 glazing Two window 70/30 glazing One window with an aluminum panel lower portion for exit doors

CityView

Mechanically fastened aluminum frame construction with full coverage quick-change glazing



Full length one piece glazing Two piece glazing to accommodate panel contours Upper portion glazed and aluminum lower panel for exit doors

Door Accessories

Universal Passenger Assist

Steele, contemporary appearance. Low profile design and universal two point vertical or diagonal mounting. See Vapor bulletin number 53-7002.



vTouch Electronic Touch Bar

No moving parts - minimizes maintenance costs. Solid-state circuitry for enhanced reliability. Eliminates annoying rattle. See Vapor bulletin number 53-7005.



CLASS Sensing System

Unique sensing technology improves passenger detection, reduces maintenance expense and enhances door system. See Vapor bulletin number 53-3099.



Specification Compliance

Vapor transit bus door panels conform to the following industry and regulatory standards.

- Door panels shall allow no more than one-half inch deflection when a 100-pound load is applied to the center of the leading edge of a door panel simply supported at the top and bottom edges. When a 200-pound load is applied in the same manner to a door panel supported in the same manner, no permanent deformation shall occur.
- Passenger assist attachment provisions support the passenger assist strength requirements of the APTA Standard Bus Procurement Guidelines Technical Specifications.
- The window retention requirements of FMVSS 217.

Classic™ Door Panel

Proven in decades of service on North American heavy transit buses, the Vapor Classic door panel employs adhesively bonded aluminum skin on frame construction for strength and durability. Suitable for all door geometries, the Classic is available in a wide range of sizes in two light, three light, partially and fully glazed configurations.

The Classic door panel uses zip-type glazing rubber to accommodate all customary transit bus glazing materials. Available factory finishes include primed both sides, or exterior side primed and metal back on the interior side. Accessories: rugged brush seal, high impact brush cover, vTouch electronic touch bars and the Universal Passenger Assist. This panel design is compatible with the CLASS® Sensing System.

AmeriView® Door Panel

The AmeriView door panel complements today's contemporary bus design and provides up to 25% more glazing area. The AmeriView panel is available in various glazing configurations including "full glass", and is suitable for all door geometries.

A unique quick-change glazing system requires no fasteners and enables replacement of the glazing in minutes. Maintenance costs are minimized because damaged parts are replaced quickly.

AmeriView panels are available in 2 finishes: black powder paint and black anodized. Accessories include a rugged brush seal, high impact brush cover, vTouch electronic touch bars and the Universal Passenger Assist. This panel design is compatible with the CLASS Sensing System.

CityView® Door Panel

All glazes exterior enhances vehicle styling and meets all industry requirements. Provides the sleek visual impact desired by appearance-conscious transit agencies.

CityView door panels are fabricated from aircraft quality aluminum and components are joined with mechanical fasteners. The quick-change glazing system allows for easy glazing replacement and accommodates industry standard glazing materials. Accessories include Glass Guard™ sacrificial liner, vTouch electronic touch bars and the Universal Passenger Assist. Compatible with the CLASS Sensing System.

CityView hidden frame windows with quick-change glazing that complement the appearance of CityView door panels are available from Ricon Corporation. Consult Ricon brochure No. W-1001 for details.

Overview of door systems POS

OUTSWING

INSWING

Rotary

Rotary+lift

Pneumatic

Electric

Prototyp

Prototyp



Article 1

The goal is the same quality at lower cost better quality at the same cost.

The door-leaf module exhibits mechanical, pneumatic, electric and electronic interfaces with the bus

- Mechanical (doorways, fastenings of door rotating columns)
- Pneumatic: plug-in connectors (see technical main data sheet)
- Electrical: generally in accordance with M 3499-2 and in addition, with conformity to door control system

Must be resistant to UV light, glycol, other blasting materials, salts, etc.

For safety The function of the door flap module is to safely close the entrance area of the bus while the vehicle is in motion

Due to legal requirements, it must be possible to operate the door leaf when the emergency opening facility is activated. In emergency situations, it must always be possible to open the door leaf from the inside and from the outside (the latter with the door unlocked) without using great force.

Edges must be rounded so that the component exhibits no sharp corners.

Design Area D1: directly visible surface

Design Area D2: surfaces not in the directly visible area

Design Area D3: invisible surfaces (surfaces processed by supplier, not compatible with MTB Design).

According to M3659

Inner handle: traffic red (RAL 3020)

Arrows on inner handle: traffic yellow (RAL 1023)

External emergency handle: traffic red (RAL 3020)

Emergency handle or lettering on outer surface: traffic white (RAL 9016)

Other visible surfaces: jet black (RAL 9005)

High-quality and solid appearance.

Compatible overall effect with adjacent parts.

Technically necessary gaps must be skillfully placed and minimized to create an aesthetic overall impression.

The promise of value and product quality.

Design that speaks for itself

The DLM system should be designed in a way that does not pose a risk to life and should be possible to open at any time.

There should be no sharp corners, the edges should be rounded

A design that displays a modern, formal identity

Harmonious overall effect together with adjacent parts

Promise of value and product quality is reflected in the component

Easy access to part/component group

Self-explanatory or easily understood design

Materials classified as damaging to the environment or to health must be avoided

All mechanical loads that frequently occur during the operation of the Vehicle should be taken into account in relation to deformation.

Structural integrity should withstand impact and rollover scenarios.

Materials must be fire-resistant and conform to fire suppression system standards.

Safety and Accessibility

Emergency exits

Power-operated doors: Must comply with automatic closing force limits.

Step height & flooring: Slip-resistant and compliant with low-floor accessibility norms.

Handrails & support grips: Positioned for easy reach by disabled passengers.

Wheelchair accommodation: Dedicated spaces with securing mechanisms.

Lighting & visibility: Emergency exit signage and illumination

Door system

Must have anti-pinch sensors and automatic obstacle detection.

Handrails

7.11.1.2.

They shall be so designed and installed as to present no risk of injury to passengers.

7.11.1.4.

The clearance between a hand rail or hand hold, along the majority of its length, and the adjacent part of the vehicle body or walls shall be at least 40 mm

7.11.1.5

Should be slip-resistant

7.11.2.4.

Areas which can be occupied by standing passengers and are not separated by seats from the side walls or rear wall of the vehicle shall be provided with horizontal handrails parallel to the walls and installed at a height of between 800 mm and 1,500 mm above the floor.

7.11.1.3.

Handrails should be grasped easily and firmly. Every handrail shall provide a length of at least 100 mm to accommodate a hand. Dimensions between 20 mm or greater than 45 mm except in the case of handrails on doors and seats.

7.11.1.3.

Handrails shall not have sharp bends.

Safety

5.8.1 Safety of persons and occupants

The components may not emit harmful substances.

No functional element should unintentionally open or an individual part become loose.

Interfaces and handling should not pose any risk to life and limb of the operating, assembly or service personnel or occupants of the vehicle

Operation may only take place when it has been enabled by the driver and the vehicle is stationary.

It must be possible to open the door at any time in emergency operating mode.

In an emergency, it must not take longer than six seconds to open the door using the emergency opening facility.

Assembly

Simple assembly procedures

exact positioning

It must be possible to install them in such a way that no subsequent adjustment work has to be carried out by MAN.

Joining directions in a single dimension.

Identical threaded-fastener lengths and heads for similar screwdriving conditions. Prevent confusion.

