



IDC School of Design
अभिकल्प विद्यालय

Parcel movement system

Final semester design project report

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Approval sheet

The Mobility and Vehicle Design project report entitled 'Material movement system' by Arka Hazra is approved in partial fulfilment of the requirement for the Master's degree in Mobility and Vehicle Design

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Declaration

I hereby declare that this written submission represents my ideas and my own words and any reference have been properly and correctly credited. I also have adhered to all academic honesty and integrity principles and have tried my utmost not to falsify, manipulate or fabricate any information. Any resemblance is a mere coincidence Any violation of the above will cause disciplinary action by the institute and can also provoke penal action from the sources from which proper permission has not been taken, or improperly cited.

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A handwritten signature in blue ink that reads "Arka Hazra". The signature is written in a cursive, flowing style.

Acknowledgement

I take this opportunity to express immense gratitude to Prof. Sugandh Malhotra for his constant guidance and supervision over the course of this project. His eagerness to see the outcome has always kept me on my toes. A special thanks to all those who provided worthy opinions and insights during the research phase. My heartiest thanks to all my friends at IDC whose critiques and suggestions helped a lot in refining my concept. And last but not least, .my parents, who always motivated me and kept reminding me how important this project is.

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Abstract

Material movement systems are essential for the efficient and effective flow of materials in manufacturing, warehousing, and distribution. These systems can be manual or automated, and they can be used to move materials over short or long distances. The design and implementation of a material movement system should take into account the specific needs of the organization, such as the type of materials being moved, the volume of materials being moved, and the desired level of automation. This project focuses on the key concepts of material movement systems, the different types of material handling equipment (manual/ automated), material flow, material storage and control, and the factors to consider when designing and implementing such a system. This project will also provide some examples of how material movement systems can be used to improve efficiency and productivity in manufacturing, warehousing, and distribution. The primary aim is to come up with a system-level design and a vehicle that

supports the movement of material in both inbound and outbound logistics. For exploratory purposes, I have chosen to design several systems for Amazon. There are two basic reasons for this.

1. Amazon has all the resources that are versatile and diverse in nature, this should allow the easy and clear justification of every design decision that I have taken
2. After doing an extensive study about Amazon I found that they are ultimately aiming to be a dedicated logistics company. This transformation has already begun.

The process for designing a system that I followed is mainly to do primary and secondary research about the parcel logistics system of various organizations, from this study I have extracted some insights and key points and these were the guiding principles for the final system design.

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1. MATERIAL MOVEMENT SYSTEM

1.1 ABOUT

The infrastructure and procedures used to manage the flow of materials inside a building or organisation are referred to as a material movement system. Raw materials, work-in-progress, and finished commodities are among the many sorts of materials that must be moved, stored, and tracked. As is evident from the title of the topic, there are three main terms in it, which are as follows:

- **Material** – The package or the parcel that is to be delivered from the point of origin to the point of delivery
- **Movement** – Moving the package from point A to point B via several means and ways
- **System** – The set of things (operations) working together as parts of the overall logistics as an interconnected network.

It can therefore easily be derived that this project is about a system design that allows transferring/ moving of material goods that are tangible, from one place to another. It might sound easy at first but there are several steps and factors in

the entire process of transferring any product. Here are the factors that are to be considered:

1. **Type/ category of material.** There are various types of materials that we need and purchase in our daily life, these can be perishable/ non-perishable, finished/ raw, or packaged/ unpackaged, these can be transported from point A to point B.
2. **The distance of travel.** In a trip/ transport route, there can be various steps and breaks. These stops might be due to several operational needs, such as destination alteration, loading/ unloading, refreshment breaks etc.
3. **The time of operation.** This is by far the most important aspect of any material movement system. That is because every second invested in an operation or sub-operation is evaluated against the cost incurred in that step. So, the lesser the time consumed the lesser the overall cost of operation.

4. **Inventory/ storage space** is another important aspect of any material movement system. Ideally, the best case will be the absence of any inventory throughout the material movement system, but the long-distance shifting of materials often requires the need of storing them at a centralized location. Here different types of storage systems are used to store materials during their movement. These can include racks, shelves, bins, and containers designed to accommodate different types of materials and optimize space utilization.
5. **Inventory Management** means tracking and managing inventory levels. This may include the use of barcode scanning, RFID (Radio Frequency Identification), or other automated systems to monitor the movement and availability of materials in real-time.
6. **Material Handling Procedures** are the standardized processes and protocols followed for the movement of materials. They include guidelines for loading and

unloading, packaging, labelling, and organizing materials to ensure efficient movement and minimal errors.

7. **Means of transport** is another crucial step in transporting material. This can happen over various distances, starting from small intracity levels to intercontinental distances. The suitable means of transport are to be selected depending on the distance of travel. It can vary from a small scooter to a very big cargo ship. It includes all three means of transport, by water, by land and by air. It also includes various tools and equipment used to move materials, such as forklifts, conveyors, cranes, pallet jacks, and automated guided vehicles (AGVs). These tools enable the efficient and safe movement of materials within a facility.
8. **Warehouse Management Systems (WMS)** is the software that is used to automate and optimize material movement processes. It helps track inventory, manage orders, plan efficient routes for transportation, and

provide real-time visibility into the movement of materials.

9. **Lean Manufacturing Principles** are a set of practice guidelines often applied to these systems to eliminate waste, improve efficiency, and reduce costs. Practices such as just-in-time (JIT) delivery, Kanban systems, and continuous improvement efforts to streamline material flow.

10. **Safety and Ergonomics** Material movement systems should prioritize safety and ergonomics to prevent accidents and injuries. This involves proper training for employees, the use of appropriate protective equipment, and the design of workstations and equipment to minimize physical strain.

Overall, an effective material movement system plays a crucial role in optimizing the flow of materials, reducing the time consumed, improving productivity, and enhancing

overall operational efficiency within a facility or organization.

1.2 THE NEED FOR SUCH A SYSTEM

There are several reasons why a material movement system is essential, some of the key benefits are as follows.

1. Efficient Operation

A well-designed material movement system ensures the smooth and efficient flow of materials. It eliminates roadblocks, reduces waiting times, and minimizes disruptions in production processes. This leads to increased productivity and improved operational efficiency.

2. Cost Reduction

An efficient system can save costs in various ways. By enabling better space utilization, reducing the need for

excessive storage, and cutting labour costs by streamlining and minimizing manual efforts. These optimized material flow helps avoid production delays, resulting in cost savings associated with downtime and missed deadlines.

3. Improved Customer Service

Timely and accurate material movement is crucial for meeting customer demands and maintaining high service levels. By ensuring that materials are available when needed, organizations can fulfil customer orders promptly, reduce lead times, and enhance customer satisfaction.

4. Safety and Risk Mitigation

A well-implemented system prioritizes safety and mitigates risks associated with material handling. It includes proper training for employees on safe handling procedures, the use of appropriate equipment and tools, and adherence to safety regulations. By reducing

accidents and injuries, organizations can create a safer work environment and avoid costly liabilities.

5. Data Visibility and Analysis

Modern material movement systems use tech solutions like WMS and RFID to track materials in real time, enabling data gathering and performance analysis.

6. Adaptation to Changing Demands

As market demands evolve, organizations need to be agile in response. An effective material movement system enables flexibility in accommodating demand fluctuations, and changes optimizing production and distribution processes accordingly.

2. SYSTEM DESIGN

2.1 ABOUT

System design is the process of creating blueprints or plans for a system with specific requirements and objectives. It involves designing the structure, components, interfaces, and interactions to achieve the desired functionality, performance, and usability. It includes both the high-level and detailed design of a system. Following are the steps.

1. Requirement Analysis

This step involves gathering and analysing the functional and non-functional requirements of the system. It includes understanding the goals, scope, constraints, and user needs to define the system's purpose and features.

2. Architectural Design

The architectural design phase focuses on defining the overall structure and organization of the system. It involves identifying system components, subsystems, modules, and their relationships. This step determines how the different components of the system will interact

and collaborate to achieve the desired functionality.

3. Detailed Design

In this phase, the high-level design is further elaborated, and detailed specifications are developed for each component of the system. It includes designing data structures, algorithms, user interfaces, databases, interfaces with external systems, and other relevant system elements. The detailed design ensures that the system meets the requirements and can be implemented effectively.

4. Interface Design

Interface design focuses on designing the interaction points and communication mechanisms between different system components or with external systems. This includes defining input and output formats, protocols, data exchange mechanisms, and user interfaces. Interface design ensures seamless integration and smooth data flow within the system and

with other systems.

5. Database Design

If the system involves data storage, database design is an important aspect of system design. It includes designing the database's structure, tables, relationships, and access methods. Database design ensures efficient storage, retrieval, and manipulation of data within the system.

6. Security and Performance Design

System design should also consider security and performance aspects. This involves identifying potential security risks, defining access controls, and encryption methods, and designing performance optimizations to ensure the system operates securely and efficiently.

7. Documentation

Throughout the system design process, documentation plays a crucial role. It includes creating design specifications, system diagrams, data models, interface definitions, and other relevant documentation to communicate the design to stakeholders, developers, and future maintainers of the system.

Hence, we can say that system design is a collaborative and iterative process involving input from various stakeholders, including business analysts, system architects, domain experts, and developers. The design process ensures that the system is effectively planned and organized to meet the desired requirements and objectives.

2.2 TYPES OF LOGISTICS SYSTEMS

1. One-day/same-day delivery

This delivery system refers to the process of delivering goods or products to customers on the same day the order is placed. It is a service that offers convenience and fast turnaround times for customers, particularly in the e-commerce industry. Examples.

- **Mumbai dabba Wala** – They are a strong army of nearly 5,000 people who ensure that 2,00,000 people get their lunch on time at their offices.
- **FMCG delivery system** - Fast-moving consumer goods (FMCG), also known as consumer-packaged goods (CPG), are products that are sold quickly and at a relatively low cost. Examples include non-durable household goods such as packaged foods, beverages, toiletries, candies, cosmetics, over-the-counter drugs, dry goods, and other consumables.

- **Amazon same-day delivery** – As the name suggests, it is about delivering the products on the same day that the consumer has ordered

2. Next-day delivery – This system is about the logistics system of products that are delivered the next day after the order is placed.

3. Scheduled delivery

- **Amazon delivery system** -
- **European Union Marco Polo project**

3. MUMBAI DABBA WALA



3.1 ABOUT

The dabbawalas (also spelt dabbawallas or dabbawallahs, called tiffin wallahs in older sources) constitute a lunchbox **delivery and return system** that delivers hot lunches from homes and restaurants to people at work in India, especially in Mumbai. The lunchboxes are picked up in the late morning, delivered predominantly using **bicycles and railway trains**, and returned empty in the afternoon.

Properties:

- **Delivery and return system** – this implies that the system has forward and reverse logistics.
- **Bicycle and railway system** – the use of existing means of transport makes the system cost-effective and inexpensive.

Coding

Every parcel is coded with a special code that is alpha-numeric and colour coded. This helps the dabbawalas to identify and sort the parcels at the source.

Area of operation

Dabbawallahs operate only in the city of Mumbai, Maharashtra.

Operations performed

Their operation is divided into two parts.

In the first half of the day, they **collect, sort, load and deliver**.

During the second half of the day, it is the reverse process, **collect, sort and deliver**



Old coding system



New coding system



E – Code of dabbawalla at the resident station

VLP – The locality name

3 – Destination station code

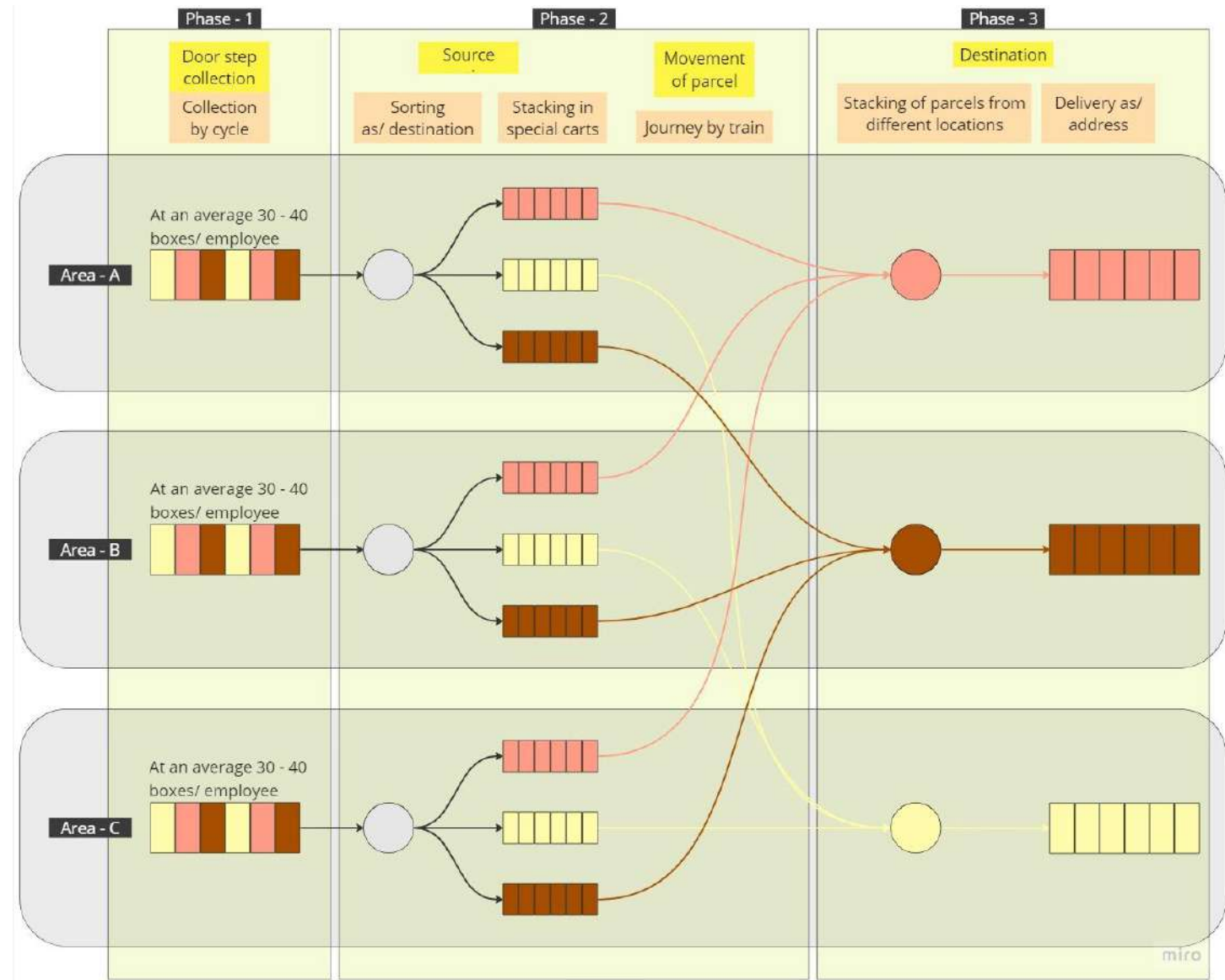
9 AI 12:

- 9 – Code of dabbawalla at the destination station
- AI – Building within the destination
- 12 – 12th floor of the building

The colour code is exclusive to the source, destination and the exact location where the parcel is to be delivered. Here blue is for Vileparle and red is for Churchgate

3.2 OPERATION MAP

- Phase 1: Collection
- Phase 2: Sorting and transportation
- Phase 3: Distribution



3.3 REVERSE LOGISTICS

In the process of reverse logistics, the code is backtracked. This allows the dabbawalas to follow the same route as in the first half, only in the reverse direction.

The system of coding is the same in the old and the new method with the addition of the **surname of the customer**, this allows easy identification of the tiffin.

3.4 INSIGHTS

1. No warehouse/ inventory
2. Same-day delivery
3. No disposable packaging, hence no waste
4. Reusable package
5. Quantity of operation is scalable
6. Sorting of parcel at source as per destination code
7. Fully manual system
8. No technology is used in the process

9. Hence the cost of operation is very less with a monthly service charge of Rs. 350 to Rs 400.
10. Point A and point B of the parcel are mostly the same.

3.5 KEY POINTS

1. Destination code-based sorting at the source
2. Single route for onward and reverse logistics

4. AMAZON DELIVERY SYSTEM



4.1 ABOUT

Amazon is a well-known retail cum logistics company based out of America. They have a very well-distributed and well-structured logistics system. As part of this system, amazon operated several warehouses, some of which are called fulfillment centres. The fulfillment centres that are run by Amazon Logistics are very uniquely operated. Unique because these centres operate under a specific process that consists of several defined steps. These steps have been designed in such a way that allows record-keeping, inventory management, material movement and tracking, order processing and delivery. These steps are as follows:

Step 1: Predicting – The Artificial intelligence that Amazon operates, predicts what an existing customer might purchase based on her/ his purchase pattern and history.

Step 2: Purchasing – Based on the prediction amazon places orders from its authorised vendors.

Step 3: Packing and Dispatch – After Amazon has placed an order, the vendors pack the parcel and give it to the Amazon parcel pickup guy.

Step 4: Transportation – After the parcels are picked and moved to the local warehouse, they are sorted and organised according to their destination fulfillment centres and shipped via air, water or land.

Step 5: Unloading – The parcels are unloaded from the container manually.

Step 6: Receiving – The parcels are then scanned and recorded, and specific storage areas are assigned.

Step 7: Stowing – In this part of the system the received and recorded parcels are manually stowed and placed/ stored in the assigned bins or racks.

This is the first part of the system where the items/parcels are stocked in the inventory. Now when an order is placed by the customer a pick task is generated by the system. This task contains the exact location of the parcels. This makes it easy for the pick boy to collect all the ordered items.

Step 8: Picking – The process of collecting all the ordered items of a particular order is called picking

Step 9: Packing – In this step, the items are packed in cartons according to their weight and sent further down the line for slamming.

Step 10: Slamming: - Here the delivery address is pasted on the packages and sent for delivery.

Step 11: Sorting: The packages are then sorted and arranged according to the delivery code and stocked.

Step 12: Loading – these parcels are then loaded into containers for delivery to the customers.

Step 13: Delivery – This is the final and last step of the process which is done via trucks, bikes, vans etc.



Image 1

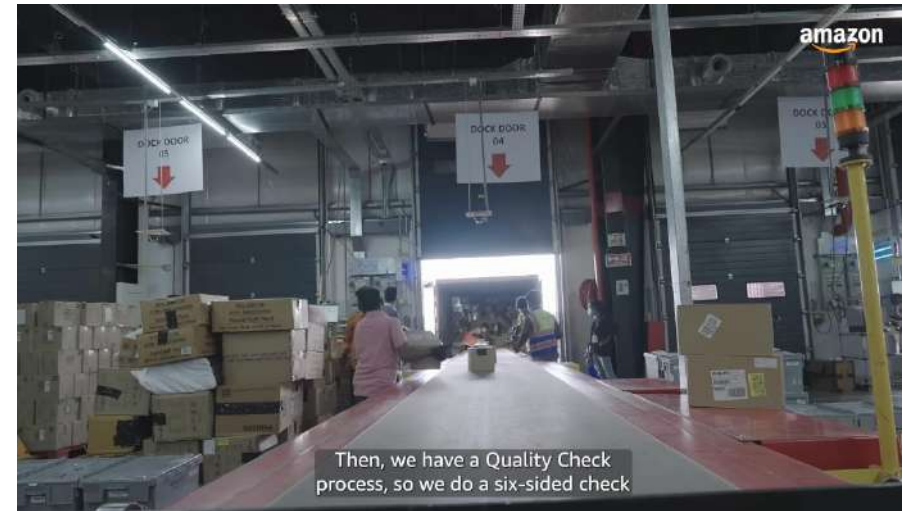


Image 2



Image 3



Image 4



Image 5



Image 6



Image 7



Image 8



Image 9

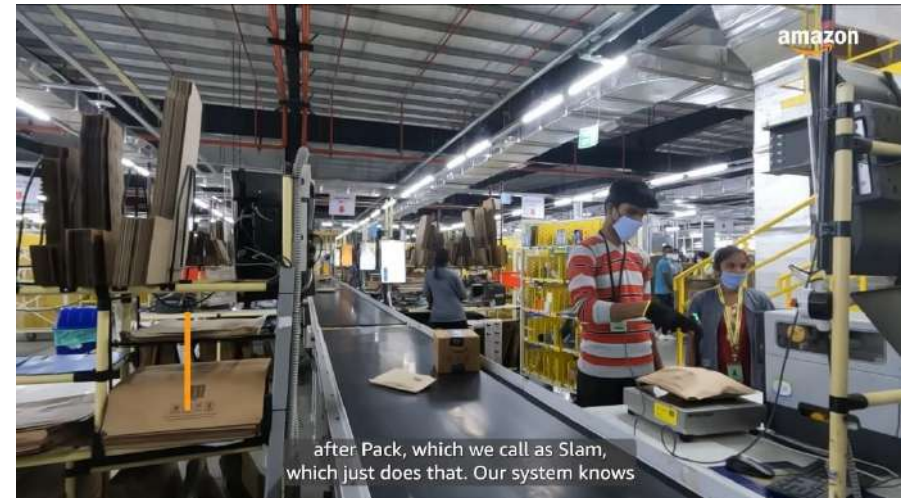


Image 10



Image 11

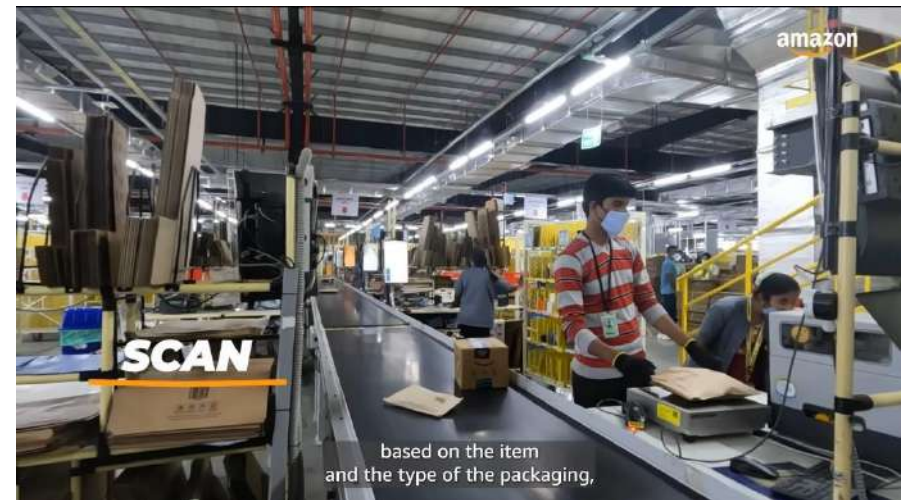


Image 12



Image 12

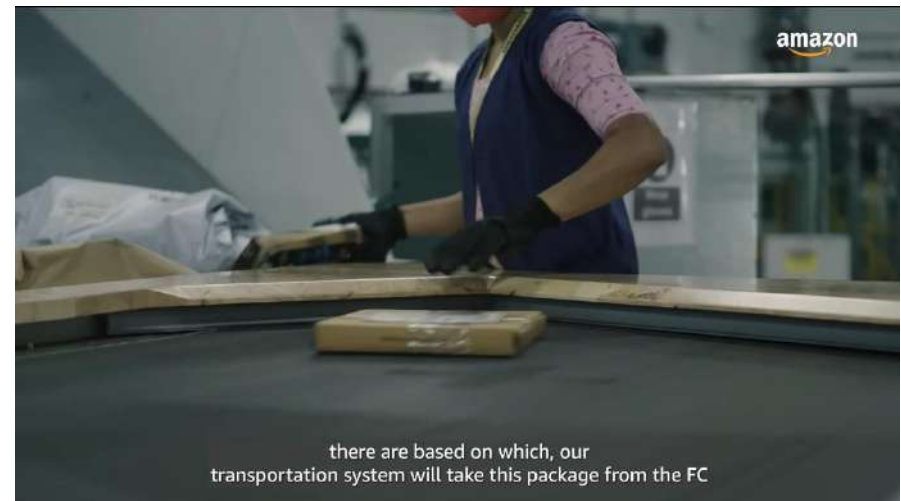


Image 13

- Image 1: Unloading the parcels
- Image 2: Receiving the parcels
- Image 3: Scanning the parcels
- Image 4: Stowing and keeping them in bins
- Image 5: Picking the parcels as per the order
- Image 6: Barcode scanning from the bin as per order
- Image 7: Scanning the products from the bin
- Image 8: Packing the parcels
- Image 9: Scanning the package
- Image 10: Sending them to the dispatch area
- Image 11: Slamming is the process where the delivery address is stuck on the package
- Image 12: Finally, the parcel is scanned according to the delivery address and sent for delivery
- Image 13: The package is directed to the delivery vehicle

4.2 TYPE OF FACILITY CENTRES

1. Sortable fulfillment centre

These centres handle small, lightweight items that can be easily sorted and packed. Items are picked, packed, and shipped as per customer orders. Items such as books, toys, and housewares are handled.