Disassembly and re-assembly option

Door Locking Mechanism (DLM)

1-Door locking mechanism must be working within its lifetime (12)

2-It must be possible to open from the inside and outside at any time without exerting a great force (34)

3-must not cause harm or carry risk to the user or employee (35)

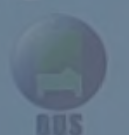
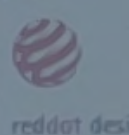
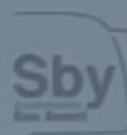
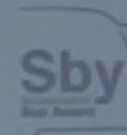
Must seal the passenger area against environmental impact from the outside (22)

Joints minimized to create an aesthetic overall impression (38)

Handling should be easy to maintenance (38)





EXISTING SOLUTIONS					
Awarded bus designs					
					
VDL Next Generation Citea 2022	NovoCiti VOLT 2023	MAN Lion's City 12 E 2023	Iveco Crossway 2024	Iveco Bus Crossway LE 2024	MAN Lion's City 12 E Low Entry 2025
					
• Scalable • Sustainable • Net-zero emissions • Lightweight composite framing • Easy passenger movement	• Silent • Eco-friendly • 100 percent electric • Low operating costs	• Energy recovery by braking • Different length options • Improved safety systems • OptiView mirror camera system	• Redesigned front • Advanced safety systems • Modern digital dashboards • Improved user interface • Driver assistance systems	• NMC battery packs • Advanced ADAS • Updated electronic platform • Mirror cam technology • CO₂-powered HVAC system • Sustainability	• 160 kW electric motor • 480 kWh battery • Zero-emission • RiO platform connectivity • Sustainability • Recyclable components

Saha Arařtırması *Field Research*

Saha Arařtırması

Projenin ikinci aşaması, toplu taşımada farklı kullanıcıların (şoförler ve yolcular) çeşitli kapı tiplerini nasıl deneyimlediğini anlamaya yönelik kapsamlı bir saha araştırmasına ayrıldı.

Öğrenciler, etnografik araştırma yöntemlerini kullanarak çeşitli semtler, günün farklı saatleri, farklı hava koşulları ve değişken trafik yoğunlukları gibi çeşitli bağlamlarda kullanımları gözlemlediler. Mümkün olduğunda kullanıcılarla sohbet niteliğinde görüşmeler gerçekleřtirdiler ve bu verileri gözlem formlarıyla ve fotoğraflarla belgelediler.

Toplanan veriler tematik diyagramlar kullanılarak analiz edildi ve çeşitli kullanıcı profillerini temsil eden personalar ile sahada gözlemlenen temel durumları betimleyen hikâye panoları (*storyboard*) şeklinde tasarım materyallerine dönüřtürüldü.

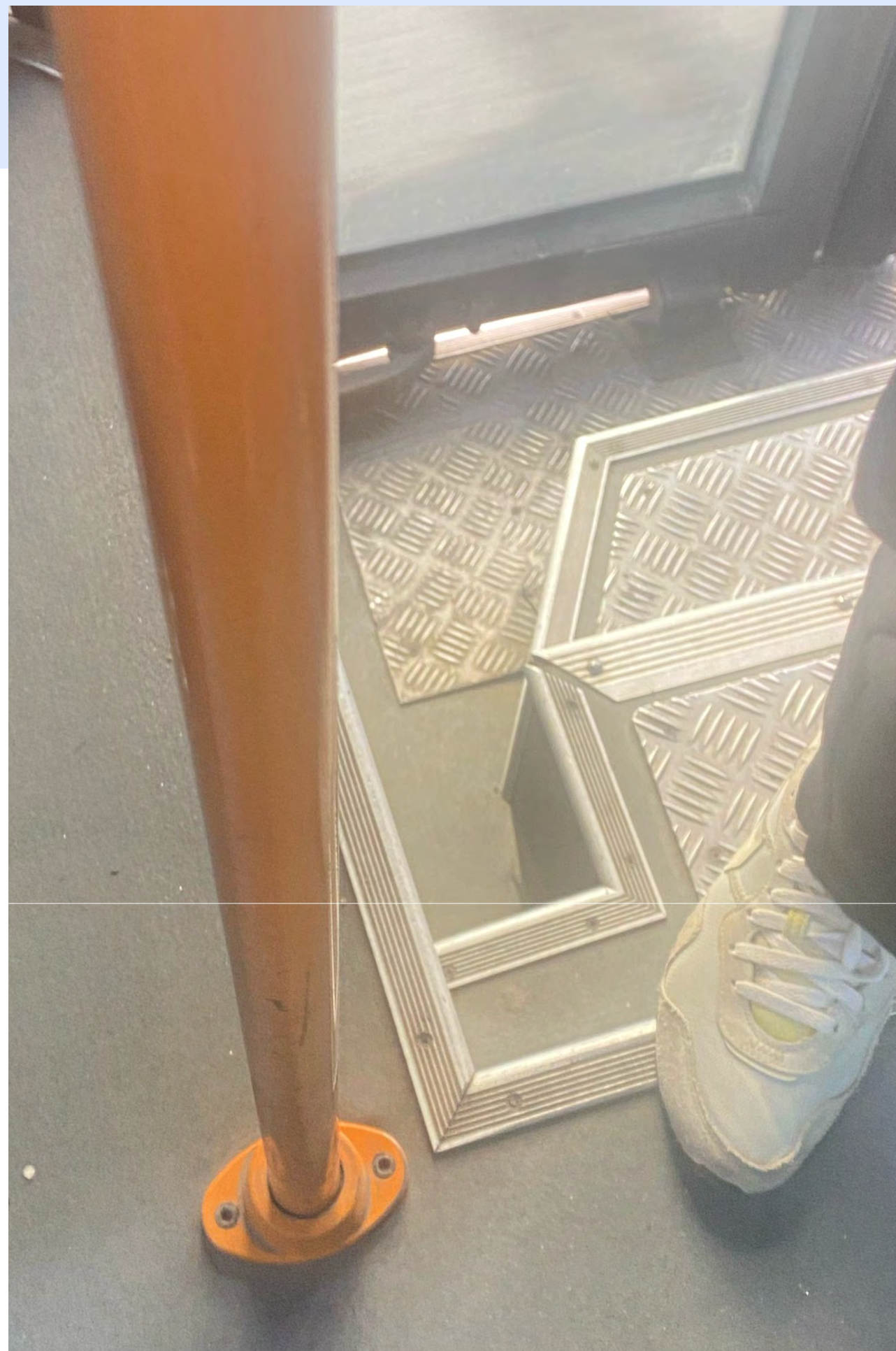
Field Research

The second phase of the project focused on in-depth field research to understand how different users, both drivers and passengers, experience various door types in public buses.

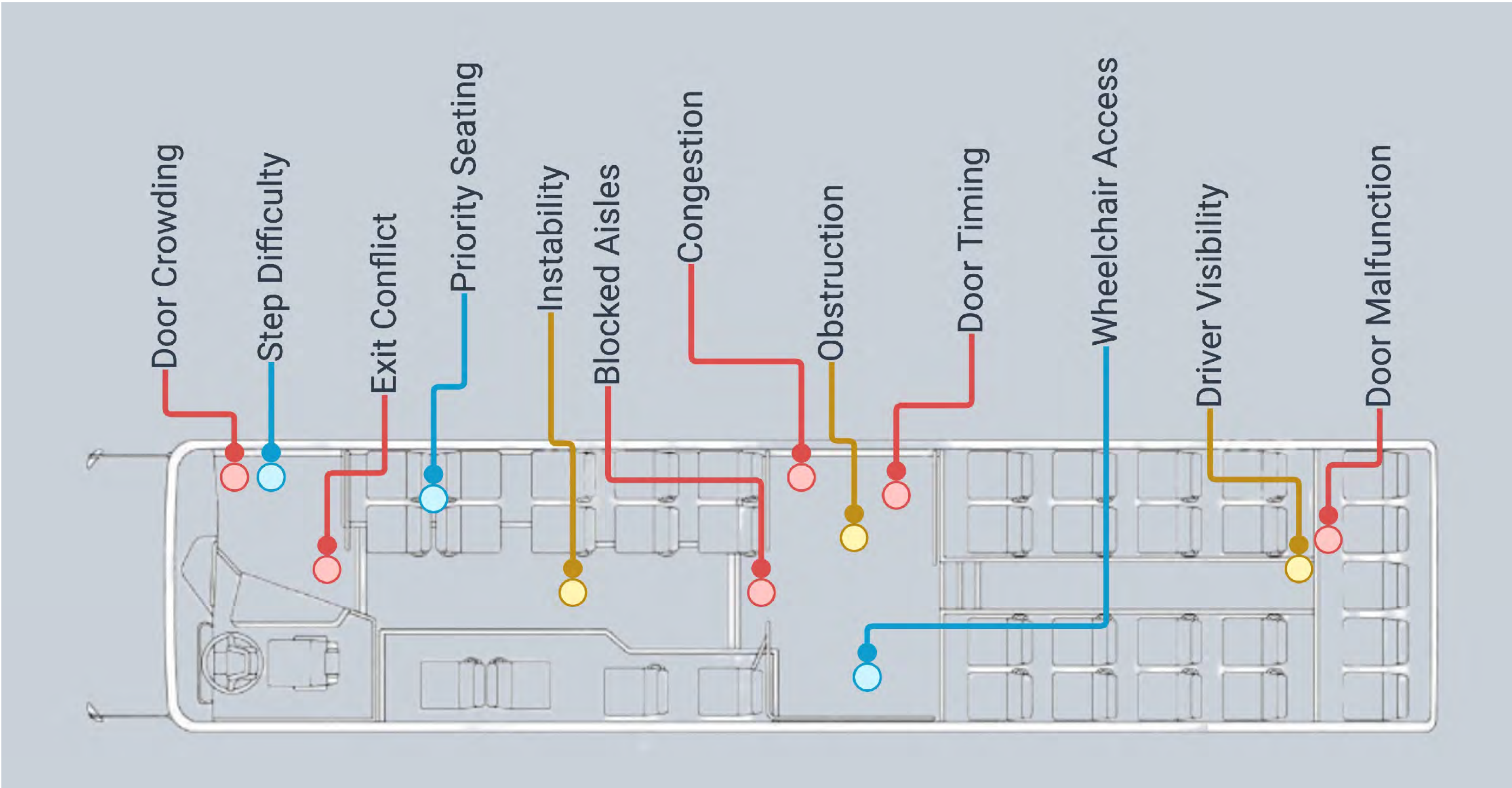
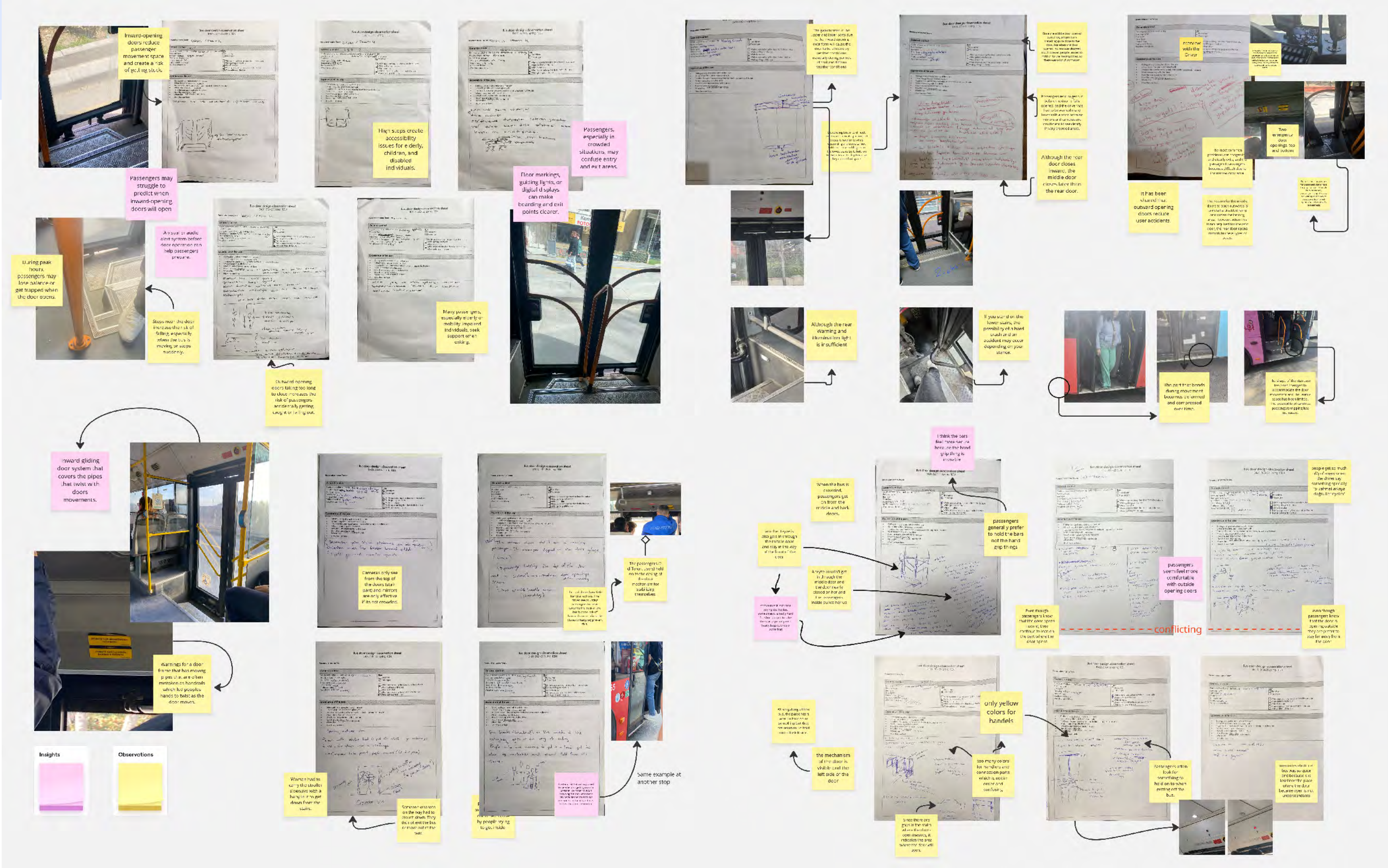
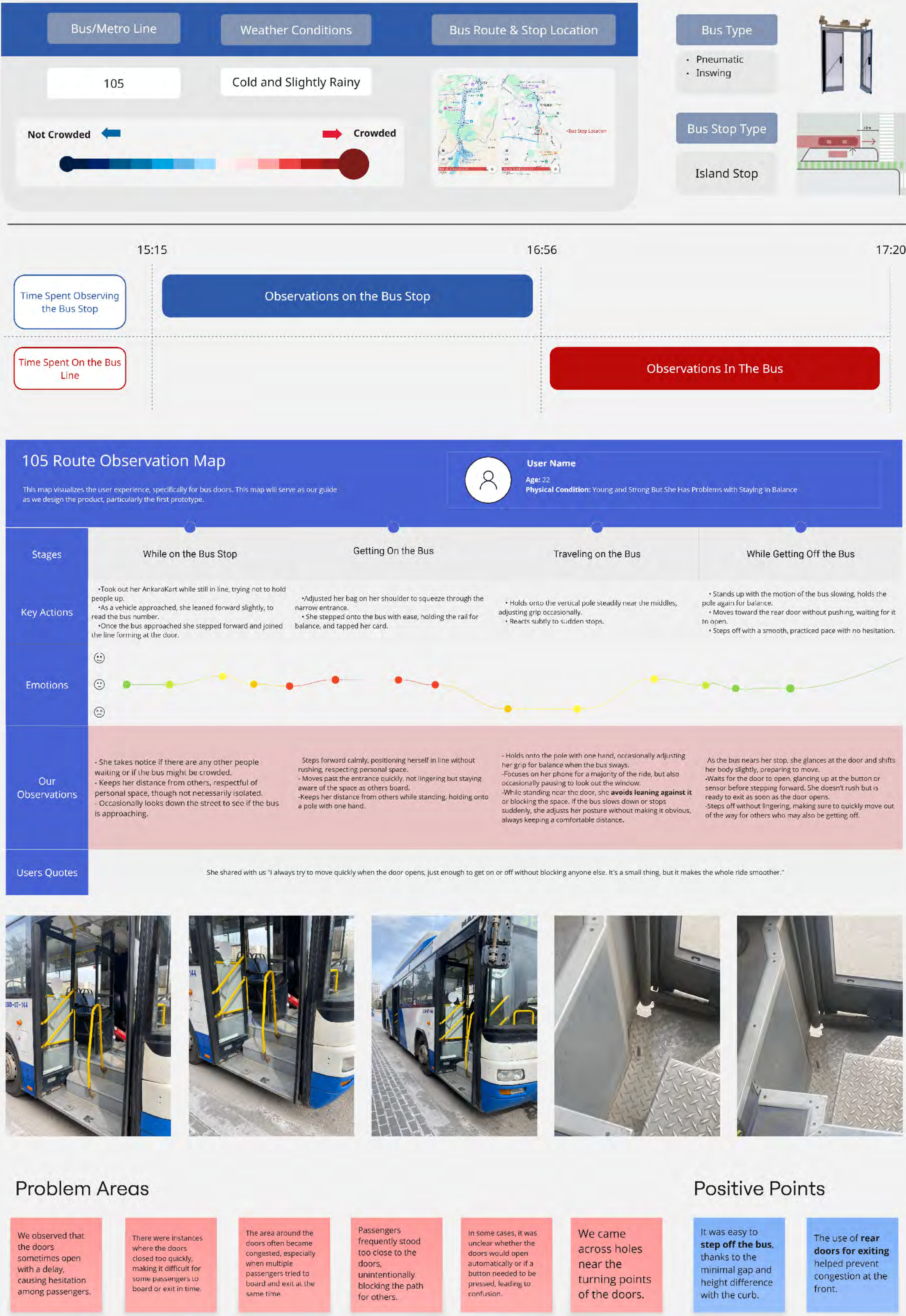
Students applied ethnographic research methods to observe user behaviour across a range of contexts, including different neighbourhoods, times of day, weather conditions, and traffic densities. Where possible, they conducted informal interviews and documented their findings using observation sheets and photographs.