2. Non-sortable fulfillment centre

These centres handle large, bulky items that cannot be easily sorted and packed.

3. Sortation centres

These centres sort customer orders by final destination and consolidate them onto trucks for faster delivery. They are typically located near major airports or shipping hubs.

4. Receive centres

These centres receive large orders of inventory from suppliers and distribute them to fulfillment centres *within the network.

5. Speciality

These centres handle specific categories of items or are pressed into service at peak times of the year such as the holiday season.

6. Delivery stations

These stations are the last stop for customer orders before they are delivered to customers. They are typically located in residential areas and are staffed by Amazon drivers.

Feature	Sortable fulfillment centers	Non-sortable fulfillment centers	Sortation centers	Receive centers	Specialty centers	Delivery stations
Items handled	Small, lightweight items	Large, bulky items	All types of items	All types of items	Specific categories of items	Customer orders
Location	Typically located near major population centers	Typically located near major shipping hubs	Typically located near major airports	Typically located near major distribution centers	Typically located near major population centers	Typically located in residential areas
Shipping speed	Typically 2-day shipping for Prime members	Typically standard shipping	Typically 1-day shipping	Typically 2-day shipping	Varies depending on the item	Typically same-day or 2-day shipping

4.3 SCENARIO

Let's consider a scenario where the AI has predicted that customer C3 might purchase product P1 which a vendor in area – A which is Bangalore sells, but she lives in area – B which is Delhi.

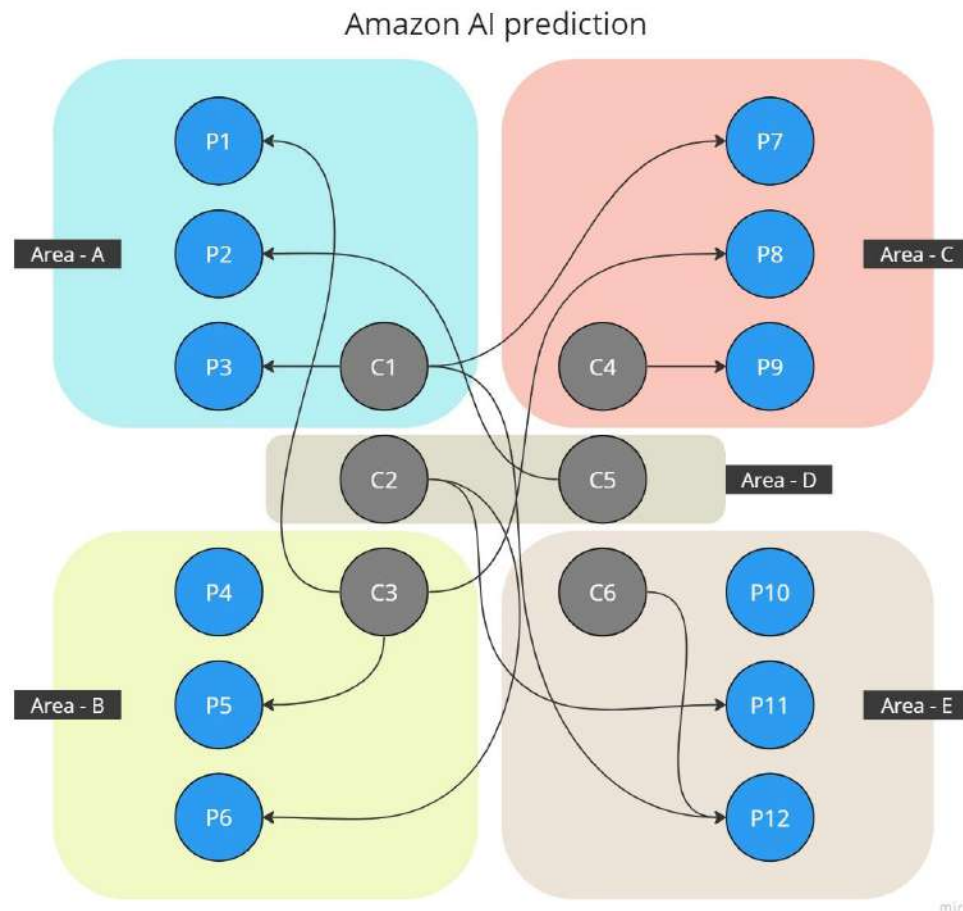
Here the ideal situation would be that the product is already in the fulfillment centre nearest to the customer in Delhi. This means that the product has to be in Delhi before an order is placed.

- **Distance:** Bangalore – Delhi
- **Means:** Truck/ train

Once the order is placed the parcel will be dispatched from the local facility. This will be done using a vehicle which is either a two-wheeled vehicle or a minivan.

- **Distance:** Delhi fulfillment centre – delivery location
- **Means:** Bikes/scooters/ minivans etc.

4.4 PREDICTING



- C1 – C6: Customers

- P1 – P12: Parcels that are located in different locations

The arrows show the desired products for each customer which may be located at a different geographical location as predicted by the AI system.

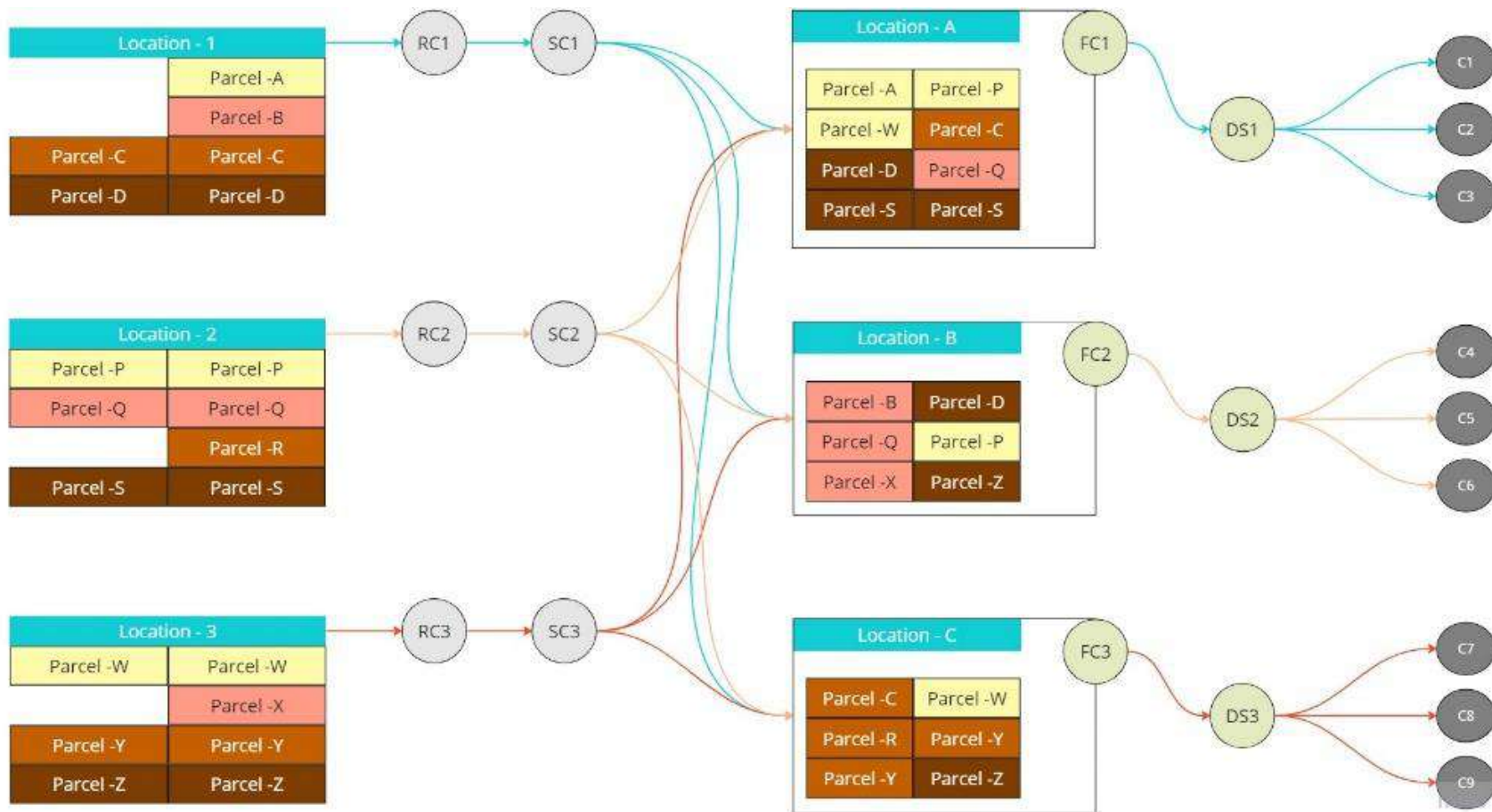
Long-distance logistics system followed by Amazon

RC – Receiving centre

SC – Sorting centre

FC – Fulfillment centre

DS – Distribution centre

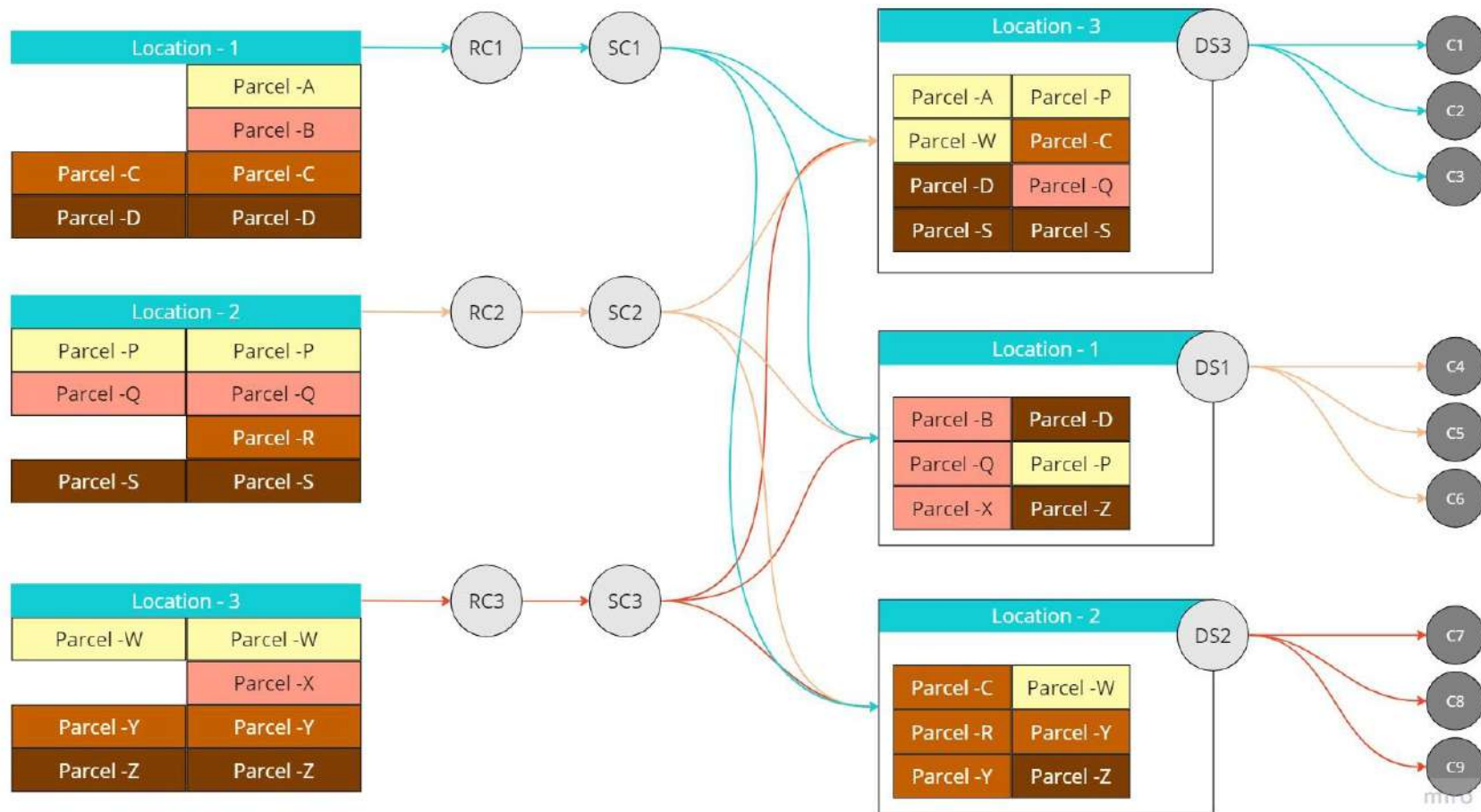


Short-

distance logistics system followed by Amazon

RC – Receiving centre

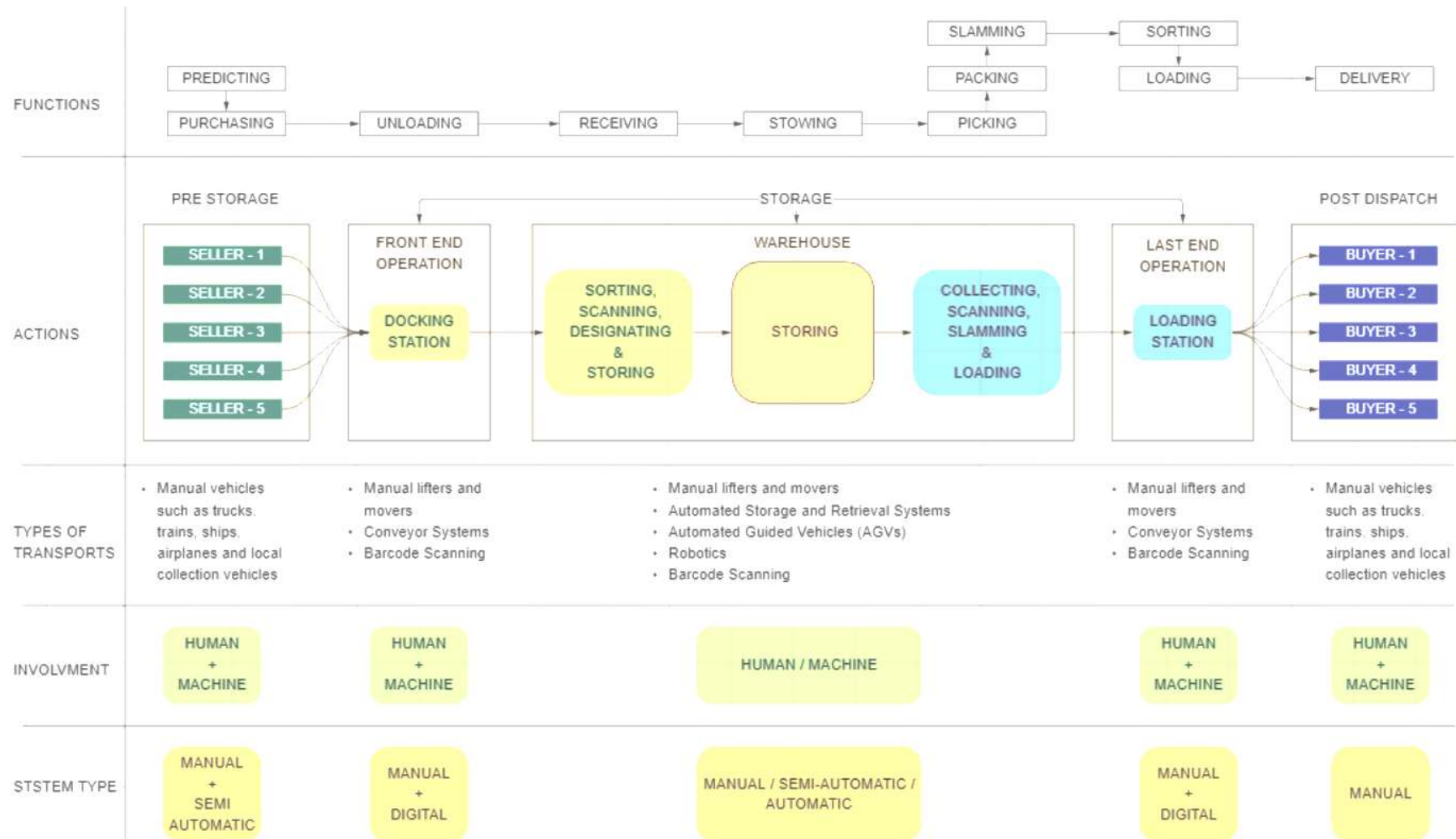
SC – Sorting centre



FC – Fulfillment centre

DS – Distribution centre

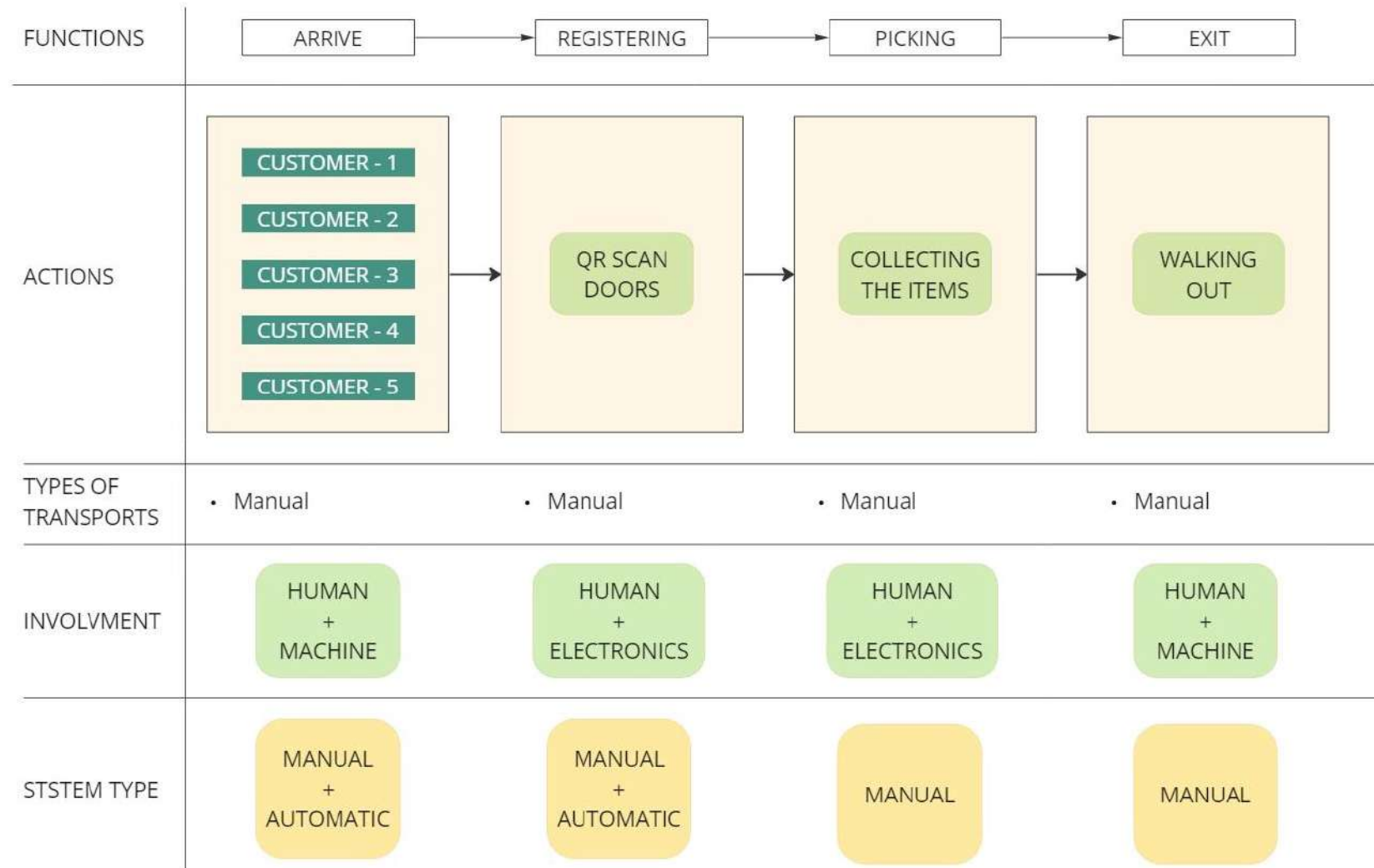
4.5 OPERATIONS INSIDE THE



4.6 WAREHOUSE INSIGHTS

1. The fulfillment centre serves as the secondary shopping mall.
2. It ensures stock
3. It also leads to the inclusion of extensive investment in order to maintain an inventory (fulfillment centre)
4. Dedicated staff for each operation
5. Every operation has a combination of humans and technology
6. Loading/ unloading is a manual process
7. Amazon has dedicated facilities at different locations for various operations
8. It has different delivery options such as same-day delivery, next-day delivery, two-day delivery

4.7 OPERATIONS INSIDE AMAZON GO



4.8 INSIGHTS



1. The entire process is automated
2. The concept of operation is walk-in grab & walk-out
3. The process eliminates the final painful step of billing
4. The entire process is card/ cashless

4.9 OPERATIONS INSIDE AMAZON FRESH

Amazon Fresh is a grocery delivery service offered by Amazon.com. It was first launched in Seattle, Washington in 2007, and has since expanded to over 26 locations in six states: California, Illinois, Indiana, Maryland, New Jersey, and Texas. Amazon Fresh offers a wide selection of fresh produce, meat, seafood, dairy, baked goods, snacks, and more. Customers can order their groceries online and have them delivered to their door within two hours. Amazon Fresh also offers a Prime Fresh membership, which gives members free two-hour delivery on eligible orders.