The collected data were analysed using thematic diagrams and then synthesised into design materials in the form of personas representing diverse user profiles, and storyboards illustrating key situations observed in the field.

Saha araştırmastından fotoğraflar
Photographs from field research



Veri analizi ve haritalama çalışmaları
Data analysis and mapping studies



Personalar ve hikaye panoları
Personas and storyboards

USER PERSONA 3



NAME Ali Yıldırım
AGE 50
OCCUPATION Bus Driver



“Every day the same problem: either the button is not pressed correctly or the door does not open. I'm tired of arguing with passengers. ”

Table with 2 columns: Category (DAILY USE, FRUSTRATION, EXPECTATION) and Description.



FIELD RESEARCH PERSONAS #1

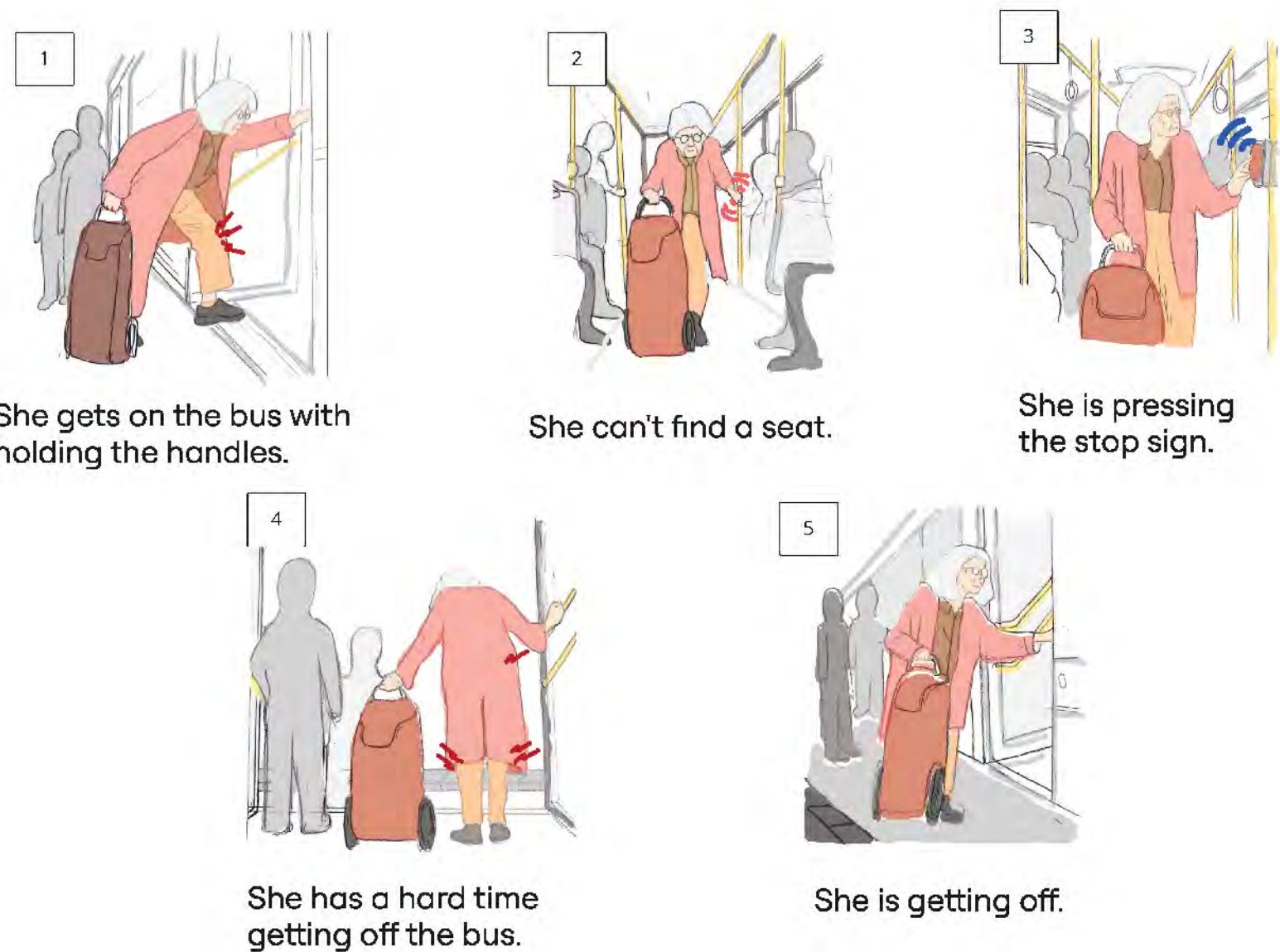
Four personas cards: Visiting Elder, Women with Babies/Children, Student, and Bus Driver. Each card includes age, gender, mobility, frequency, purpose, and specific needs/pains related to bus use.

Personas & Storyboard



Persona Name: Necla Yılmaz
Age: 76
Occupation: Housewife
Location: Ankara, Dikmen

She doesn't regularly use the bus, in total she spends 5-6 hours per week traveling.
She feels almost always tired.
She usually uses the bus in the morning and the afternoon. She sometimes carries grocery bags or a shopping trolley.
Because of her age, getting on and off the bus is difficult for her, she might pull on the door handles to support herself.



USER PROFILES

Four user profile cards: BERKAY (28 yr old, call center employee), ŞEVVAL (34 yr old, medical secretary), CENGİZ (19 yr old, university student), and MAHMUT (72 yr old, retired teacher). Each card includes a photo, job, and specific needs/pains related to bus use.



Saha araştırması bulgularının sunumları *Presentations of the desk research findings*

Fikir Geliřtirme *Ideation*

Fikir Geliştirme

İlk tasarım konseptlerini üretmek üzere, proje hedeflerine göre yorumlanan araştırma bulgularını temel alan bir fikir geliştirme çalıştayı organize edildi. Bu çalıştayda öğrencilere, MAN Türkiye ekibinden katılımcılar eşlik etti.

Çalıştay kapsamında farklı kapı operasyonlarına yönlendirecek farklı parametreler kullanılarak bir fikir havuzu oluşturuldu. Bu fikirler daha sonra araştırma bulgularına göre kullanılabilirlik ve fizibilite ölçütlerine göre değerlendirildi.