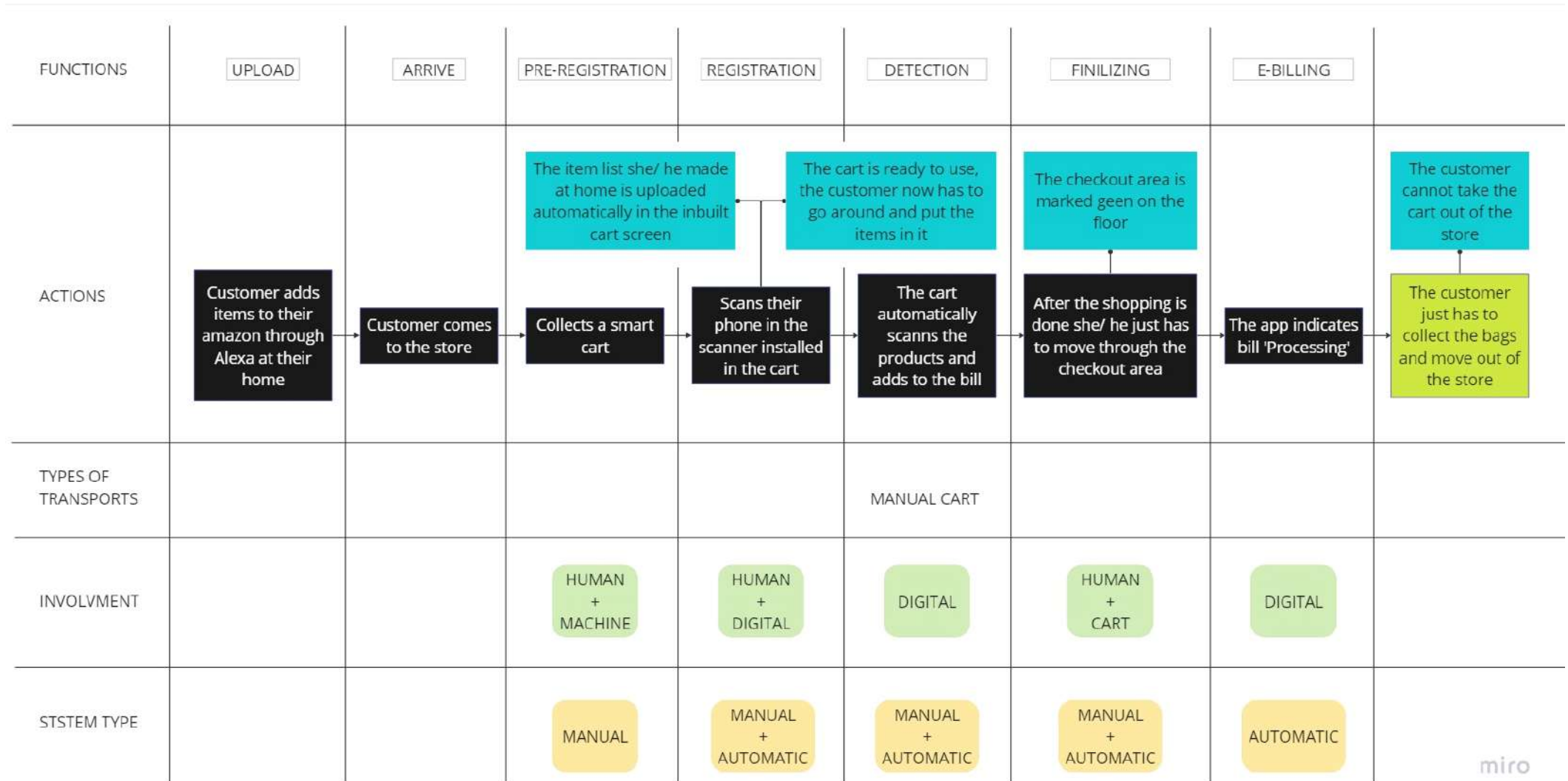
BENEFITS

1. **Convenience:** Amazon Fresh makes it easy to get the groceries you need without having to leave your home.
2. **Freshness:** Amazon Fresh's groceries are delivered fresh from the store.

3. **Variety:** Amazon Fresh offers a wide selection of groceries, including fresh produce, meat, seafood, dairy, baked goods, snacks, and more.
4. **Affordability:** Amazon Fresh offers competitive prices on groceries.
5. **Prime Fresh membership:** Amazon Fresh Prime members get free two-hour delivery on eligible orders.

CHALLENGES

1. **Cost:** Amazon Fresh's prices are higher than some traditional grocery stores.
2. **Availability:** Amazon Fresh is not available in all areas.
3. **Technology:** Amazon Fresh relies on technology to operate, which can be a challenge if there are problems with the website or app.





4.10 INSIGHTS

1. The entire process is human-assisted automation
2. The system removes the need for a billing area
3. The system is tech-based and tech-heavy
4. The entire process is card/ cashless
5. The system is designed around the convenience of the customer.



4.11 AMAZON SAME-DAY DELIVERY

Also known as 24-hour delivery service. In this form of delivery service, the ordered parcel reaches the customer within 24 hours of placing the order.

WHO

- **Prime Members** can avail the free Same-day or One/Two-day delivery in select cities on eligible items.
- **Non-Prime Members** can avail of **paid** same-day or one/two-day delivery on eligible items in select cities.

WHICH

- This delivery option is available on all **sortable item types** in select cities.
- Shipping speeds and charges vary based on the items in your cart and the delivery address.

- **Seller-fulfilled Items** are those items that the seller promises to deliver to the customer within a day or two days. The delivery charge might vary.
- **Items belonging to large appliances and furniture categories do not qualify for these express shipping options.**

WERE

- Same-day and One/Two-day delivery options are available in select cities and only in certain pin codes. Ahmedabad, Gurgaon, Bangalore, Kanchipuram, Chennai, Mumbai, Delhi, Navi Mumbai, Faridabad, Noida, Gandhi Nagar Thane, Ghaziabad, Tiruvallur
- **Same-Day Delivery is available only to residential addresses.**

CONDITIONS FOR SAME-DAY DELIVERY

- The customer is not present at the delivery address to take the delivery or

- The customer picks up the package on a later date though the package has been delivered at the pickup store on the promised date.

WHEN

- Cut-off time - if the customer orders the item within the time displayed on the product details page.
- If the cut-off time has passed, then the product might be eligible for the next day delivery
- On Weekends (Saturday and Sunday), and regional or national holidays, deliveries are not guaranteed to establishments like offices that might be closed. This is applicable to all types of deliveries.

WHAT

The cost of same-day delivery may vary according to the membership of the customer.

For Prime members, it can be between zero or rupees 50. For non-prime members, the price can be rupees 40, 120, 150, 175

Often the delivery charge can be more than the product price.

Seller-fulfilled items: Shipping speeds and charges for these items vary depending on the seller. You can check the speeds and charges before you place the order.

4.12 CONDITIONS

1. Same-day delivery is eligible only on items that are sortable.
2. Same-day delivery is only applicable in residential areas.
3. Same-day delivery by the seller can be possible with selected vendors
4. The delivery charge can be more than the product price for non-prime members.

4.13 IN HOUSE MOBILITY

1. TRANSPORTING EQUIPMENT





2. POSITIONING EQUIPMENT



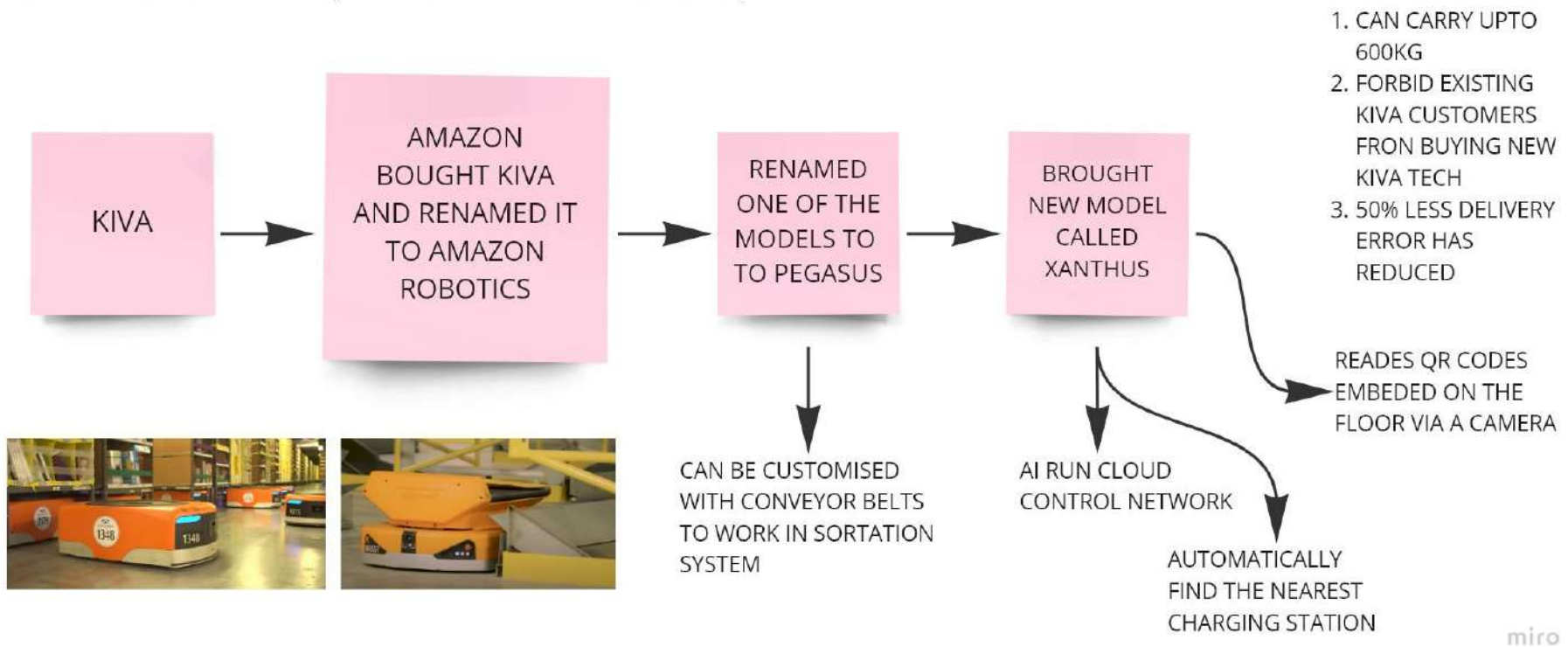
3. PALLETIZING & DEPALLETIZING EQUIPMENT



4.14 AMAZON ROBOTICS

Amazon Robotics is a brand that has acquired several robotics brands such as Kiva, Canvas technologies etc. to create its own ecosystem of Automated Guided Robots for in-house application

AMAZON ROBOTICS SYSTEM (NON-HUMAN WAREHOUSE SYSTEM)



4.15 FLOATING FULFILMENT CENTRE



The newest Amazon logistical technology includes the use of airships. This will enable them to access areas that are difficult and inconvenient to reach by land. An Amazon FC may be positioned at an altitude above a metropolitan area and be designed to maintain an inventory of items that may be purchased by a user and delivered to the user by a UAV

4.16 AMAZON INTERCONTINENTAL LOGISTICS

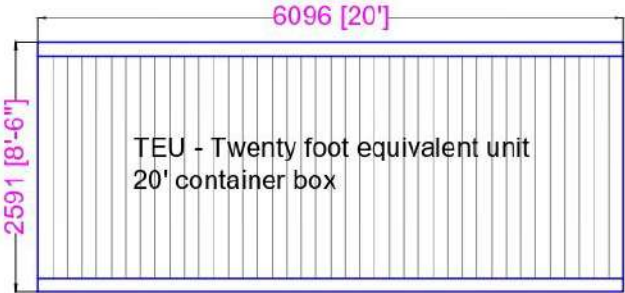
1. Amazon Prime Air:

Also known as **Prime Air**, is an air delivery service operated by Amazon. The service uses delivery drones and aeroplanes to fly individual packages and bulk consignments to customers across the world.

2. Via water:

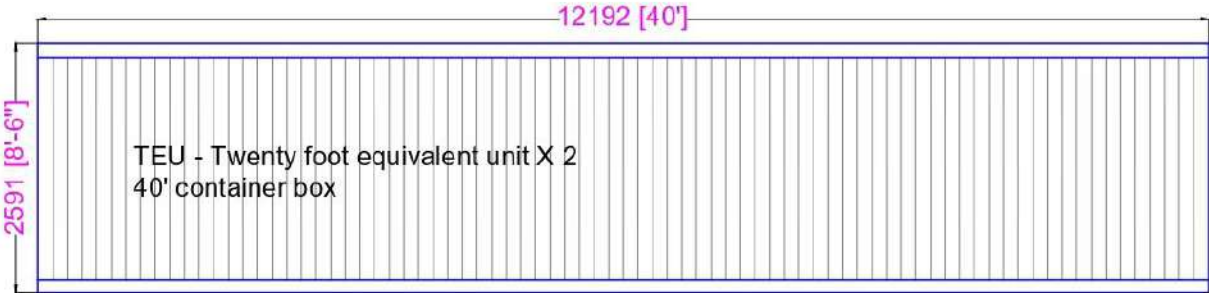
This is the more traditional way of transport logistics. Like every company/ organisation, Amazon also uses these services. The only difference is that the container size that is used by Amazon is different from that of the conventional sizes. There is a very specific reason for this:

CONTAINER SIZE



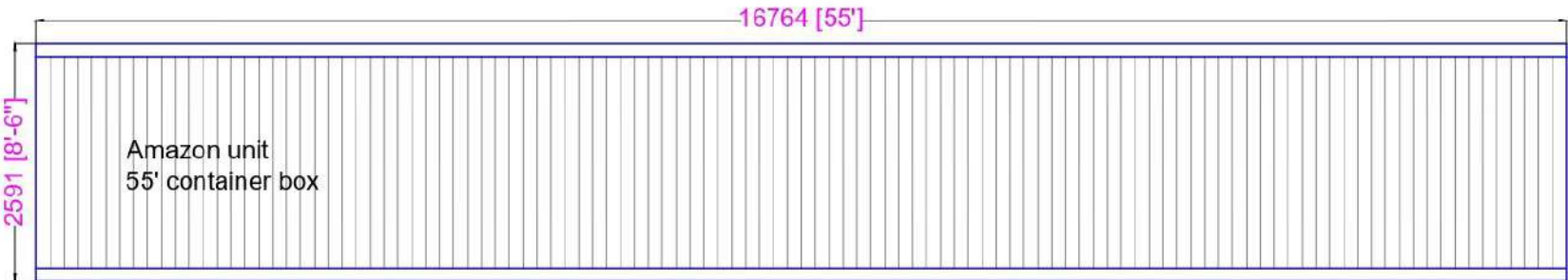
TEU - Twenty foot equivalent unit
20' container box

$20' \times 22 = 440'$
Average time to load is 2-6 hours
considering the lower limit
 $2 \times 22 = 44 \text{ hrs}$



TEU - Twenty foot equivalent unit X 2
40' container box

$40' \times 11 = 440'$
Average time to load is 3-6 hours
considering the lower limit
 $3 \times 11 = 33 \text{ hrs}$



Amazon unit
55' container box

$55' \times 8 = 440'$
Average time to load is 3-6 hours
considering the lower limit
 $3 \times 8 = 24 \text{ hrs}$

Let's say a container of size 20 feet needs 3 hours at minimum to be filled completely and there are 22 such containers. So, the time taken is $3 \times 22 = 66$ hrs. (2 days 18 hours) and this is if the containers are being continuously filled for almost 3 days straight without any break, which is impossible. Hence it can be assumed that the total time to accomplish this mammoth task will be around 4 days.

Now let's consider a 40 feet container that needs a minimum of 4 hours to be loaded. As the size is double so, 11 number of 40 feet containers will be the same as 22 numbers of 20 feet containers. Therefore, the total time needed to load them is $4 \times 11 = 44$ hours. (1 day 20 hours). Rounding it to an equivalent of 2 days

Now the Amazon containers are 55 feet long. 8 numbers of this length container are the same as 11 numbers 40 feet and 22 numbers of 20 feet containers. So, the time consumed to fill it is $5 \times 8 = 40$ hrs (1 day 16 hours).

From this comparison, it is quite evident that the bigger the size of the container the less time is needed to fill multiple containers. There are various time factors that need to be considered, here such as;

- Time to position the container
- Time to move the parcels inside the container
- Time to carry the parcels to the container
- Time to replace the container
- Time to transport each of them to the dock
- Shift changes
- Meal breaks, refreshments etc.

4.17 INSIGHTS

1. The logistics process is well divided into zones and centres based on the travel distance.
2. The entire logistics is divided into steps, and from each step delivery is possible to the customer.

3. The application of various means of transport is used in the step of operation.
4. The short-distance system is also used for same-day or one-day delivery.
5. Amazon may venture into the **transport business** in the near future besides their retail business
6. The acquisition of the robotics company means it is into **robotics** as well
7. They are already in a space programme named **blue origin**
8. With their robust delivery system, they can **easily merge** their space programme with their sorting, packing and delivery system to build a solid **space delivery system**
9. Amazon has a robotic solution for every weight category in their fulfilment centres so **error margins will reduce to almost zero** in the near decades.
10. Patents like **floating fulfilment centres** enable them to be present in every possible corner of the world
11. **Zero human facility** is the clear future of Amazon
12. Amazon tries to save time in every possible way and portion of their delivery system
13. The lesser number of containers that need to be loaded on the cargo vessel the earlier the ship can leave the dock without affecting the quantity.

5. FAST-MOVING CONSUMER GOODS

5.1 FMCG (FAST MOVING CONSUMER GOOD)

Fast-moving consumer goods also known as consumer-packaged goods are products that are sold at fast speed and at a relatively low cost. Examples include non-durable household goods such as packaged foods, beverages, toiletries, candies, cosmetics, over-the-counter drugs, dry goods, and other consumables.

The following are the main characteristics of FMCG

1. Frequent purchases
2. Low engagement (little or no effort to choose the item)
3. Low prices
4. Short shelf life
5. Rapid consumption

5.2 CATEGORIES

- **Processed foods:** Cheese products, cereals, and boxed pasta
- **Prepared meals:** Ready-to-eat meals
- **Beverages:** Bottled water, energy drinks, and juices
- **Baked goods:** Cookies, croissants, and bagels
- **Fresh foods, frozen foods, and dry goods:** Fruits, vegetables, and nuts
- **Medicines:** Aspirin, pain relievers, and other medication that can be purchased without a prescription
- **Cleaning products:** baking soda, oven cleaner, and window and glass cleaner
- **Cosmetics and toiletries:** Hair care products, concealers, toothpaste, and soap
- **Office supplies:** Pens, pencils, and markers

5.3 JUST IN TIME

The just-in-time (JIT) inventory system is a management strategy that aligns raw-material orders from suppliers directly with production schedules. This is also known as **Toyota Production System (TPS)** because the car manufacturer Toyota adopted the system in the 1970s. This form of inventory system minimizes inventory and increases efficiency. JIT production systems cut inventory costs because **manufacturers receive materials and parts as needed for production and do not have to pay storage costs**. Manufacturers are also not left with unwanted inventory if an order is cancelled or not fulfilled.

One example of a JIT inventory system is a car manufacturer that operates with low inventory levels but heavily relies on its supply chain to deliver the parts it requires to build cars on an as-needed basis. Consequently, the manufacturer orders the parts required to assemble the vehicles only after an order is received.

For JIT manufacturing to succeed, companies must have steady production, high-quality workmanship, glitch-free plant machinery, and reliable suppliers.