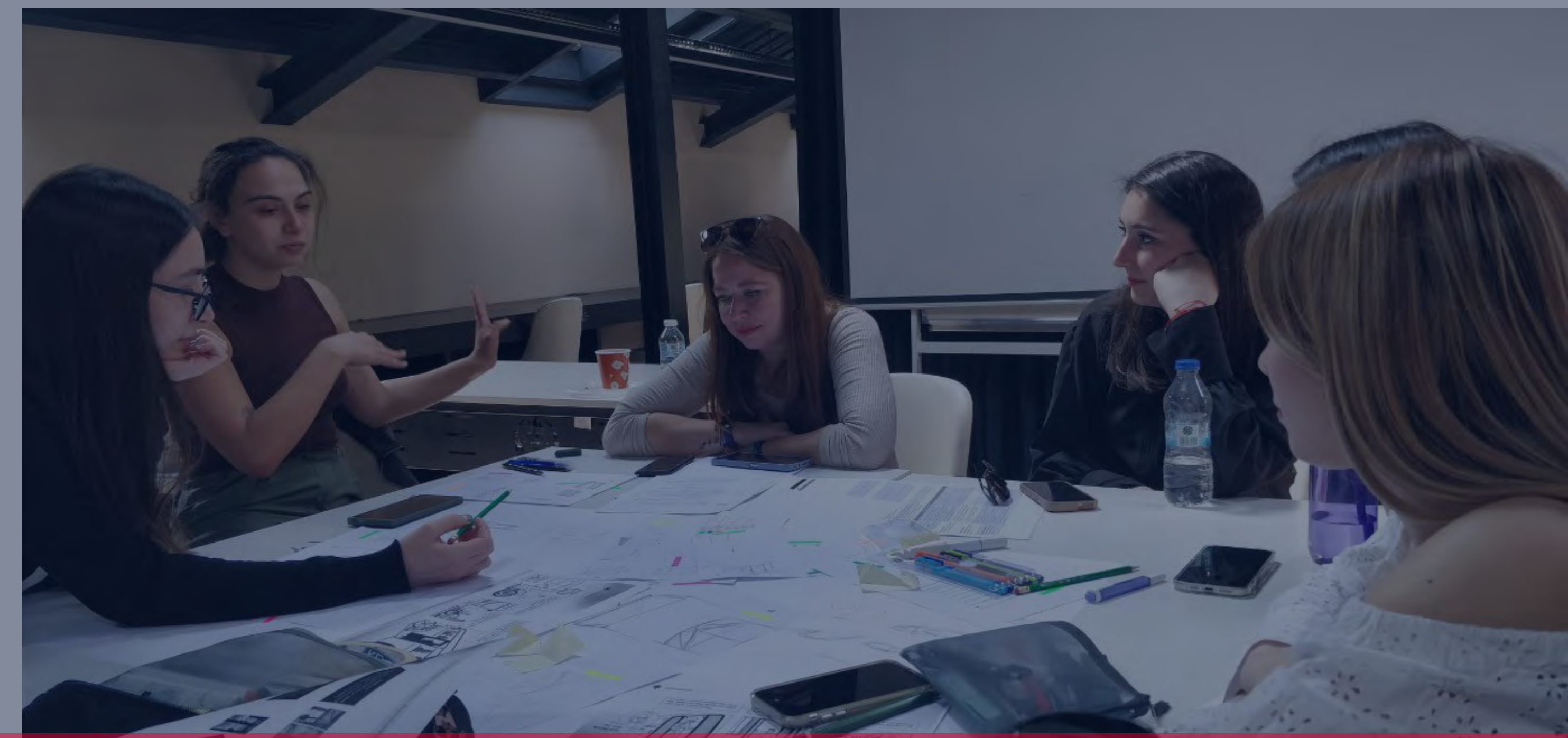
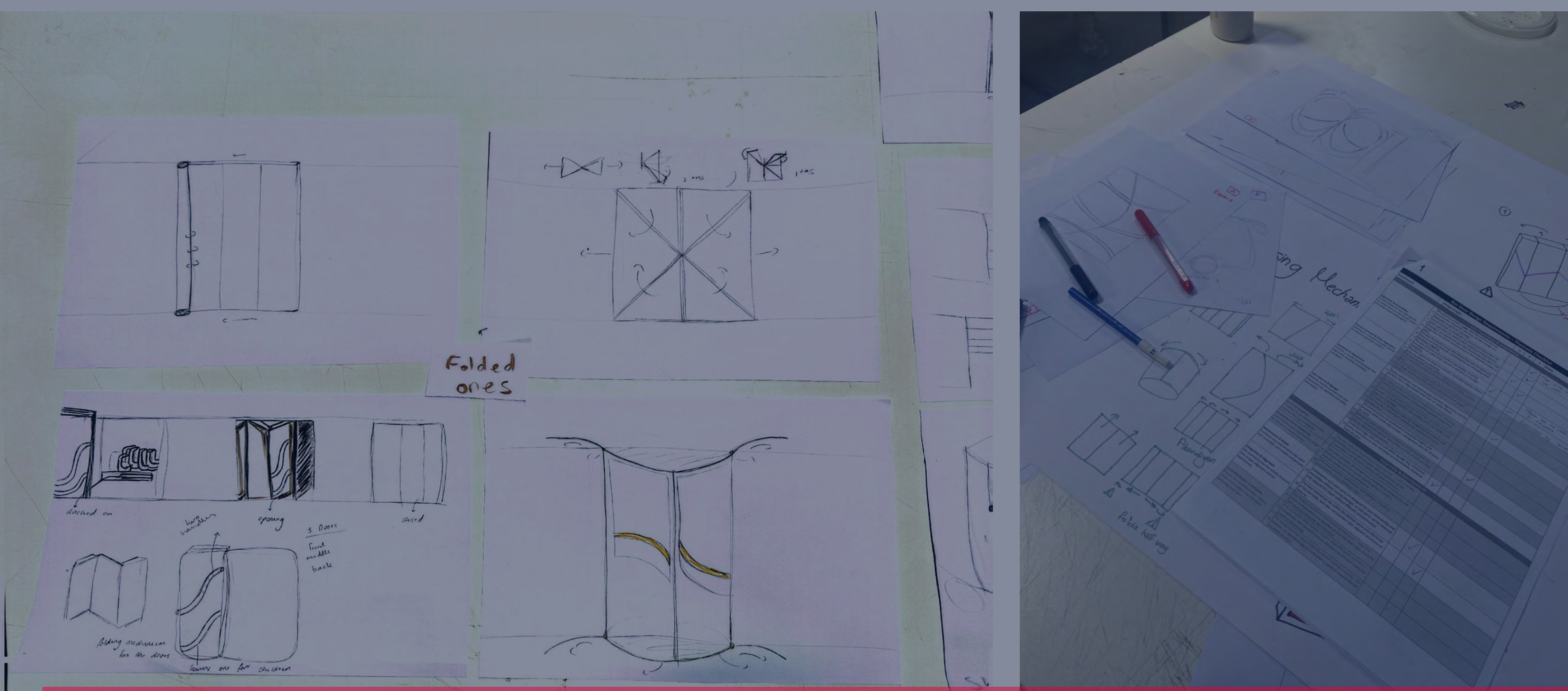
Her ekip çalıştay çıktılarından iki farklı konsept sentezledi ve bilgisayar destekli tasarım araçlarıyla form ve hareket çalışmalarına başladı. Bu sürecin sonunda birer konsept seçilerek detaylandırma aşamasına geçildi.

Ideation

An ideation workshop was organised to develop initial design concepts based on the research findings interpreted in line with the project goals. Participants from the MAN Türkiye team joined the students in the workshop.