5.4 VEHICLES USED

- **Trucks:** Trucks are a versatile option for transporting FMCG goods, as they can be used to move large quantities of products over long distances.
- **Vans:** Vans are a good option for transporting smaller quantities of FMCG goods, as they are more manoeuvrable than trucks and can be used to make deliveries in urban areas.
- **Trailers:** Trailers can be attached to trucks or vans to increase the carrying capacity of these vehicles.
- **Pickup trucks:** Pickup trucks are a good option for businesses that need to transport both goods and people.

- **Three-wheelers:** Three-wheelers are a cost-effective option for transporting FMCG goods in urban areas.

The type of vehicle that is best for a particular FMCG business will depend on the size of the business, the types of products that it sells, and the distances that the products need to be transported.





5.5 CHANNELS IN FMCG SUPPLY CHAIN

- **Direct channel:** This channel is the shortest and most efficient. The manufacturer sells directly to the consumer. This channel is often used for high-value or specialized products.
- **Indirect channel:** This channel is longer and less efficient. The manufacturer sells to a wholesaler, who then sells to a retailer, who then sells to the consumer. This channel is often used for low-value or general-purpose products.
- **Dual channel:** This channel is a combination of direct and indirect channels. The manufacturer sells directly to the consumer and also to wholesalers and retailers. This channel is often used for products that are sold both online and in stores.

6. MOVEMENT PLATFORM

6.1 ABOUT

In the context of a material movement system, a platform refers to a technological foundation or framework that supports the digitalization, automation, and optimization of material movement processes. It provides the necessary tools, software, and infrastructure to manage and streamline the movement of materials within a facility or organization. Here's how a platform can be utilized in a material movement system:

6.2 EXAMPLES

1. Warehouse Management System (WMS) Platforms

Designed to manage material movement within warehouses or distribution centres. These platforms provide functionalities such as inventory tracking, order management, picking and packing optimization, and real-time visibility into material location and status.

WMS platforms enable efficient material flow, reduce

errors, and improve overall warehouse operations.

2. Robotics and Automation Platforms

Automation plays a significant role in material movement systems. Platforms that support robotics and automation technologies, such as robotic process automation (RPA), autonomous mobile robots (AMRs), or robotic arms, can be utilized to automate repetitive and manual tasks involved in material movement. These platforms enable efficient and precise material handling, reduce labour costs, and enhance operational efficiency.

3. Integration and Connectivity Platforms

Material movement systems often involve multiple systems and technologies that need to communicate and exchange data seamlessly. Integration platforms provide connectors, APIs, and middleware that facilitate the integration of different systems, such as enterprise resource planning (ERP), warehouse management, and

transportation management systems. These platforms enable the exchange of data and information, ensuring synchronized material movement across various stages and processes.

4. Data Analytics Platforms

Data analytics platforms can be utilized in a material movement system to gather, process, and analyse data related to material movement processes. These platforms provide insights into performance metrics, identify bottlenecks, and support decision-making for process optimization. By leveraging data analytics platforms, organizations can make data-driven improvements to material movement processes and enhance overall efficiency.

5. Mobile Platforms and Applications

Mobile platforms and applications can be used to facilitate material movement tasks on handheld devices. These platforms enable workers to access real-time

information, scan barcodes or RFID tags, update inventory records, and communicate with other stakeholders. Mobile platforms improve accuracy, speed up material movement tasks, and provide flexibility in accessing and managing material-related information.

Organizations can automate processes, improve visibility and control, optimize inventory management, reduce errors, enhance operational efficiency, and ultimately achieve a more streamlined and effective material movement process by utilising these platforms in a material movement system.



Image 14: Warehouse Management System



Image 16: Integration and Connectivity System



7. FULFILLMENT CENTRE

7.1 ABOUT

A fulfillment centre, also known as a distribution centre, is a facility where product storage, processing, and shipment take place to fulfil customer orders. It serves as a critical component of supply chain management, particularly in the e-commerce and retail industries. The primary purpose of a fulfillment centre is to efficiently receive, store, and ship products to customers or other distribution channels. Here are the key aspects and functions of a fulfillment centre:

1. Receiving and Inventory Management

Upon arrival, products are received, inspected, and checked for accuracy against the purchase orders. Inventory management systems track and organize the products within the fulfillment centre, ensuring accurate inventory counts and efficient storage allocation.

2. Storage and Organization

Fulfillment centres utilize various storage systems such as racks, shelves, bins, and pallets to efficiently store



Image 18



Image 19

and organize products. The layout and organization of the fulfillment centre are designed to maximize space

utilization and ease of product retrieval for order fulfillment.

3. Order Processing

When customer orders are received, the fulfillment centre processes them by picking the items from the inventory and preparing them for shipment. This involves locating the products, assembling the order, and packaging it securely.

4. Packing and Labelling

Fulfillment centres have packing stations where orders are packed according to specific packaging requirements and customer preferences. This includes adding protective packaging materials, inserting promotional materials or invoices, and affixing shipping labels and tracking numbers.



Image 20



Image 21



Image 22

5. Shipping and Carrier Management

Fulfillment centres work closely with shipping carriers to ensure timely and accurate delivery of orders. They coordinate carrier pickups, generate shipping labels, and manage the logistics of transporting packages from the fulfillment centre to the customer's location.

6. Returns Processing

Fulfillment centres also handle returns and manage the reverse logistics process. They inspect returned products, determine their condition and eligibility for resale, process refunds or replacements, and update inventory accordingly.

7. Technology and Automation

Fulfillment centres often leverage technology and automation to improve efficiency and accuracy. This may include barcode scanning, RFID tracking, automated conveyor systems, robotics, and software



Image 23



Image 24

systems for inventory management, order processing, and tracking.

8. Workforce Management

Fulfillment centres employ a workforce responsible for various tasks such as order fulfillment, inventory management, quality control, and customer service. Workforce management involves training, scheduling, and ensuring a safe and productive work environment.



Image 25

Efficient fulfillment centre operations are crucial for meeting customer expectations, optimizing inventory, reducing shipping times, and minimizing costs. By streamlining processes, leveraging technology, and maintaining accurate inventory records, fulfillment centres play a vital role in ensuring smooth order fulfillment and customer satisfaction.

8. WHY AMAZON

1. Amazon is a retail cum logistics company with a future prospect of completely transforming into a major logistics company. This allowed me the opportunity to think of a system that is completely focused on the movement of freight/ cargo from point A to point B.
2. Presently Amazon owns its own mobility and transportation solutions and vehicles from all categories. It has its own army of ships, aeroplanes, trucks, vans, bikes, scooters, drones and airships. All of which can be optimised, customised and prioritised according to the specific need and demand as Amazon deems fit for any consignment.

9. INTERNAL Vs EXTERNAL LOGISTICS

9.1 INTERNAL LOGISTICS

also known as **inbound logistics** or intralogistics, refers to the movement, storage, and management of materials, products, and information within an organization's premises or facilities. It focuses on the efficient flow of goods and materials between different points **within a facility**, such as production lines, workstations, storage areas, and distribution centres. Internal logistics plays a crucial role in optimizing operational efficiency, reducing costs, and ensuring smooth operations.

Keywords:

- Within
- Internal
- Short span

9.2 EXTERNAL LOGISTICS

also known as **outbound logistics**, refers to the processes and activities involved in the movement of goods, products, or materials from a company or organization to its customers, suppliers, or other external entities. It encompasses the planning, execution, and management of activities related to the transportation, distribution, and delivery of goods outside of the organization

Keywords:

- Without
- External
- Long distance

1. **Material Handling** is the physical movement and transportation of materials within and without a facility.

Actions:

- Loading
- Unloading
- Transferring
- Transporting

Action area:

- Storage areas
- Production lines
- Workstations
- Assembly areas.

Means:

- Manual labour
- Forklifts
- Conveyors

- Automated guided vehicles (AGVs)
- Robotic systems
- Trucks
- Ships
- Aeroplanes



2. Inventory Management:

Internal logistics includes managing and optimizing the inventory stock level within the facility.

Actions:

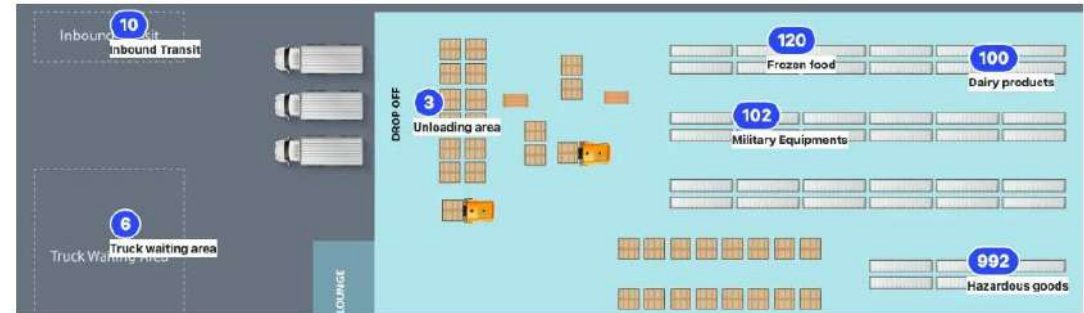
- Tracking
- Scanning
- Recording

Action area:

- Storage areas
- Loading/ unloading area

Means:

- Computers
- WMS software



3. Warehousing and Storage:

Internal logistics encompasses the proper storage and organization of materials and products within a facility in appropriate conditions and locations, that enables efficient retrieval of products or orders.

- Forklifts
- Conveyors
- Automated guided vehicles (AGVs)
- Robotic systems.

Actions:

- Moving
- Picking
- Scanning
- Placing

Action area:

- Storage areas
- Shelves
- Racks
- Bins

Means:

- Manual labour



4. Order Fulfillment:

Internal logistics support the timely and accurate fulfilment of customer orders or internal requisitions. It involves coordinating the picking, packing, and staging of products for shipment, ensuring that the right items are assembled and prepared according to order

Actions:

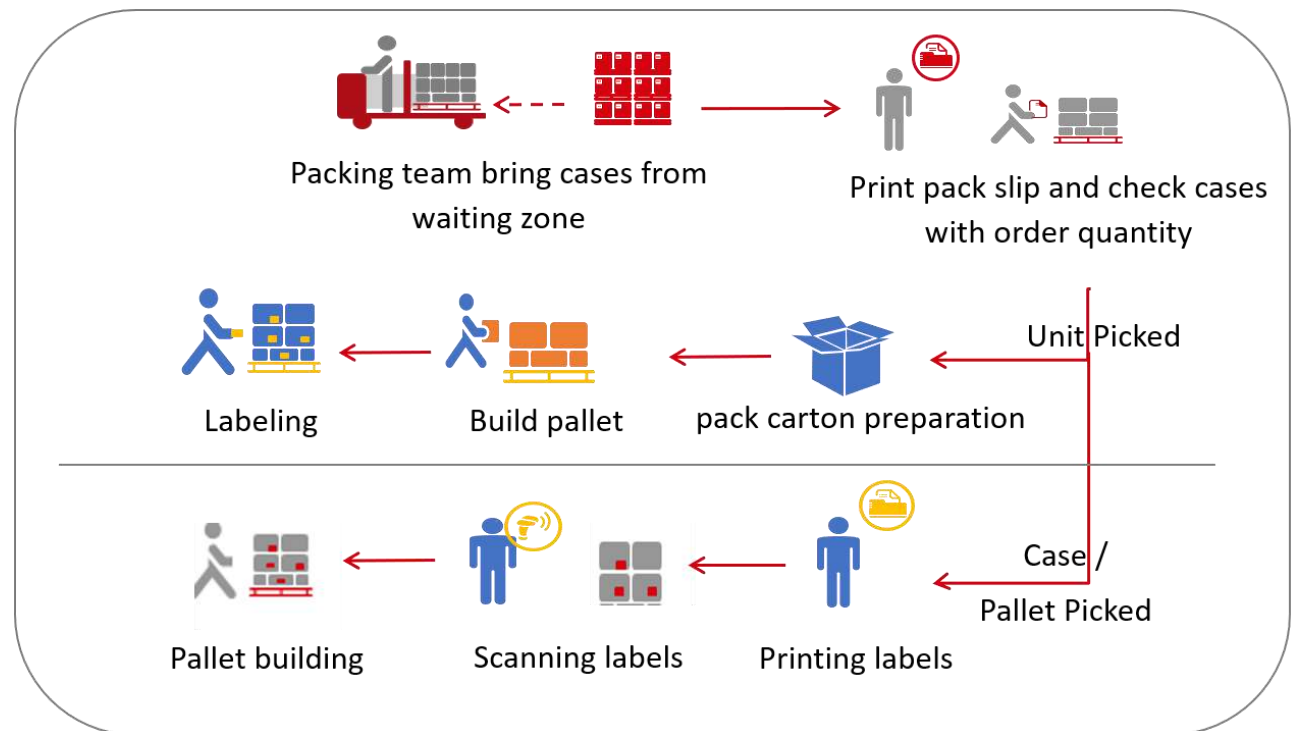
- Picking
- Packing
- Staging
- Labelling

Action area:

- Dispatch

Means:

- Manual labour
- Hand scanner
- Computers



5. Production Support:

It is about timely providing the necessary materials, components, and tools to production lines or workstations. This ensures a continuous flow of materials, reduces downtime and enables efficient production operations.

Actions:

- Timely delivery

Action area:

- Entire supply chain

Means:

- Manual labour
- Outdoor transport
- Shipping
- Quality check, etc.

6. Information Management:

Internal logistics relies on accurate and real-time information to coordinate material flow effectively.

Actions:

- Track and manage inventory
- Resource planning
- Monitor material movement
- Visibility into stock level

Action area:

- Loading/ unloading
- Recording of inbound and outbound parcel
- Storage area
- Inhouse transportation

Means:

- Computerised systems
- Scanners
- Camera

10. TYPE OF EQUIPMENT

1. Transport equipment

- Industrial trucks
- Automated guided vehicles
- Rail-guided equipment
- Conveyors and hoist

2. Positioning equipment

- Cranes
- Robotic arms

3. Unit load formation equipment

- Robot arms
- Rotary index table
- Robotic Pick and Place Palletizers
- Depalletizes

4. Storage equipment

- Conventional storage & retrieval system
- Bulk storage

- Rack system
- Shelving and bin
- Drawer storage
- Automated storage & retrieval system

5. Identification and control equipment

- Scanners
- Barcoding readers
- RFID

11. INVENTORY MANAGEMENT METHODS

As part of the research, I tried to understand various methods that are used in the industry for effective management of inventory.

Some of these are as follows:

1. Just in time:

Just-in-time, or JIT, is an inventory management method in which goods are received from suppliers **only as they are needed**. The main objective of this method is to **reduce inventory holding costs and increase inventory turnover**.

2. Demand forecasting:

As the name suggests this is a process of **predicting the quantity of goods and services** that will be demanded by consumers at a future point in time. More specifically, demand forecasting methods entail using **predictive analytics** to estimate customer demand in consideration of key economic conditions.

3. Drop shipping:

This is a form of retail business in which the seller accepts customer orders **without keeping stock on hand**. **Instead**, in a form of supply chain management, the seller transfers the orders and their shipment details either to the manufacturer, a wholesaler, another retailer, or a fulfillment house which then ships the goods directly to the customer.

4. Safety stock:

Safety stock is an extra quantity of a product which is stored in the warehouse to prevent an out-of-stock situation. It serves as insurance against fluctuations in demand.

11.1 AMAZON VENDOR VERIFICATION

I learned about their vendor verification process in an interview with an Amazon employee. What I found was very that their process of vendor verification is very strict and stringent.

They have a multistep validation and verification process, such as

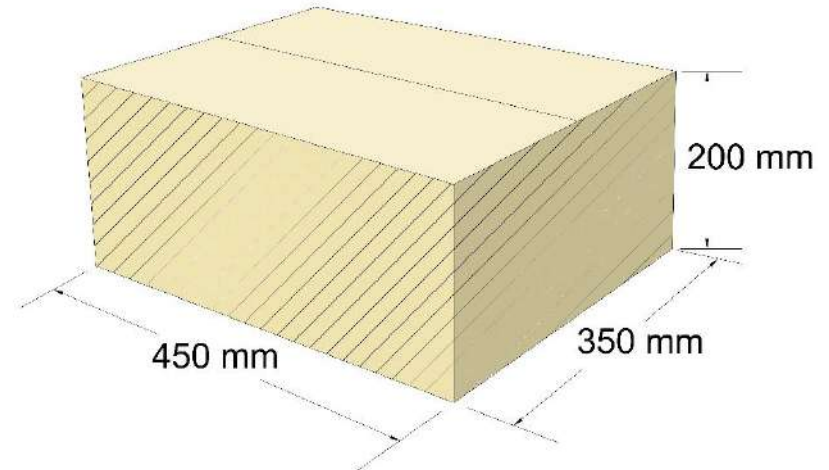
1. The past sales record of the vendor.
2. Number of failed deadlines on consignments in the past 3 months
3. Customer review
4. Amazon performance points which should be more than 3 out of 5.
5. The category of products the vendor deals in.

These are some of the validation points that I was able to curate out of the interview that I conducted with the Amazon executive.

Only after satisfying all the criteria amazon is able to provide the Amazon guarantee on its products.

11.2 AMAZON'S STANDARD PACKAGE SIZE

- Weighs 20 pounds or less
- The length (or longest side) is less than or equal to 18 inches
- The width (or median side) is less than or equal to 14 inches
- The height (or shortest side) is less than or equal to 8 inches



12. DESIGN BRIEF

To design a material/parcel movement system/ solution(s) that can be modular and customizable for the workers in the fulfilment centres based on the application. It should allow the possibility of rearranging to optimize space utilization. The solution should also reduce the chance of human error. And make the process more efficient, improving or eliminating the need for human intervention.

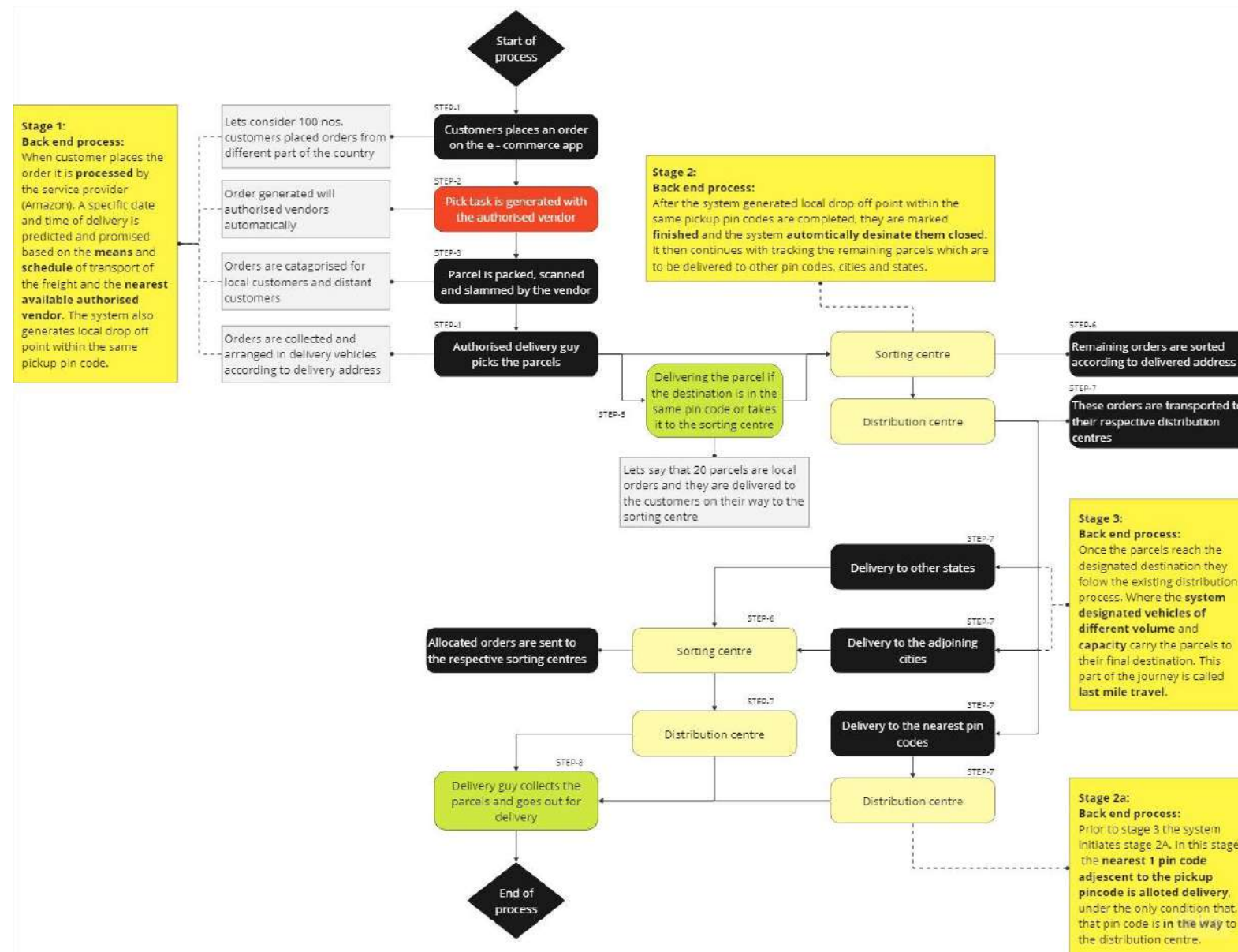
The solution(s) should also be easy to use and operate to assist and meet the designated time for a particular operation.

13. DESIGN GAPS

1. Error reduction where there is human intervention.
Amazon releases roughly 16,00,000 parcels per day and 1 error per 2,200 is allowed. Around 727 errors/day. This error can be in **dispatch** or **storage**
2. At the docking station the system can be streamlined and improved to make it faster
3. An array of mini bots can be designed which can be assembled for bigger tasks
4. Designing custom conveyor systems that meet a facility's specific requirements can improve material flow.
5. In Amazon style the system allows can be improved for better service.