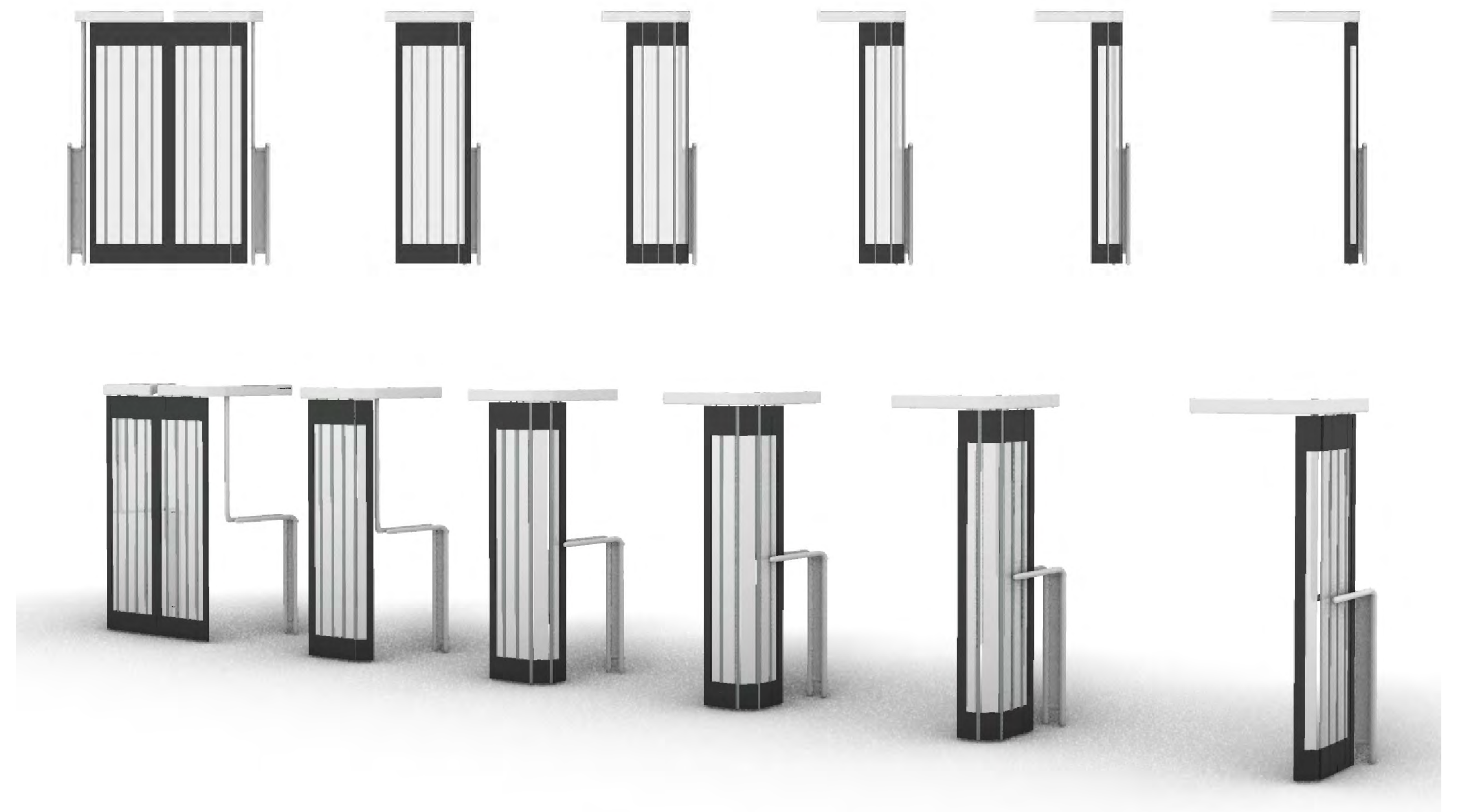
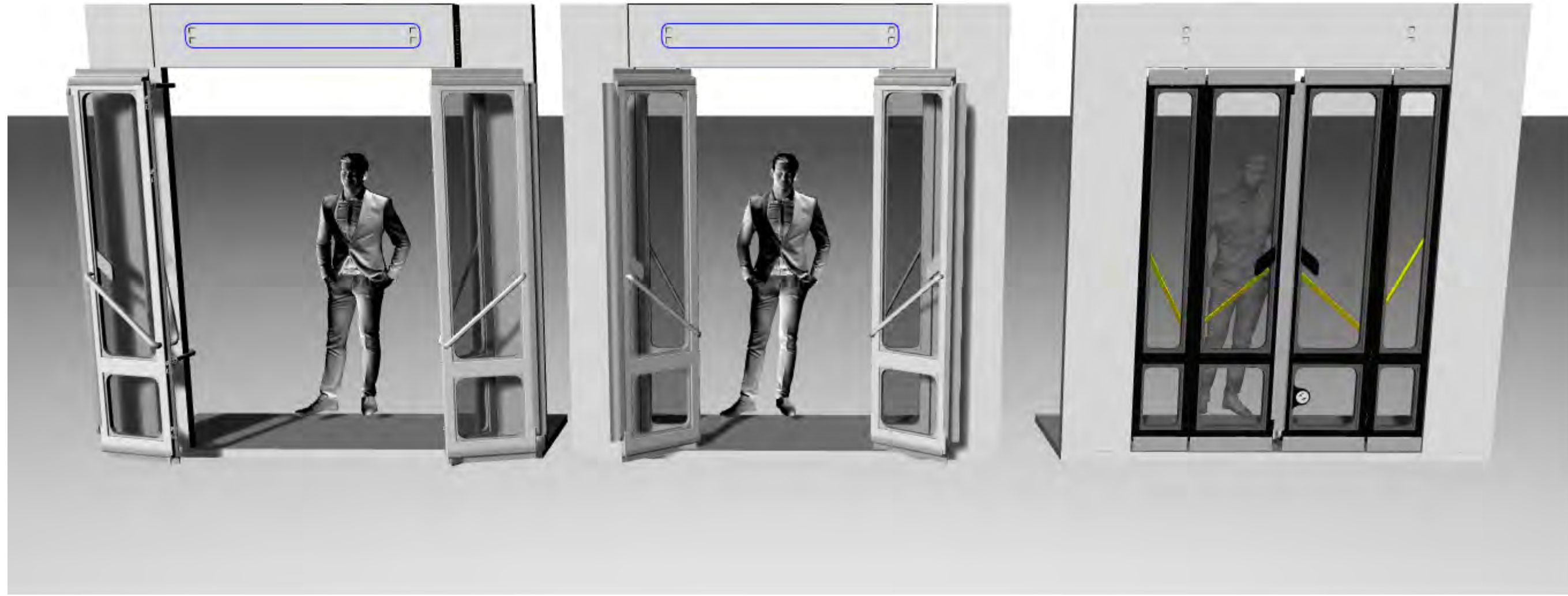
During the session, teams generated a pool of ideas using various parameters that would lead to different door operations. These ideas were then evaluated based on usability and feasibility criteria derived from the research findings.

Each team synthesised two distinct concepts from the workshop outcomes and began exploring form and movement using computer-aided design tools. At the end of this stage, one concept per team was selected to advance to the detailing phase.