14. DESIGN SOLUTION

15. SYSTEM DESIGN CONCEPT 1



15.1 ABOUT

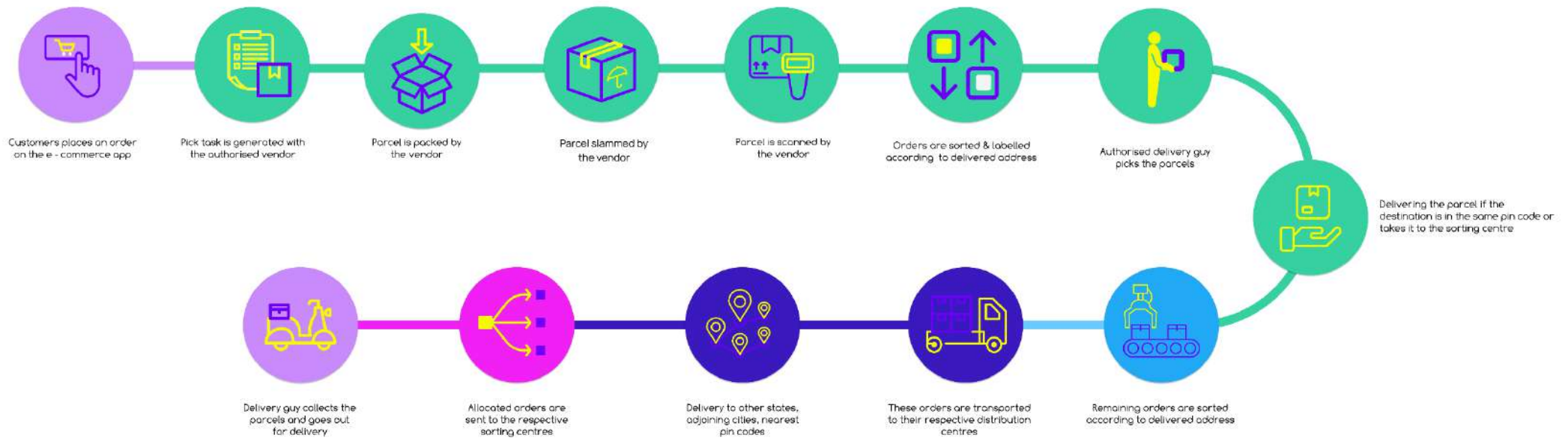
The first concept is about creating a system that is focused on functioning without an inventory.

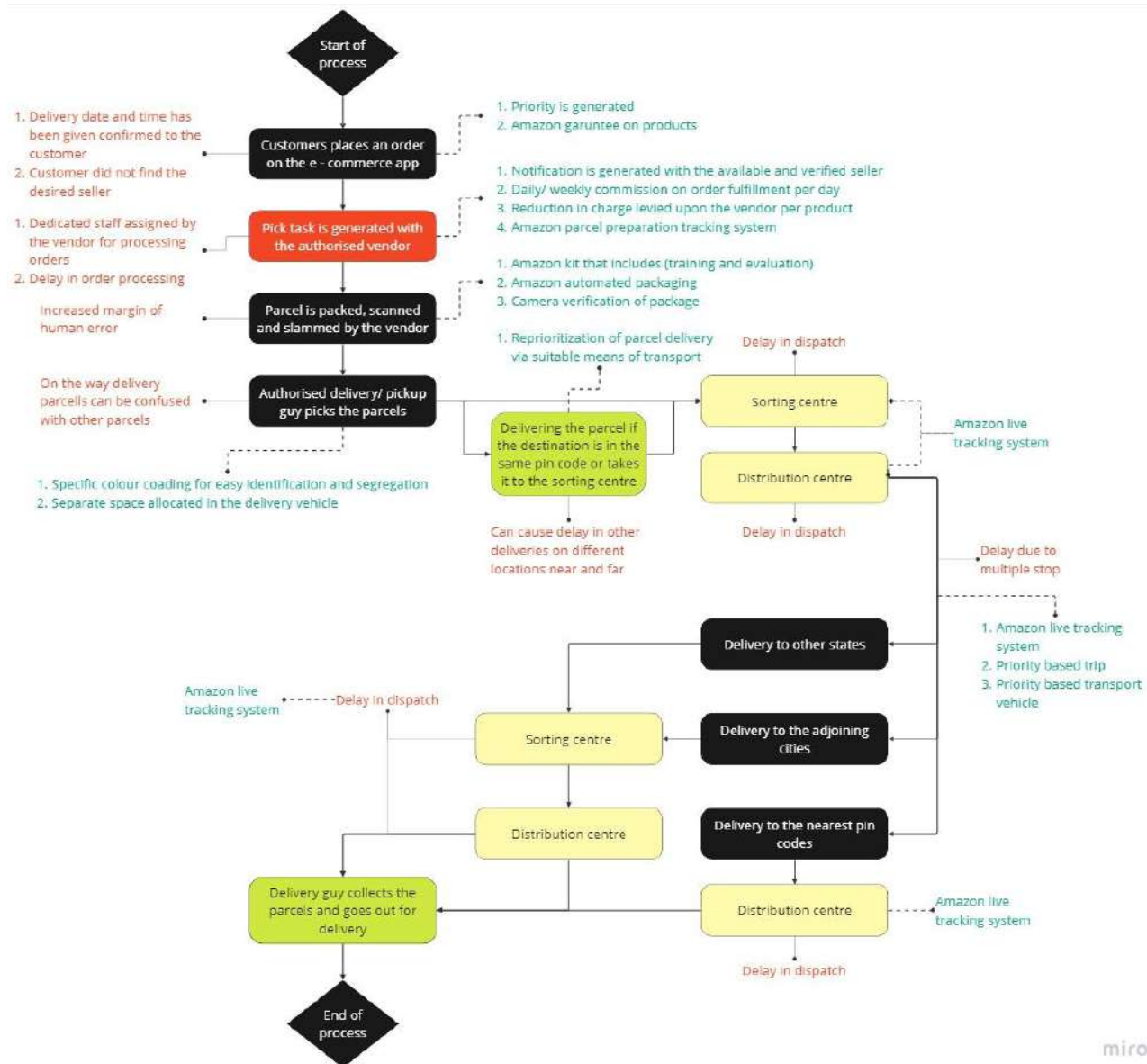
Inspirations were the **Mumbai dabbawallas** and the **Just in Time** model followed by FMCG organizations.

From the secondary research I found that the inventory carrying cost is around 20% - 30% of the total inventory cost. Judging by the running cost it can be derived that the inventory establishing cost, filling cost will be a huge amount. Although the establishment cost is a one-time investment but it is a big amount that can be repurposed in some other operation.

My idea is to divert that investment into the logistics system so that new modes of transport can be explored.

15.2 VISUAL MAP

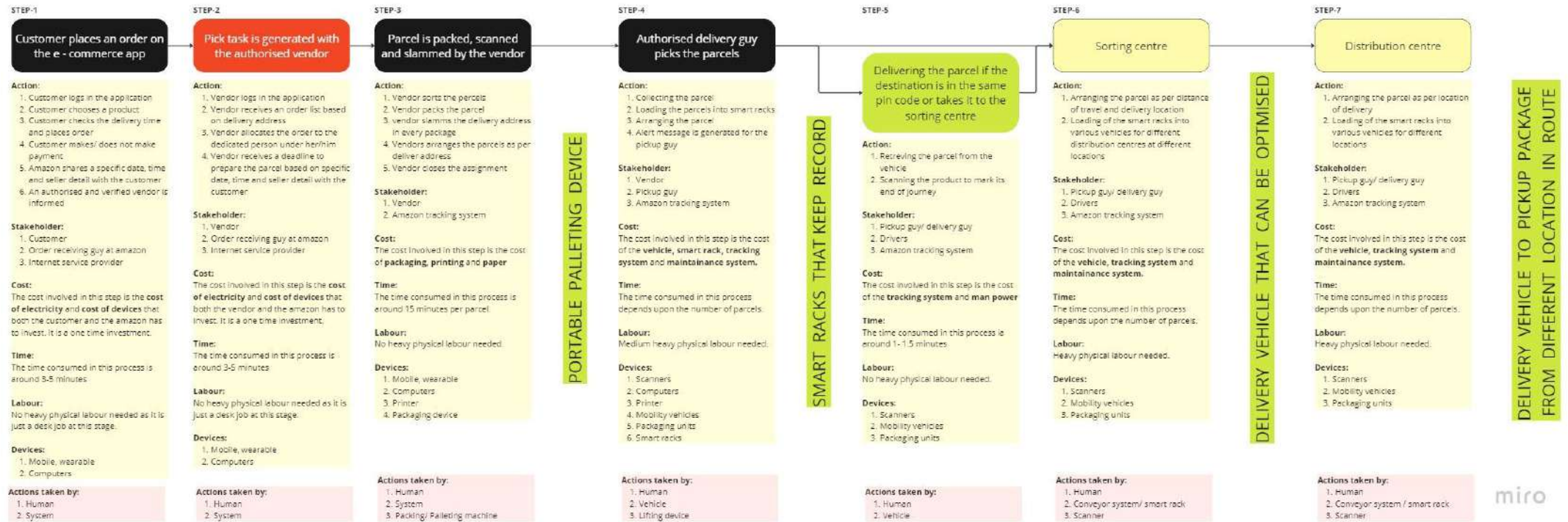




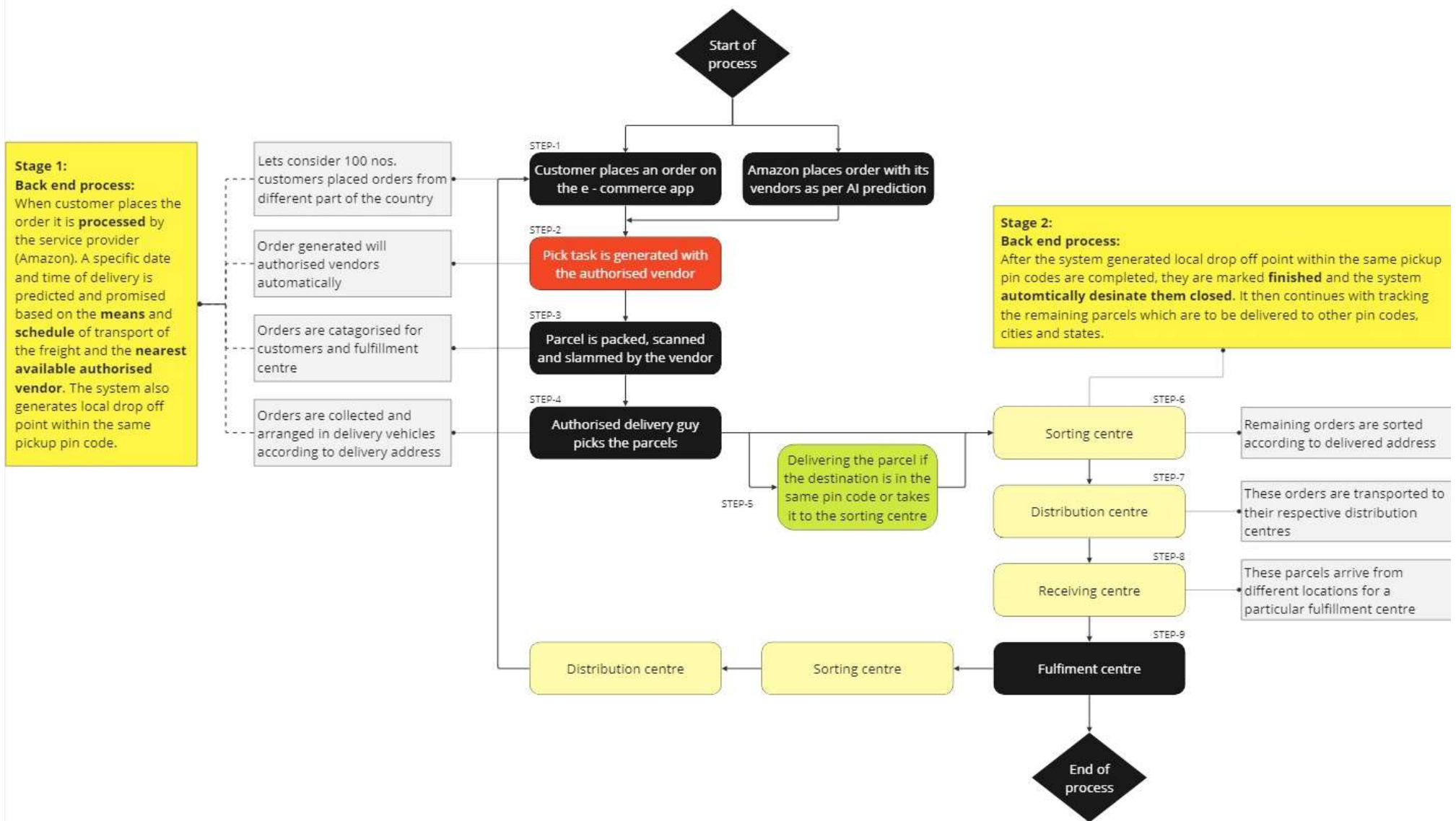
Service error/ failure and recovery is a vital part of any service/ system design. Service errors are the points where the possible failures in expectation are identified and proper measures are taken to rectify it to give a proper smooth experience. In the above system I have tried to identify various such loopholes that needed to be addressed.

These loopholes can be rectified by various means and ways. Some such possible errors and recovery are mentioned in the above diagram.

15.3 SYSTEM DETAILS AND GAPS IN MOBILITY DESIGN



16. SYSTEM DESIGN CONCEPT 2

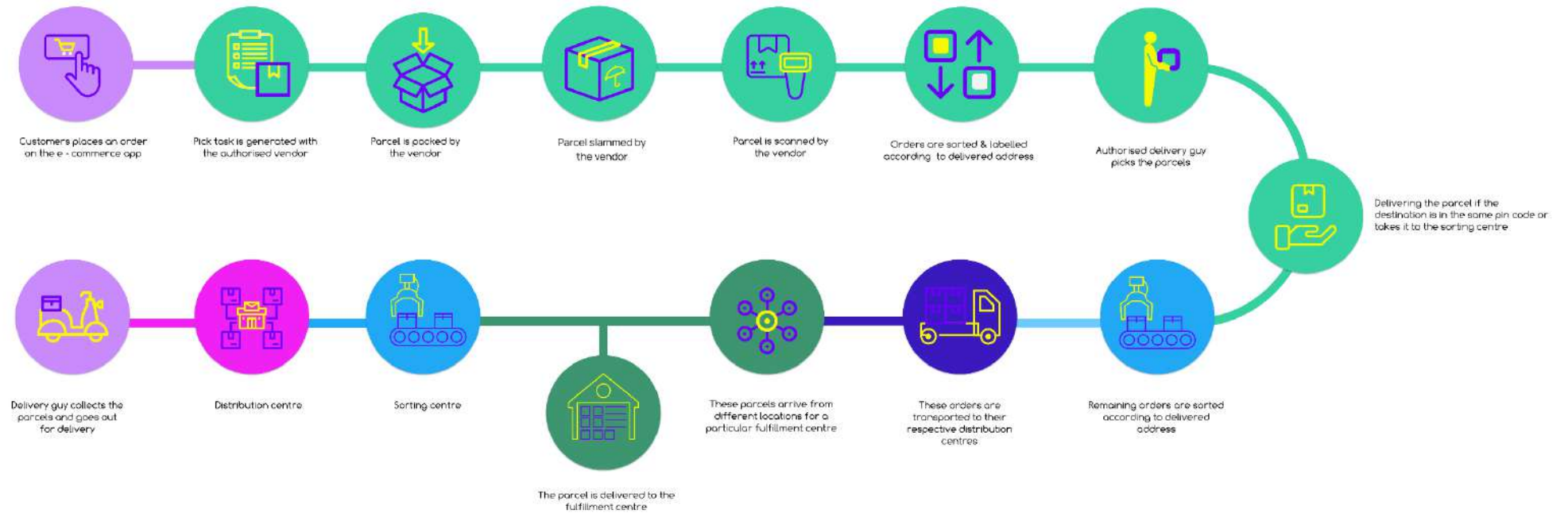


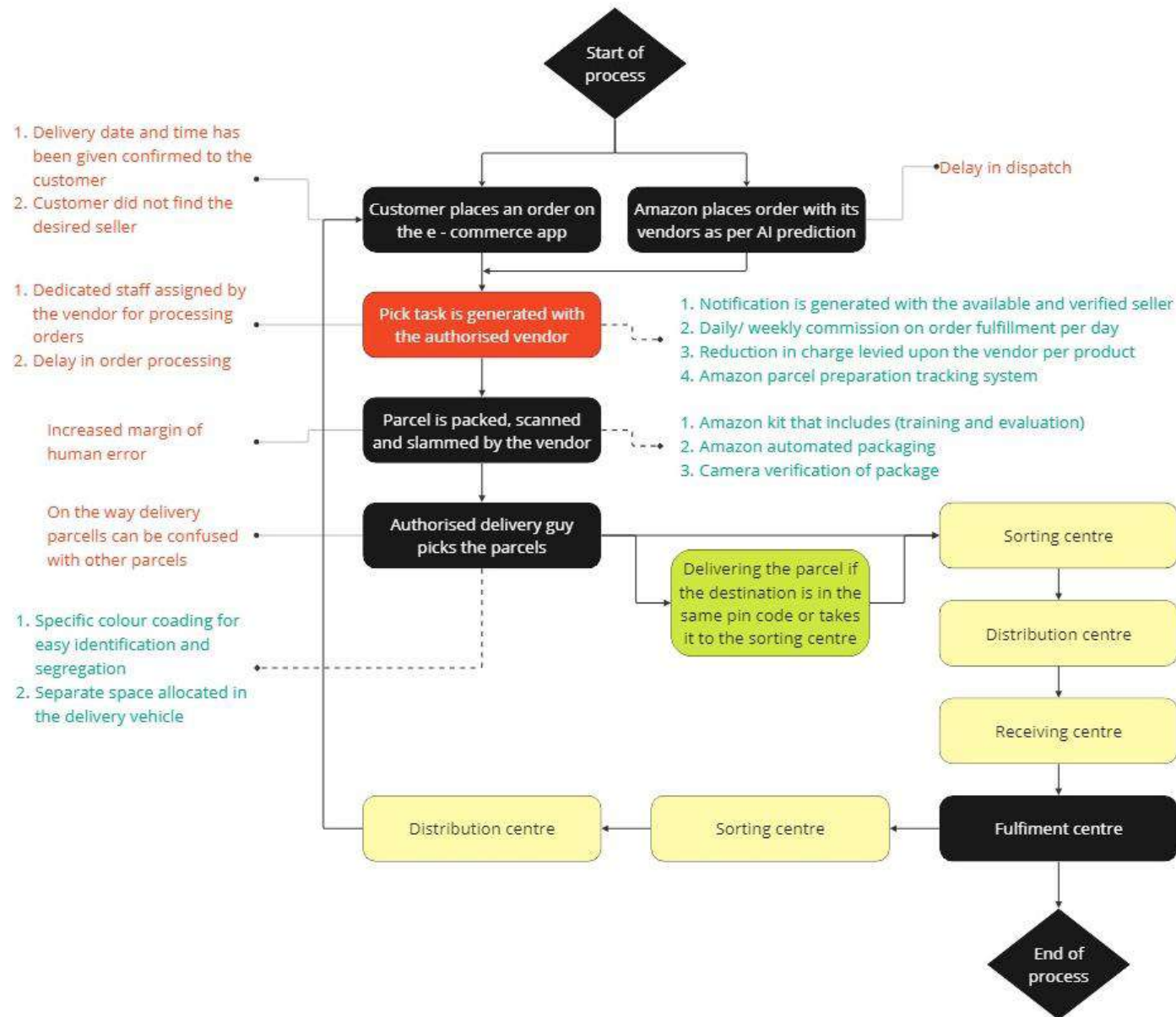
16.1 ABOUT

The second design is about creating a system that integrates the concept of same day delivery and the shipping of parcels to the fulfillment centre.

The idea was just to merge the pickup and drop off of parcels within the same location while on the way to the fulfillment centre. The concept works like this, when a bunch of customers place an order via the e-commerce app the orders will digitally be received by the service provider, and then transferred to the available local authorised vendor who will ship the product/s to the customer. Or, there will be dedicated delivery boys operated by the e-commerce service provider who will only be in charge of picking the order and delivering it to the customer.

16.2 VISUAL MAP





Service error/ failure and recovery is a vital part of any service/ system design. Service errors are the points where the possible failures in expectation are identified and proper measures are taken to rectify it to give a proper smooth experience. In the above system I have tried to identify various such loopholes that needed to be addressed.

These loopholes can be rectified by various means and ways. Some such possible errors and recovery are mentioned in the above diagram.