Fikir geliştirme çalıştay *Ideation workshop*

Konsept geliştirme
Concept development



TECHNICAL

Rotating swing-fold mechanism

Visual Cues

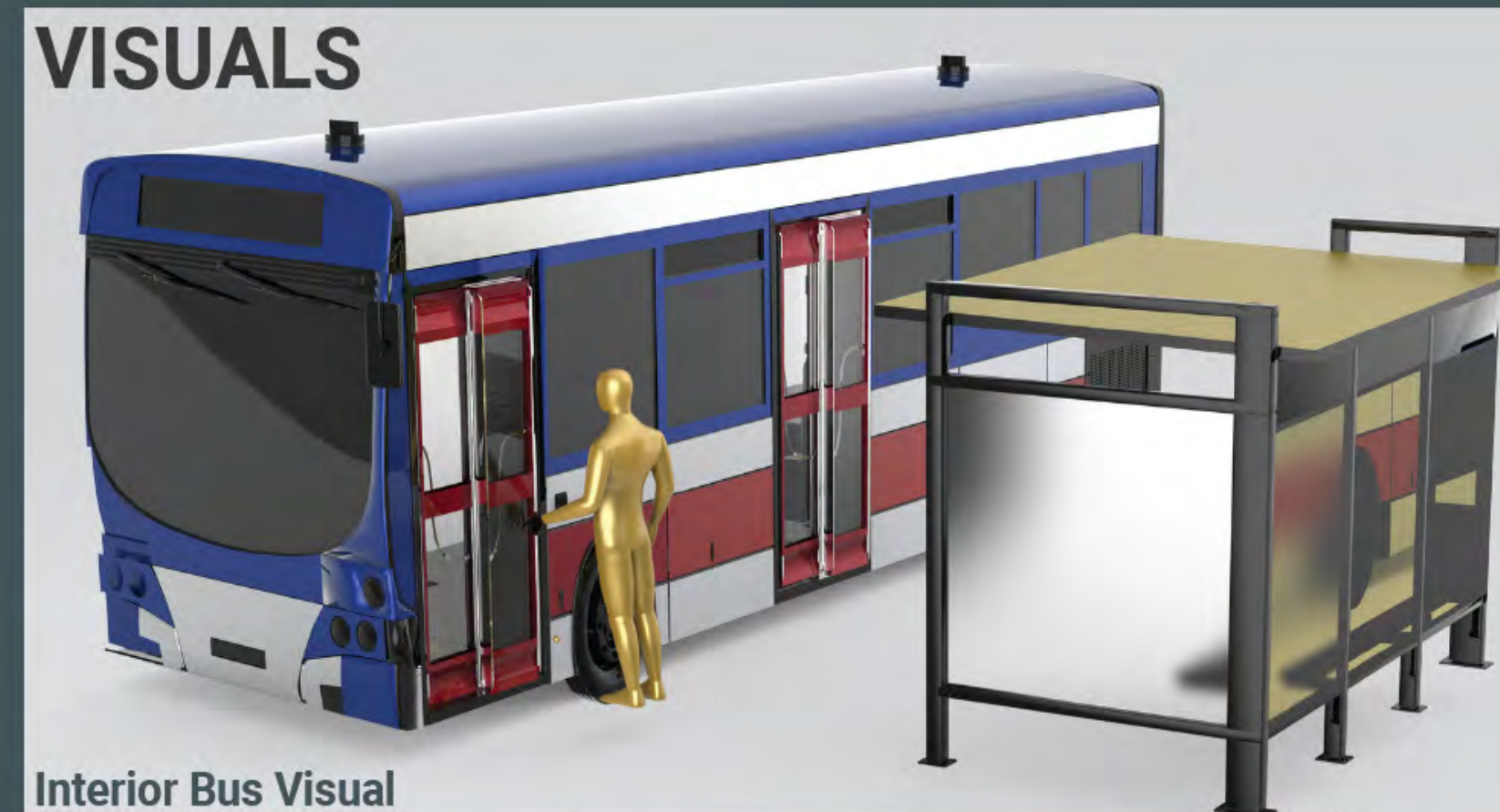
Fold along a central hinge

Consistency



VISUALS

LAYERED SLIDING BUS DOOR



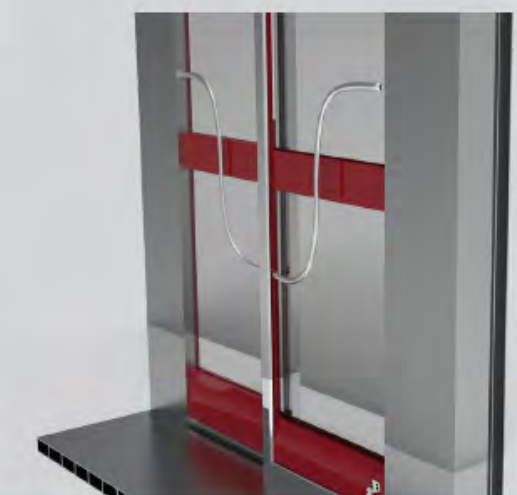
Interior Bus Visual



Exterior View of the Door

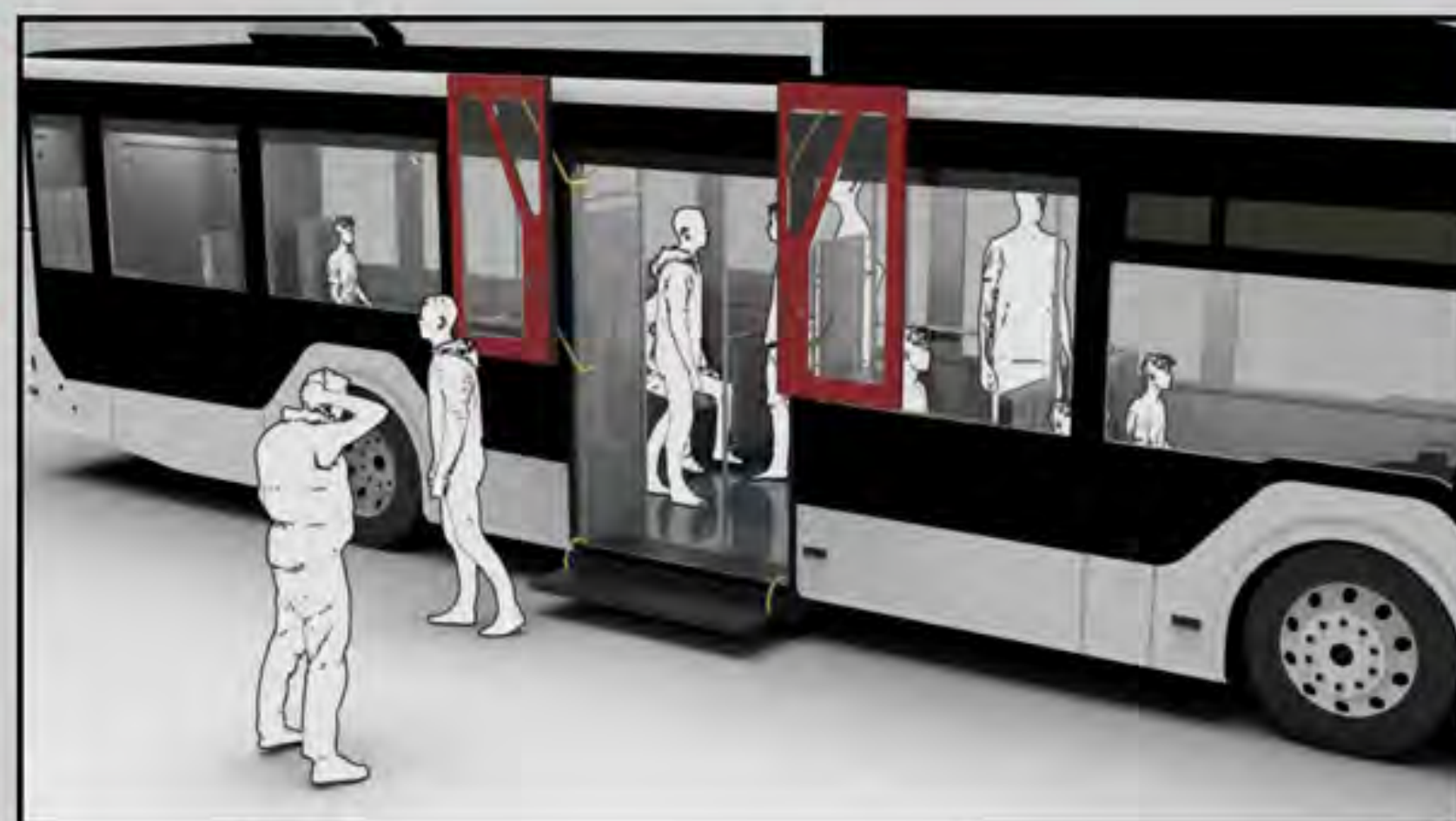


Interior View of the Door



Passenger Circulation

#1

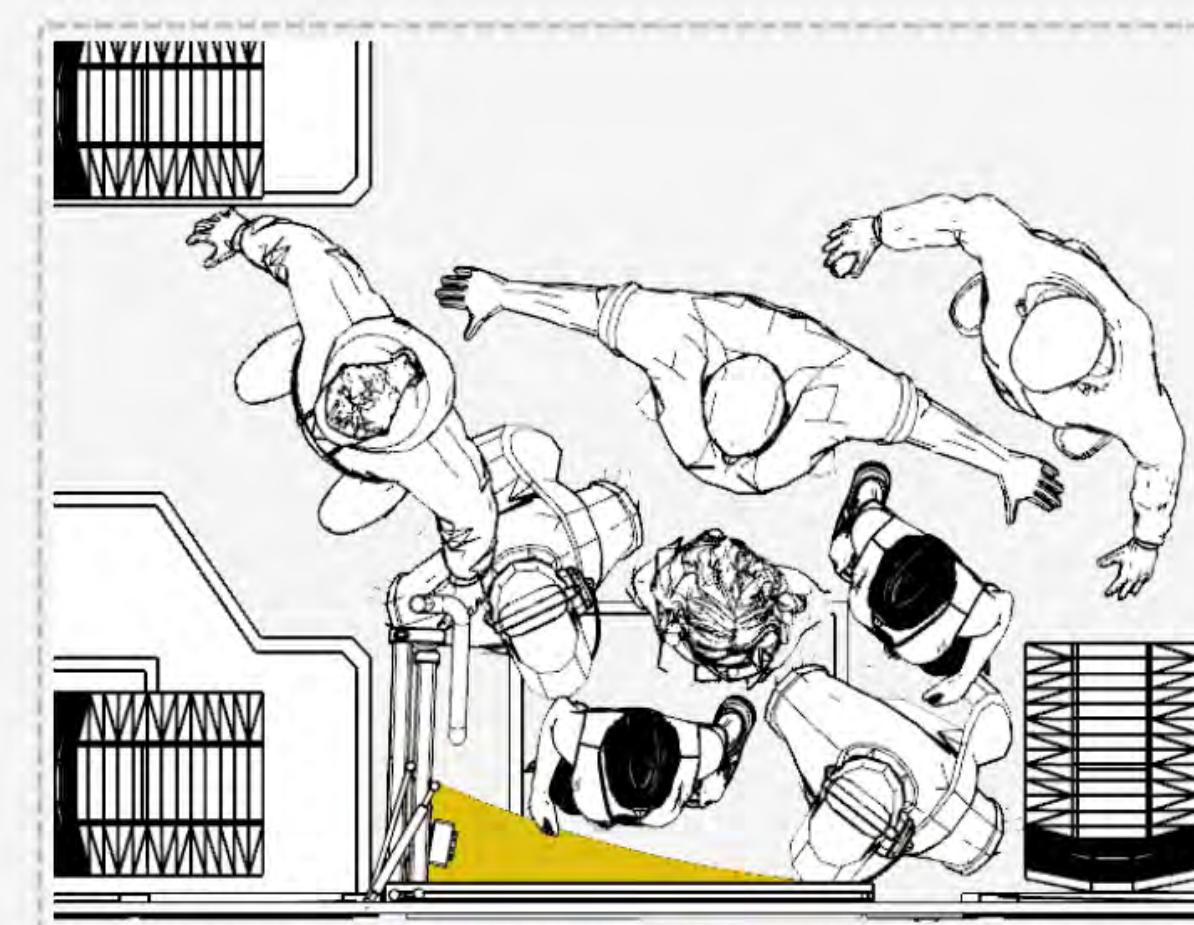


Doors designed to avoid hitting passengers and to prevent obstruction of landing areas.

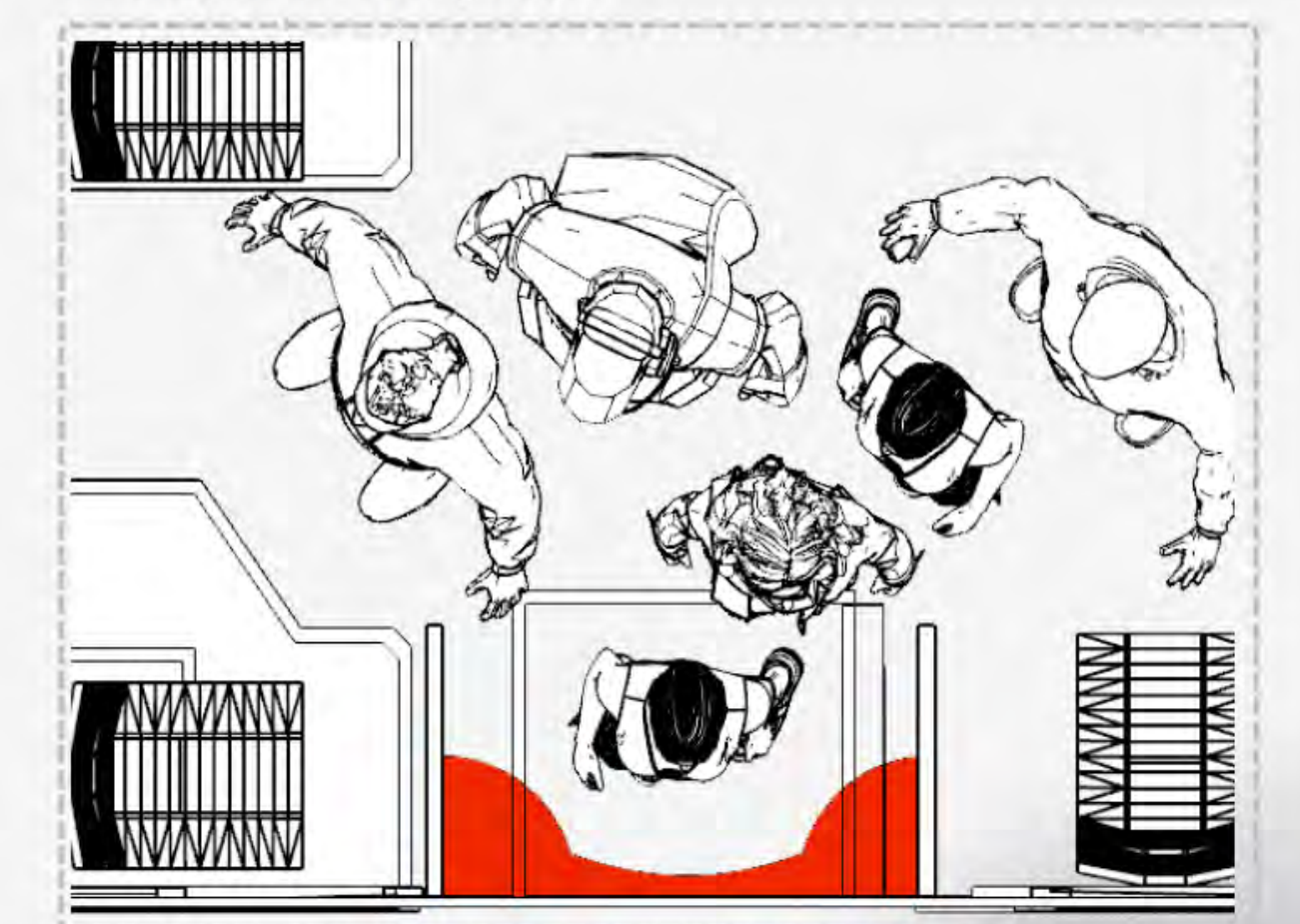


SPACE DEFINITION

Idea 1



Traditional In-swing door



Detaylandırma *Detailing*

Detaylandırma

Ekipler, seçilen konseptleri; hareket mekanizmalarını geliştirerek, motor ve tahrik elemanlarını konumlandırarak, ebatlandırma ve malzeme seçimlerini yaparak, güvenlik ve erişilebilirlikle ilgili yönergelere uyum sağlayacak şekilde detaylandırıdılar.

Bu aşamada öğrenciler, haftalık soru-cevap ve geri bildirim oturumları aracılığıyla MAN mühendislik ekibiyle yakın çalışma fırsatı buldu. Nihai konseptler, MAN Türkiye Ürün Geliştirme Merkezi'nde sunuldu. Yenilikçilik, uygulanabilirlik ve pazar potansiyeline göre yapılan değerlendirmeler sonucunda, öğrenciler Berk Karaağaç, Eylül Deniz, Kerem Alsan ve Mehmet Berk Kuru, MAN Türkiye'de staj yapma hakkı kazandı.

TED Üniversitesi ile MAN Türkiye A.Ş. arasında imzalanan protokol kapsamında gizlilik ve fikri mülkiyet başvuru süreci devam ettiğinden, nihai tasarımlar bu aşamada paylaşılamamaktadır.

Detailing

Teams further developed the selected concepts by refining movement mechanisms, positioning motors and actuators, determining dimensions, selecting materials, and ensuring compliance with the safety and accessibility regulations.

During this phase, students had the opportunity to work closely with the MAN engineering team through weekly Q&A and feedback sessions. Finalised concepts were presented at the MAN Türkiye Product Development Centre. Following evaluations based on innovativeness, feasibility, and market potential, students Berk Karaağaç, Eylül Deniz, Kerem Alsan, and Mehmet Berk Kuru were awarded internship opportunities at MAN Türkiye.

Due to the ongoing confidentiality and intellectual property application process under the protocol signed between TED University and MAN Türkiye A.Ş., the final designs cannot be shared at this stage.







FIELD OBSERVATION TOUCHPOINTS



1

Space loss

How to design, build, create
space for people and the
place.



2

Frightening sounds

How to design, build, create
sounds and vibrations.



3

Material wear

How to design, build, create
the space, materials, and
the way it is used.



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