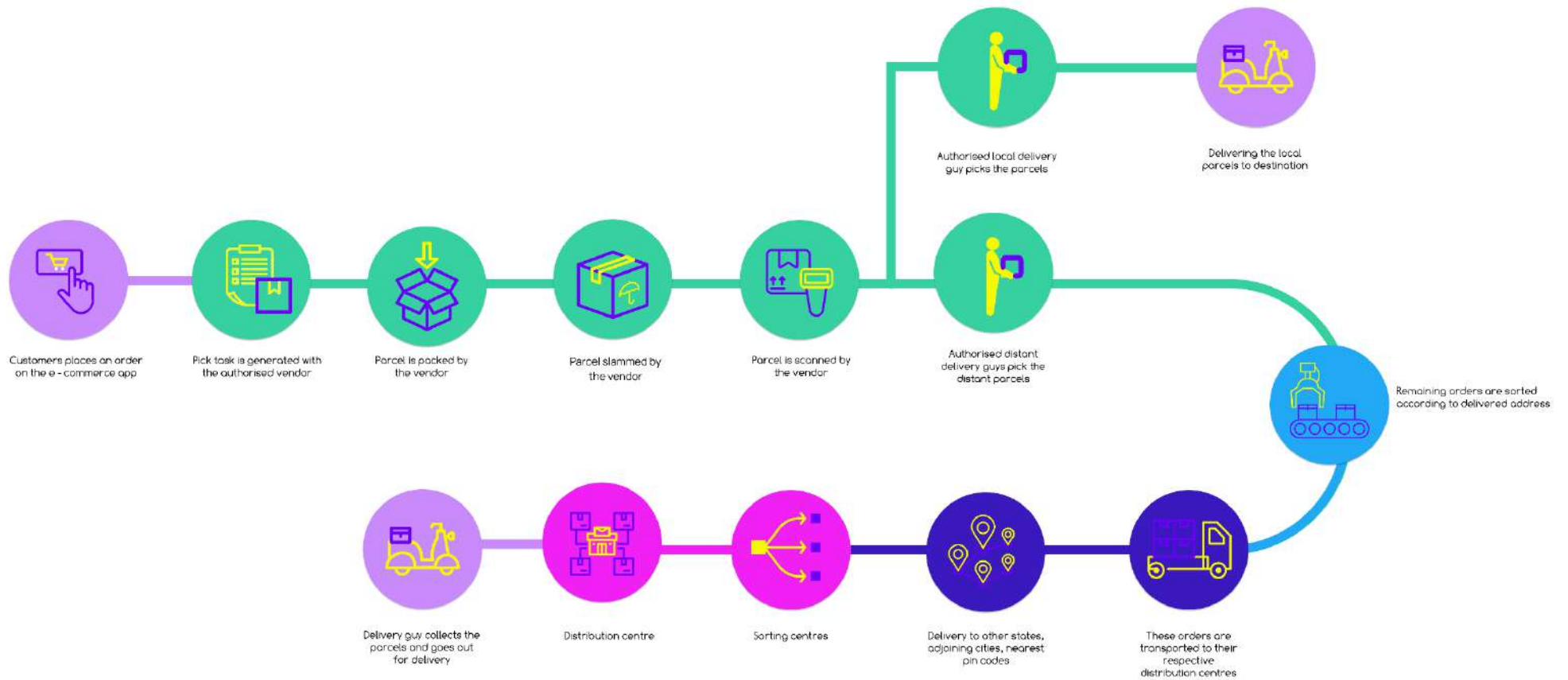
17. SYSTEM DESIGN CONCEPT 3

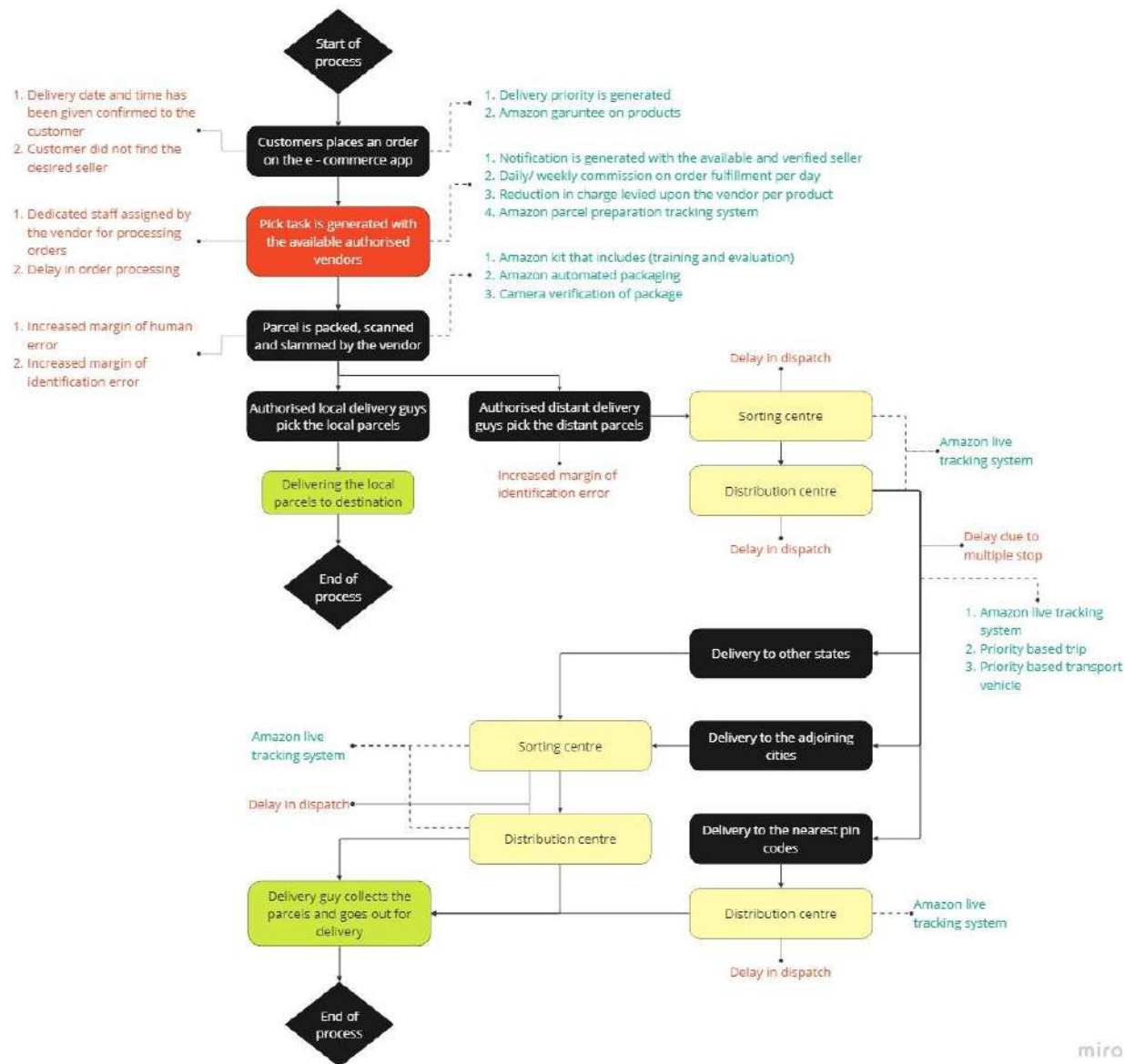
17.1 ABOUT

The third concept is a modified approach of the first concepts.

Here there is no inventory and the delivery of parcels are managed by the e-commerce service provider themselves at the local level and at national level.

17.2 VISUAL MAP



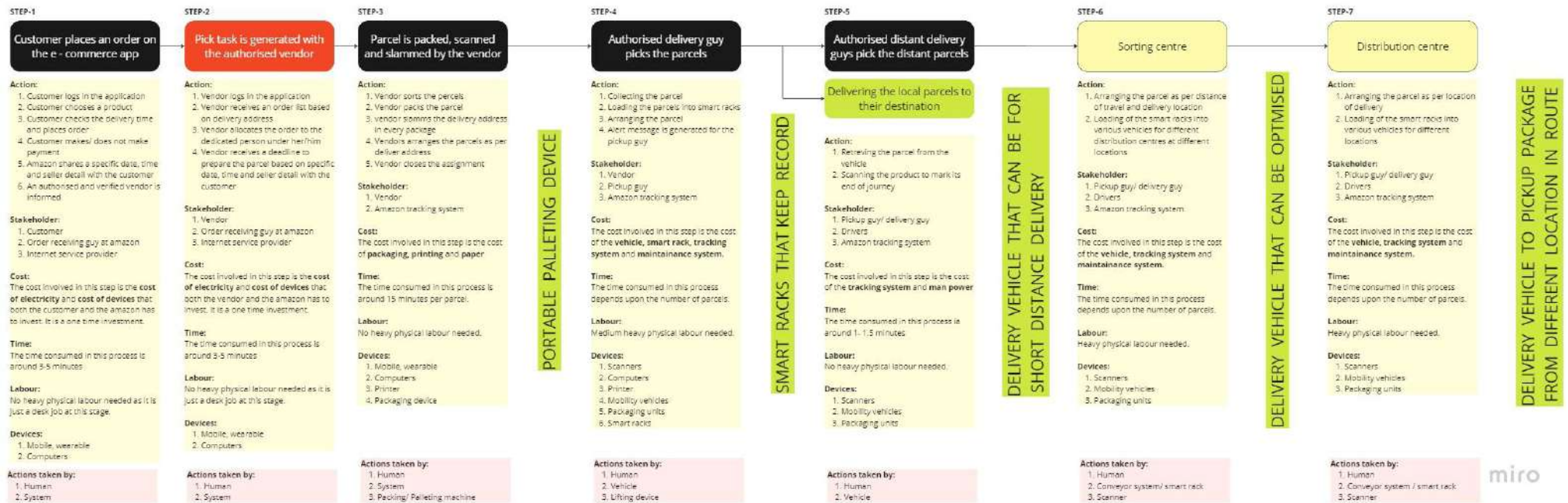


miro

Service error/ failure and recovery is a vital part of any service/ system design. Service errors are the points where the possible failures in expectation are identified and proper measures are taken to rectify it to give a proper smooth experience. In the above system I have tried to identify various such loopholes that needed to be addressed.

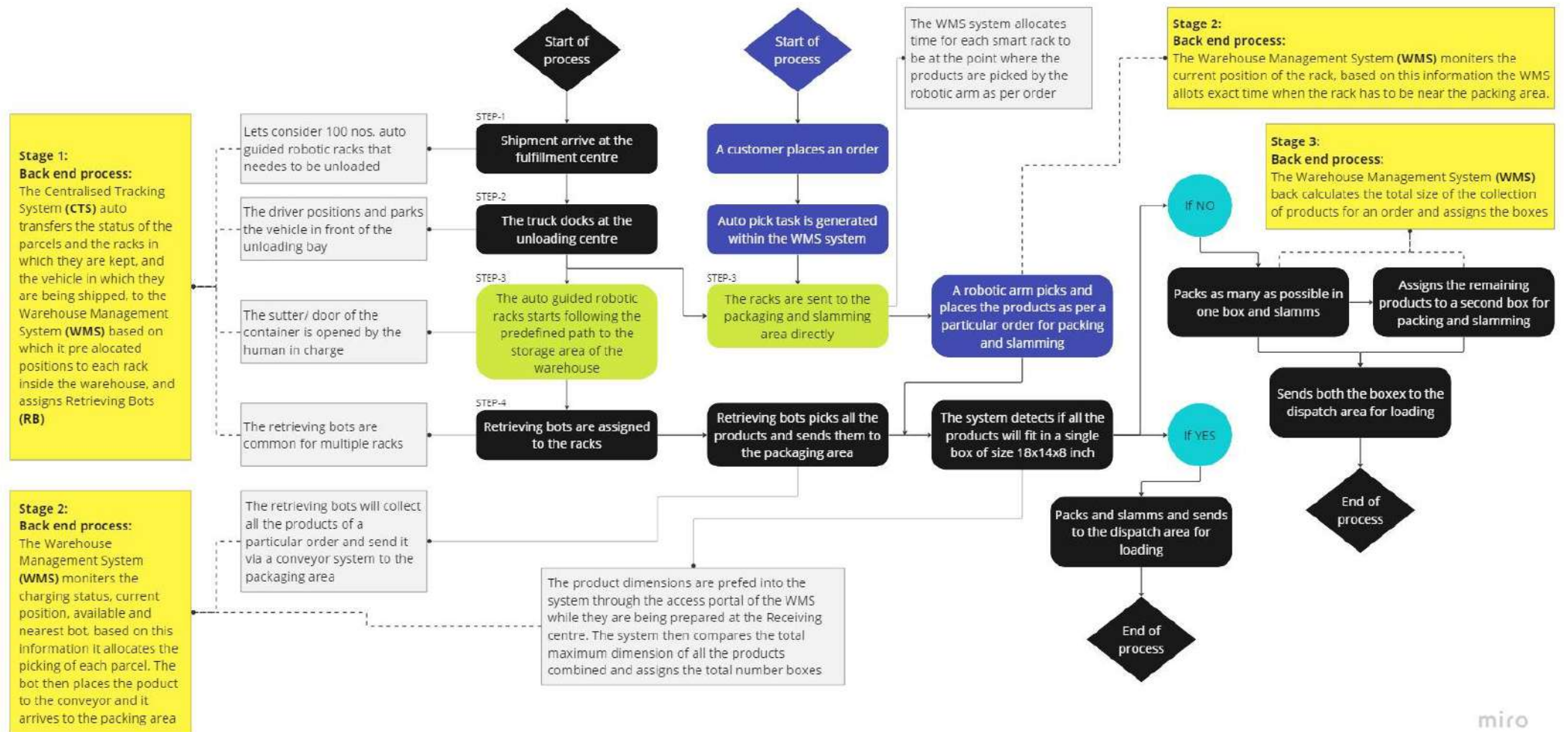
These loopholes can be rectified by various means and ways. Some such possible errors and recovery are mentioned in the above diagram.

17.3 SYSTEM DETAILS AND GAPS IN MOBILITY DESIGN



The vertical text highlighted in green are the gaps as per the system that I have designed. As part of the mobility and vehicle design project and based on these gaps I have also designed the vehicles which are in the later part of the report.

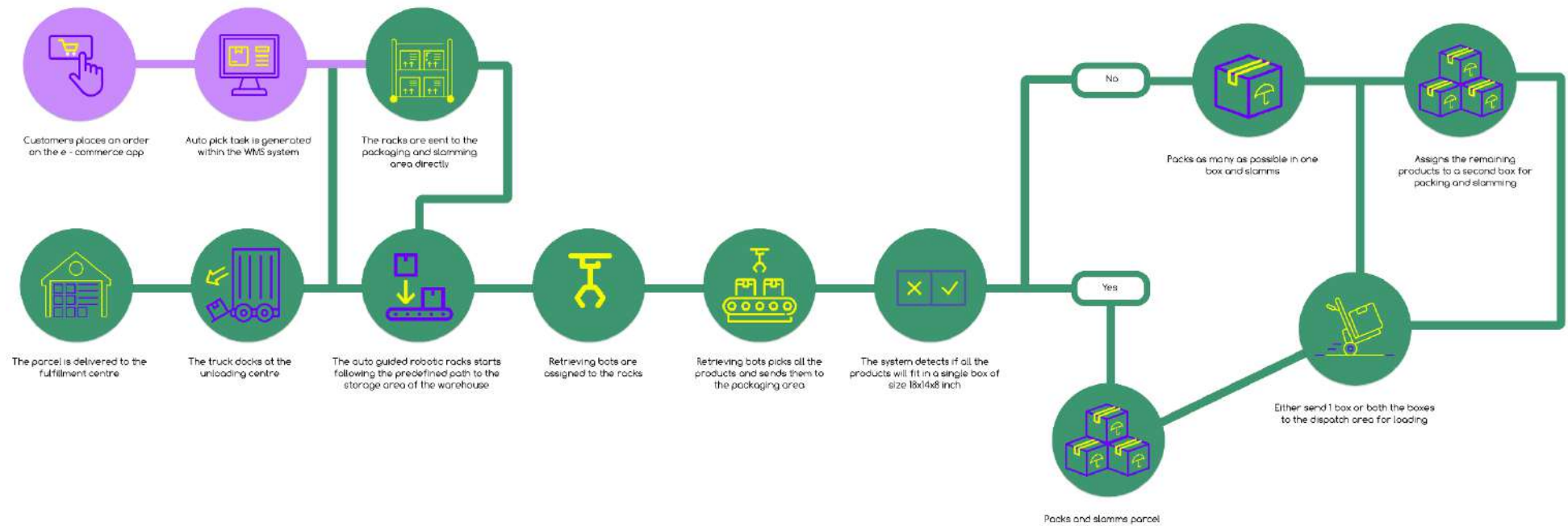
18. INHOUSE SYSTEM DESIGN CONCEPT



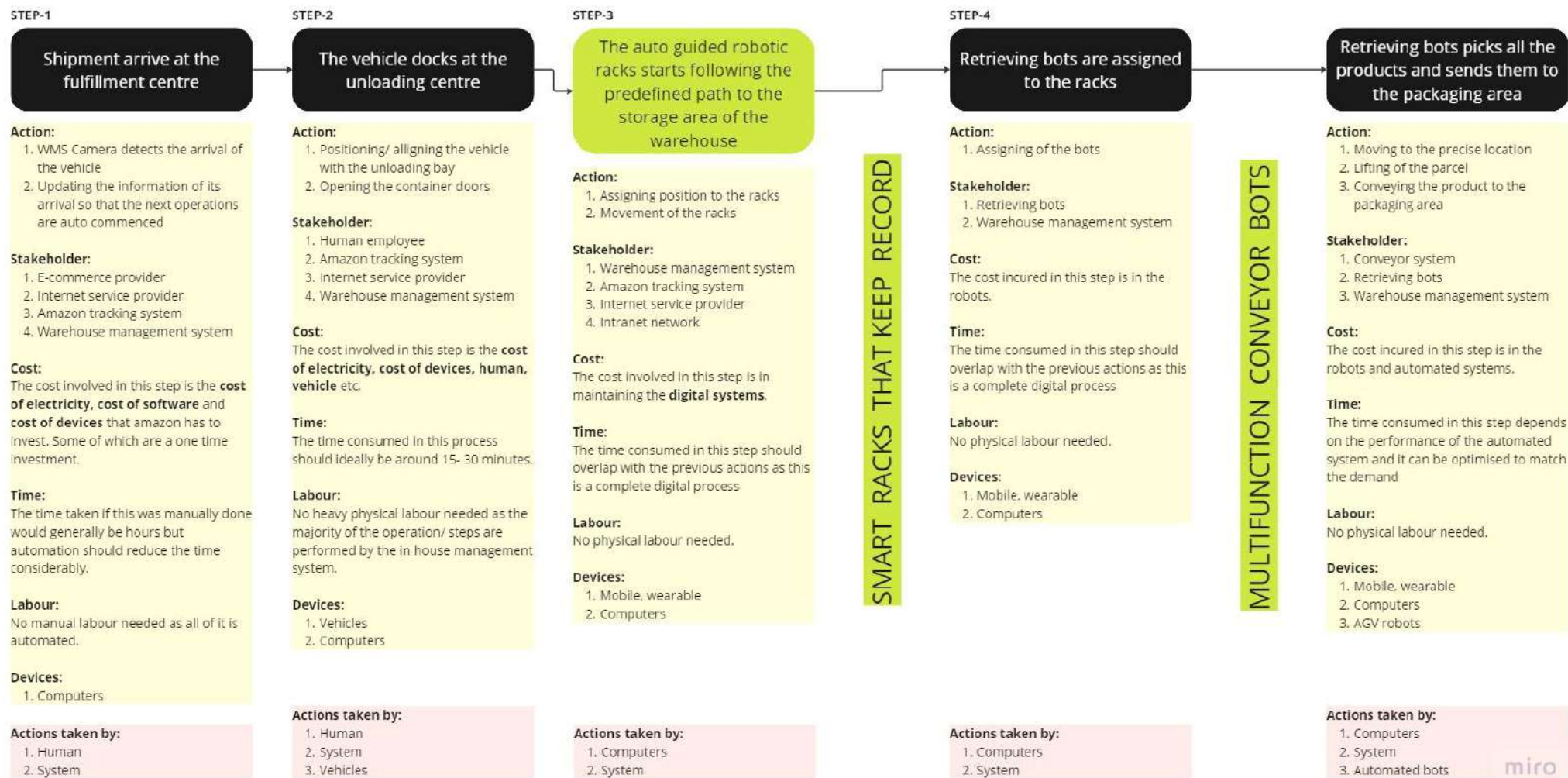
18.1 ABOUT

This concept is about creating a system that increases the efficiency of parcel packaging, order preparation and package delivery more efficient. My idea was to create a fully automated system that is self-running with the minimum possible human intervention. This helps in error reduction, which in turn leads to a more efficient system. This system would be more tech and automation focused.

18.2 VISUAL MAP

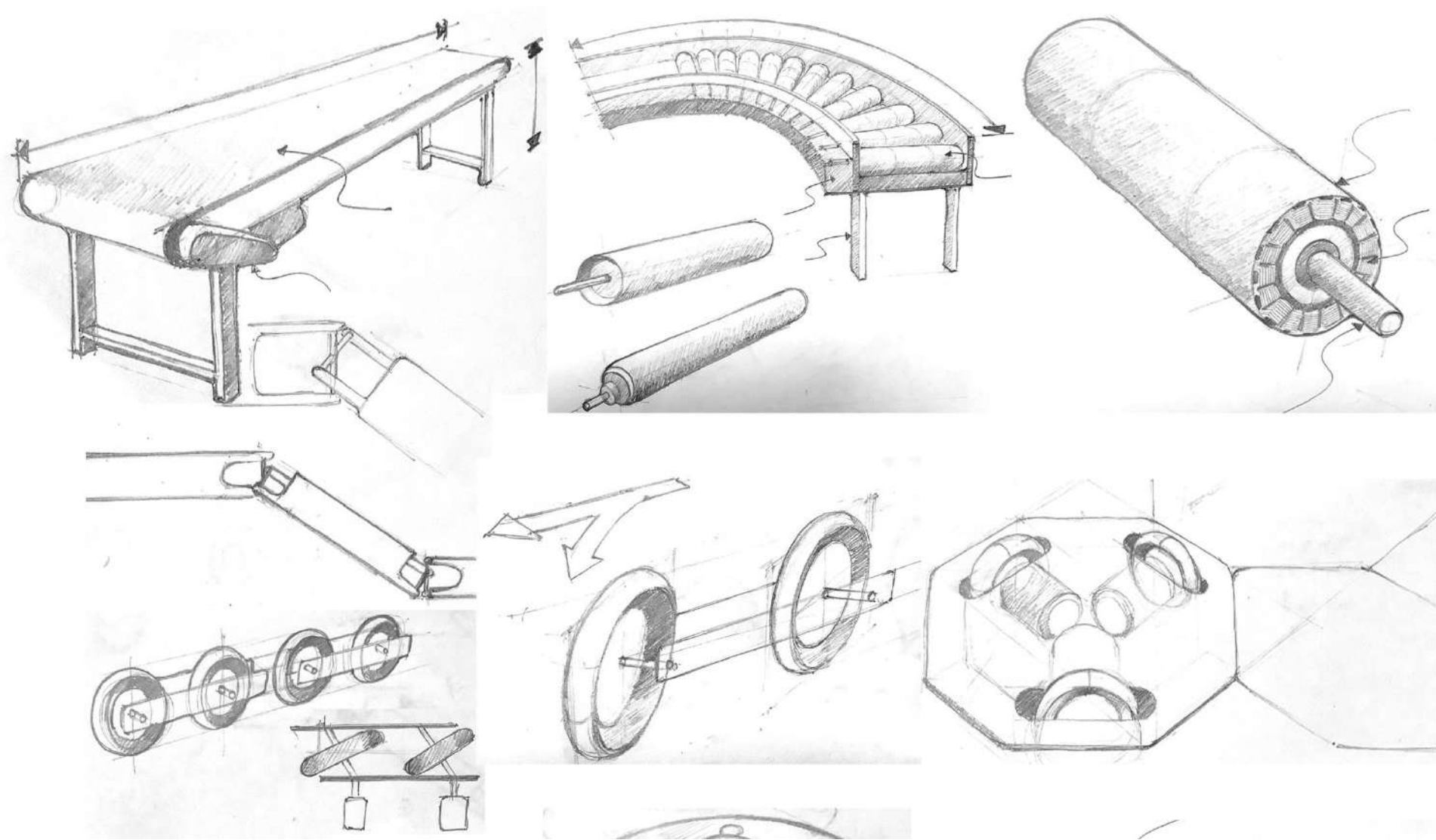


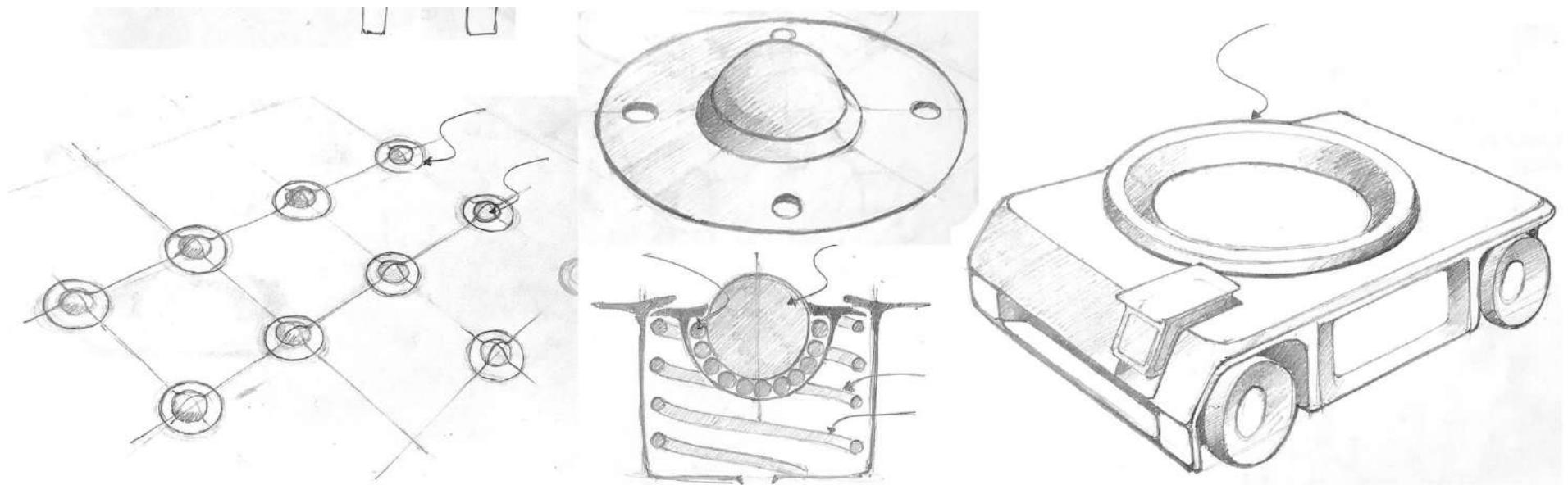
18.3 SYSTEM DETAILS AND GAPS IN MOBILITY DESIGN



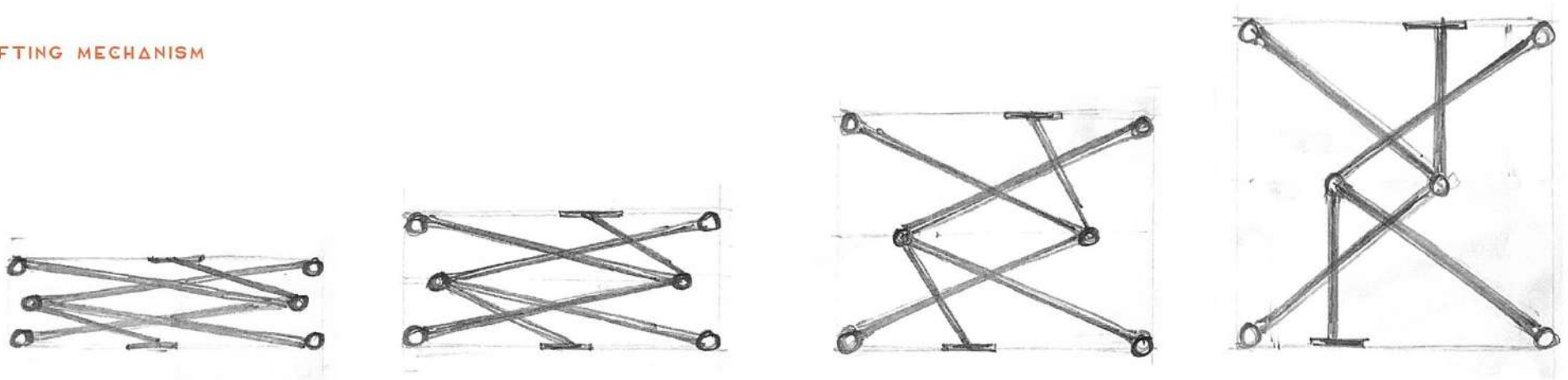
19. VEHICLE CONCEPT BASED ON THE SYSTEM

19.1 IDEATIONS

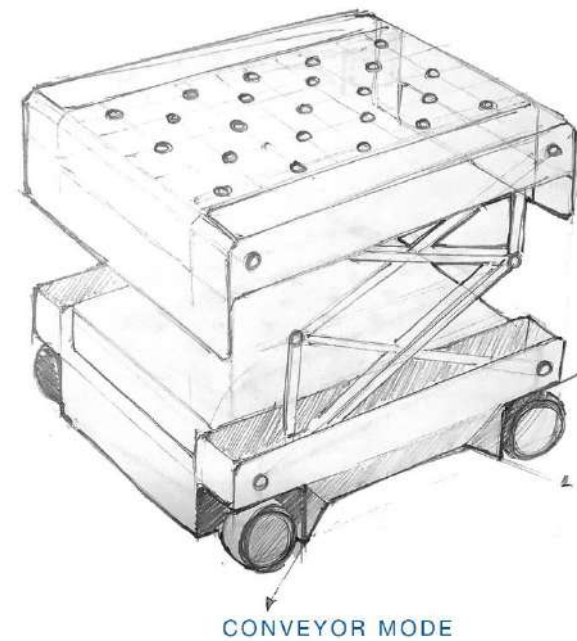
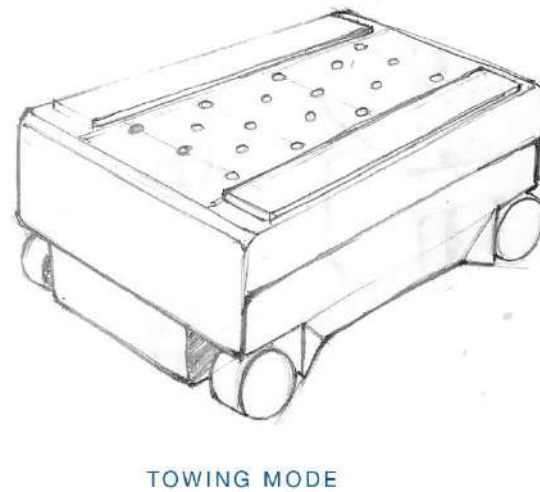
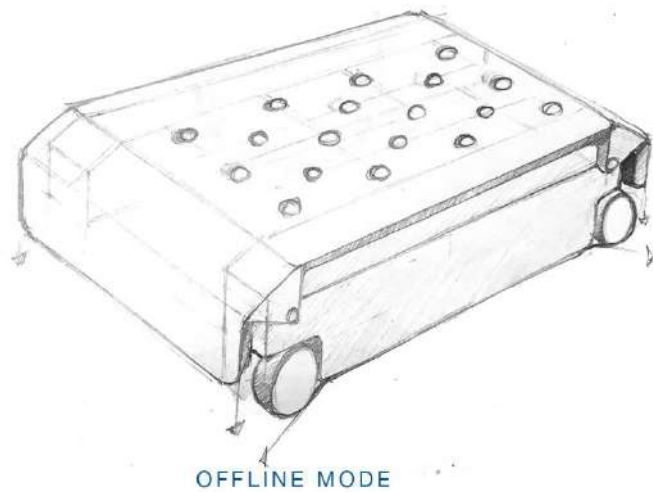




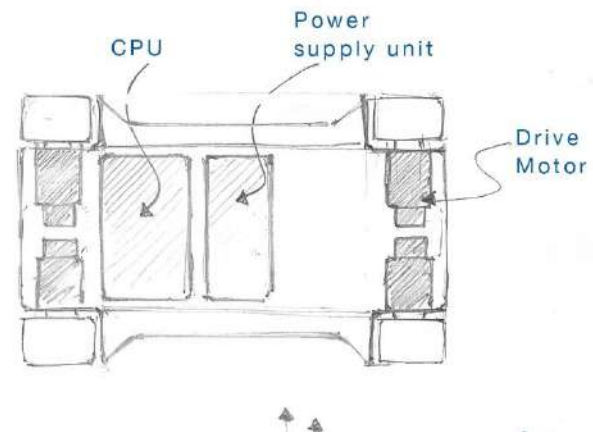
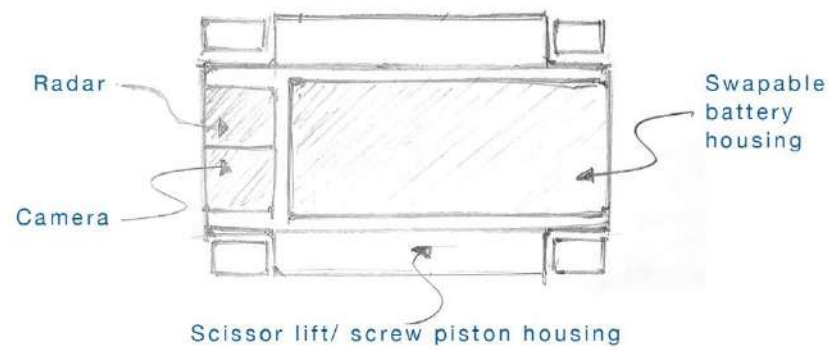
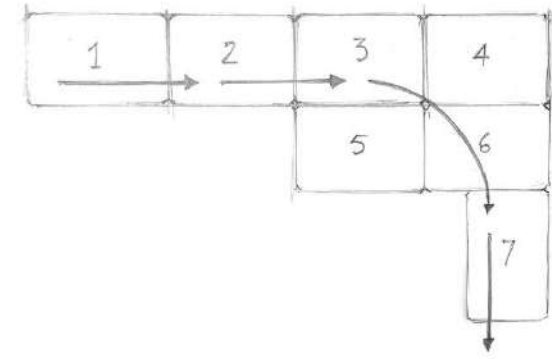
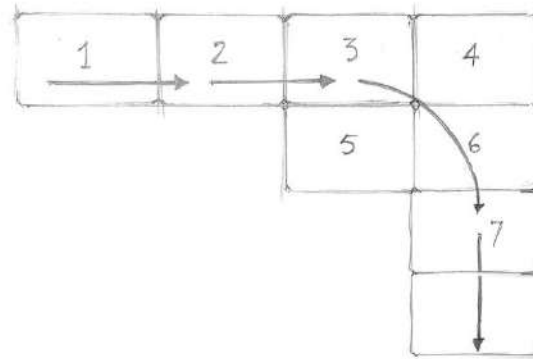
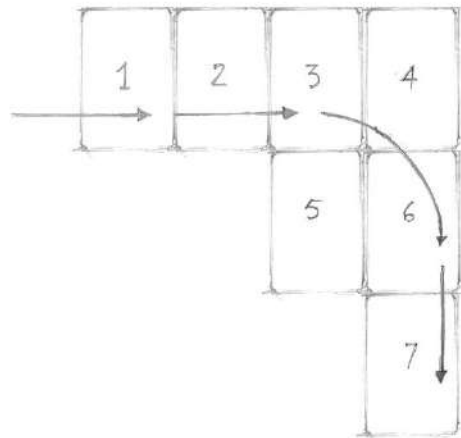
LIFTING MECHANISM



MERGING CONVEYOR WITH TOWING

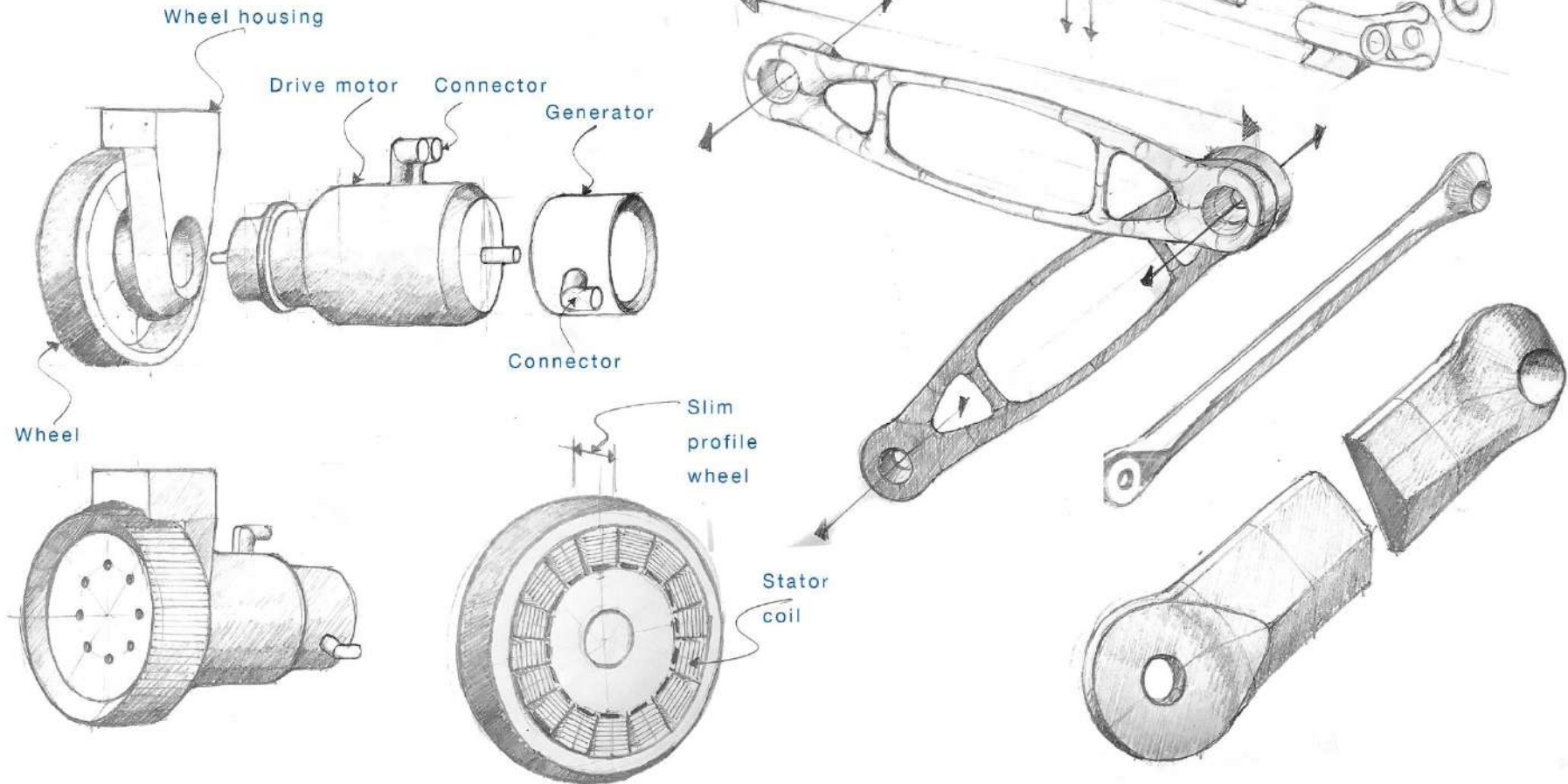


POSSIBLE CONVEYOR LAYOUT

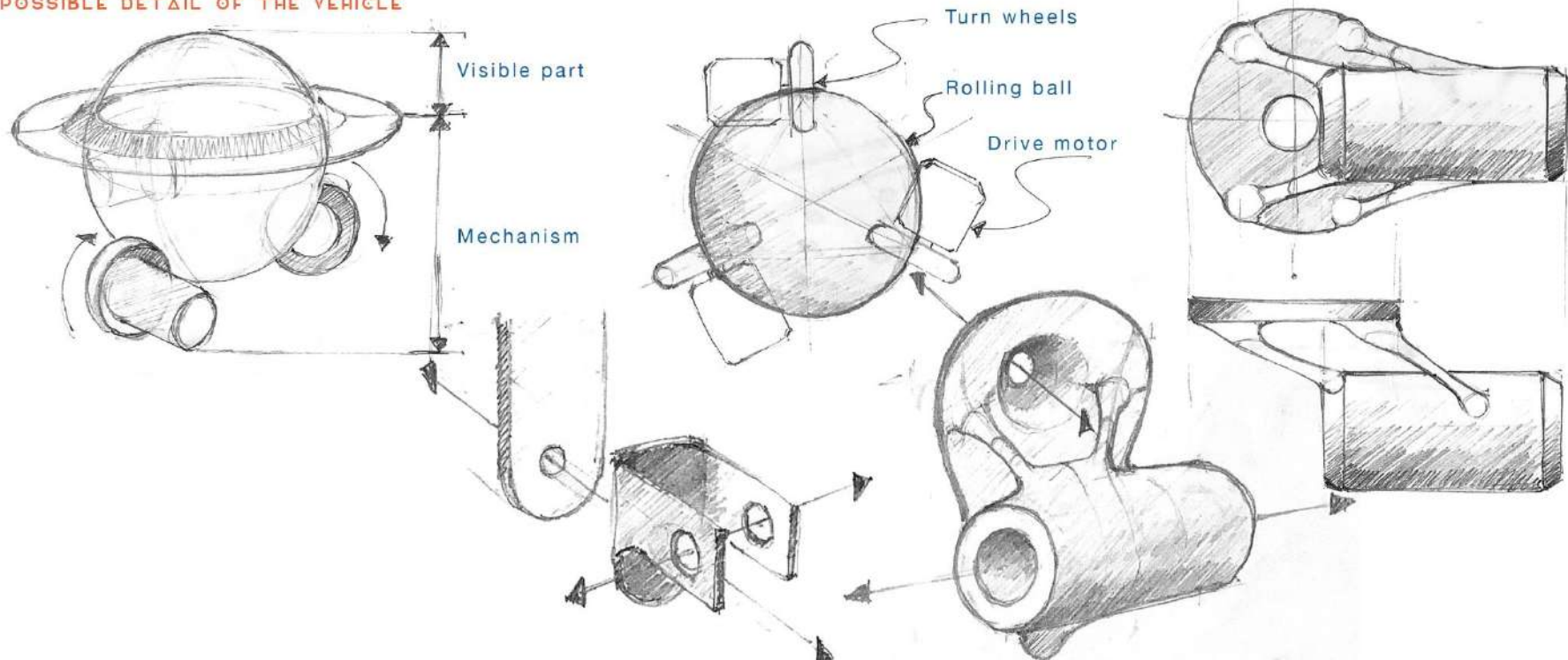


Scissor lift/ screw piston housing

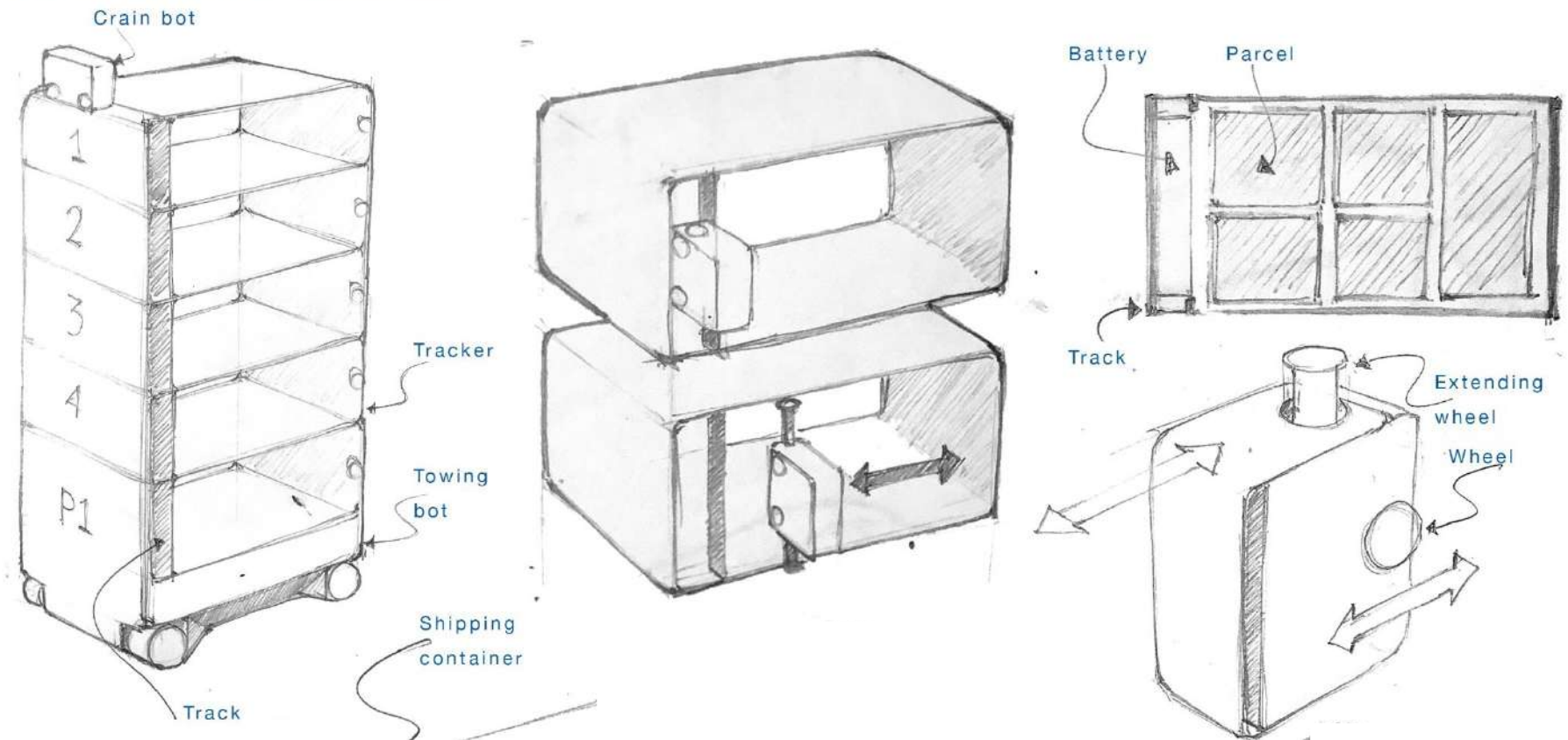
POSSIBLE DETAIL OF THE VEHICLE

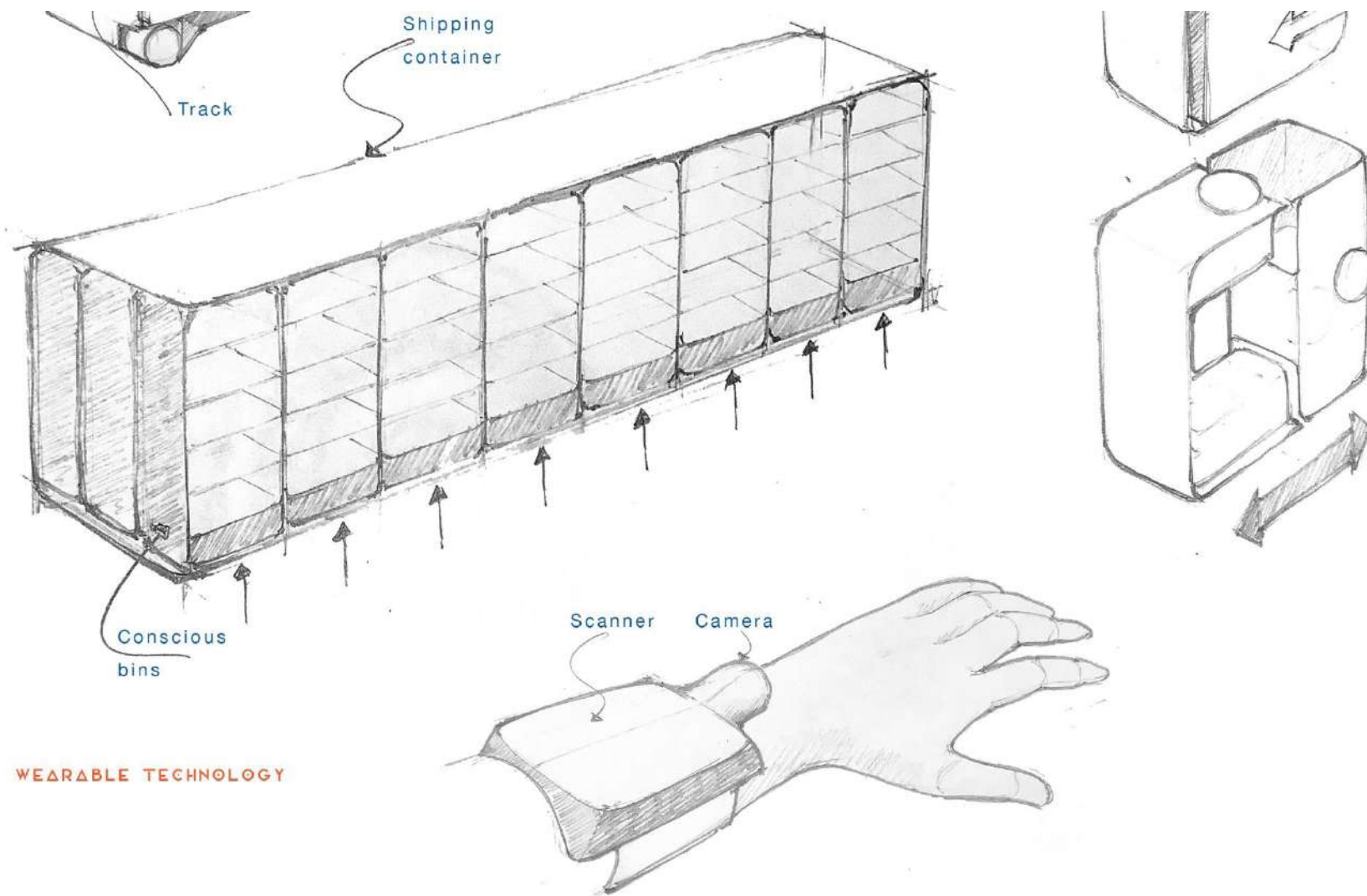


POSSIBLE DETAIL OF THE VEHICLE

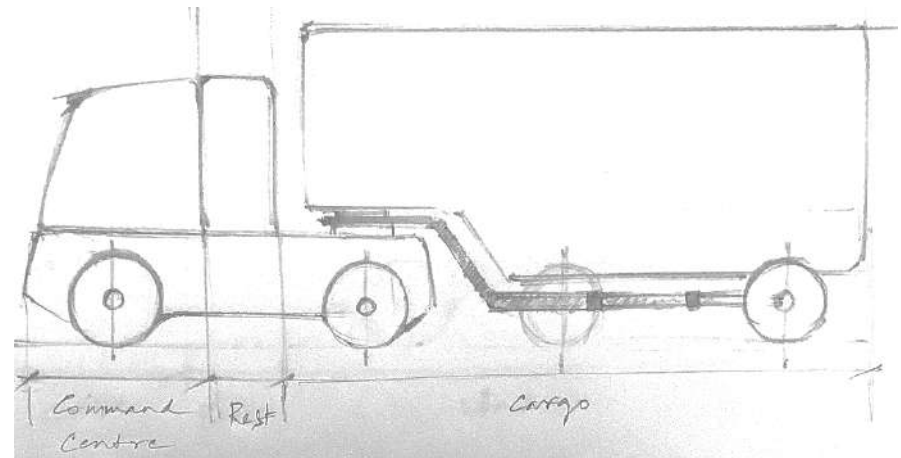
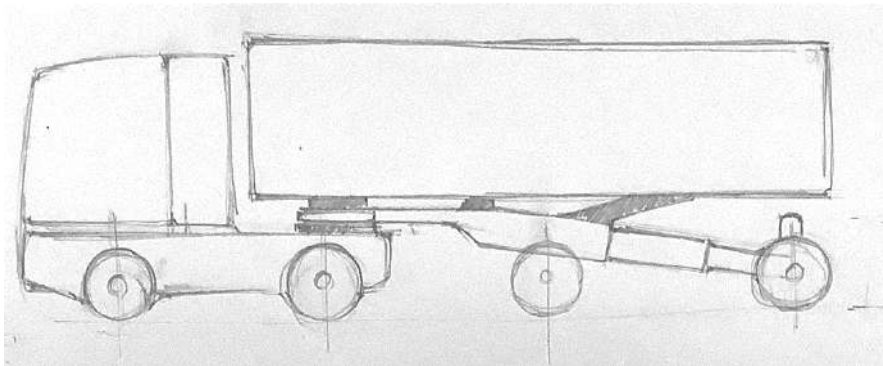
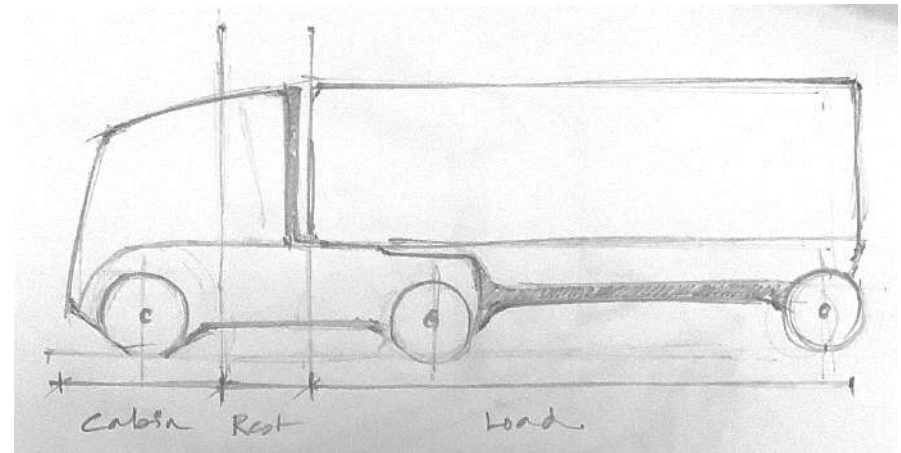
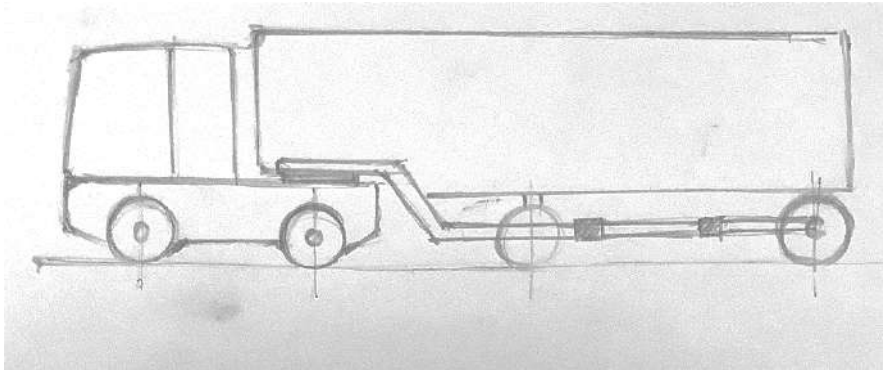


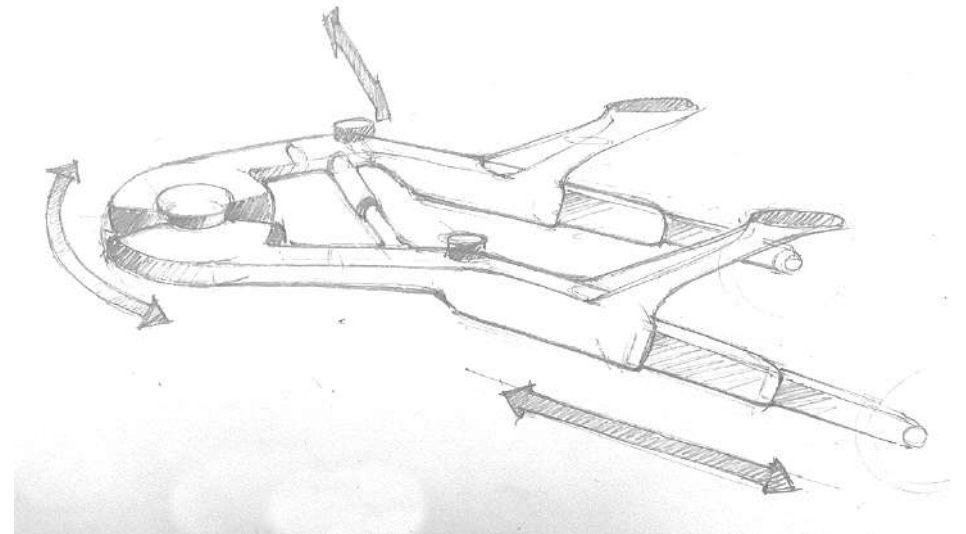
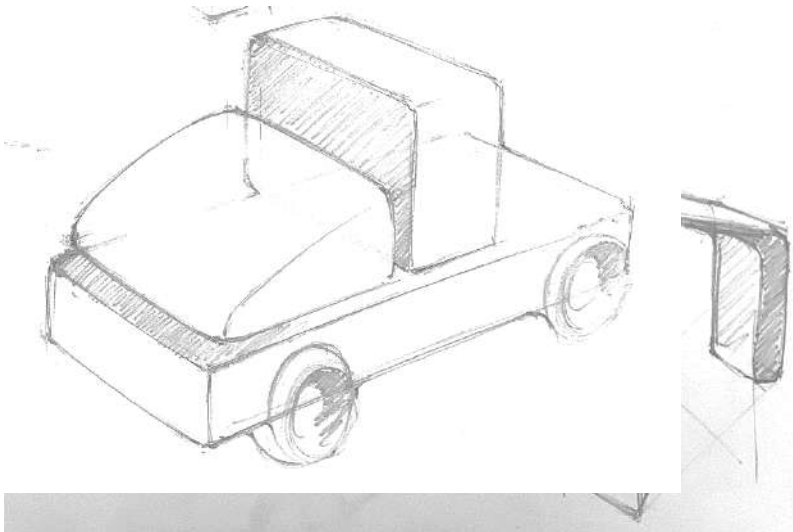
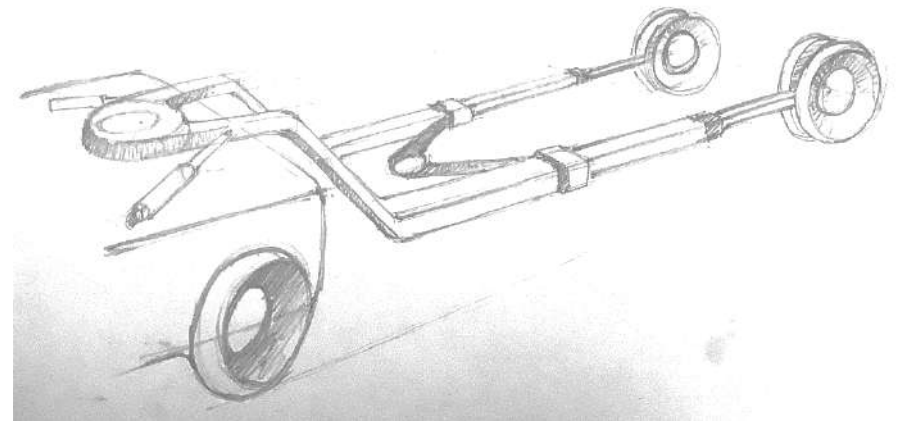
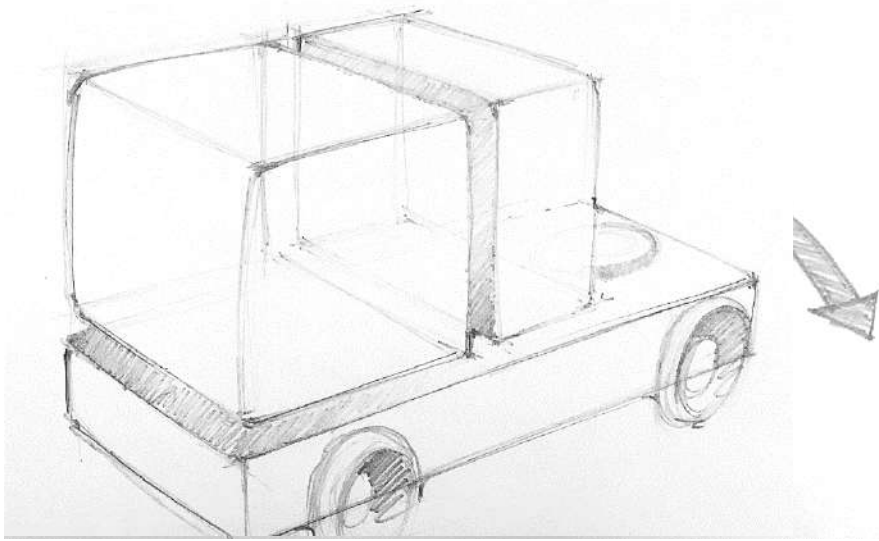
SORTING AND STORING (conscious bins)

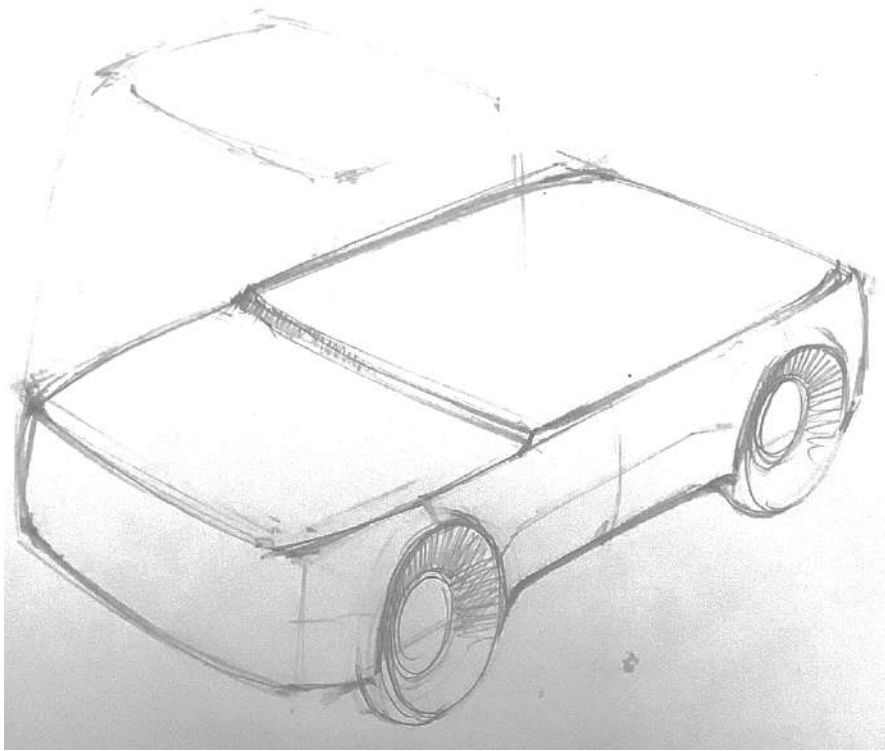




WEARABLE TECHNOLOGY







20. CONCEPT – 1 (SMART RACK)

20.1 ABOUT

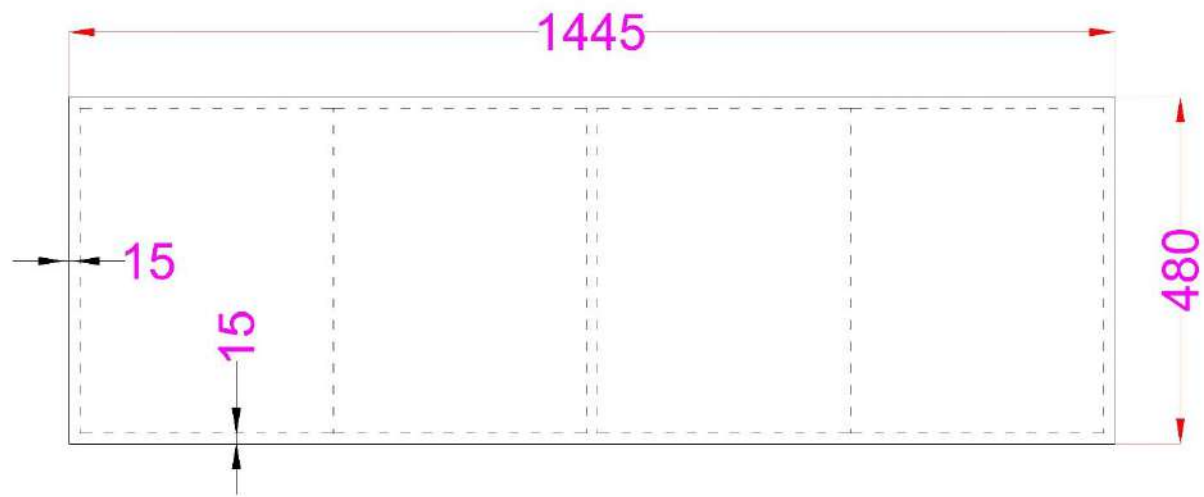
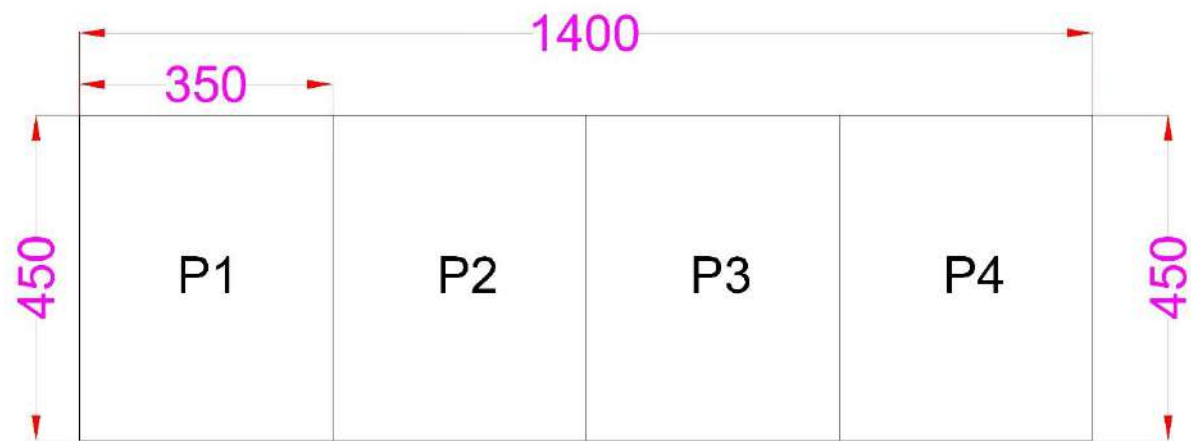
The concept was designed to suit any of the system concepts. The idea was to create a solution that fits the maximum size of a sortable parcel as defined by Amazon, which is 450mm x 350mm x 200mm.

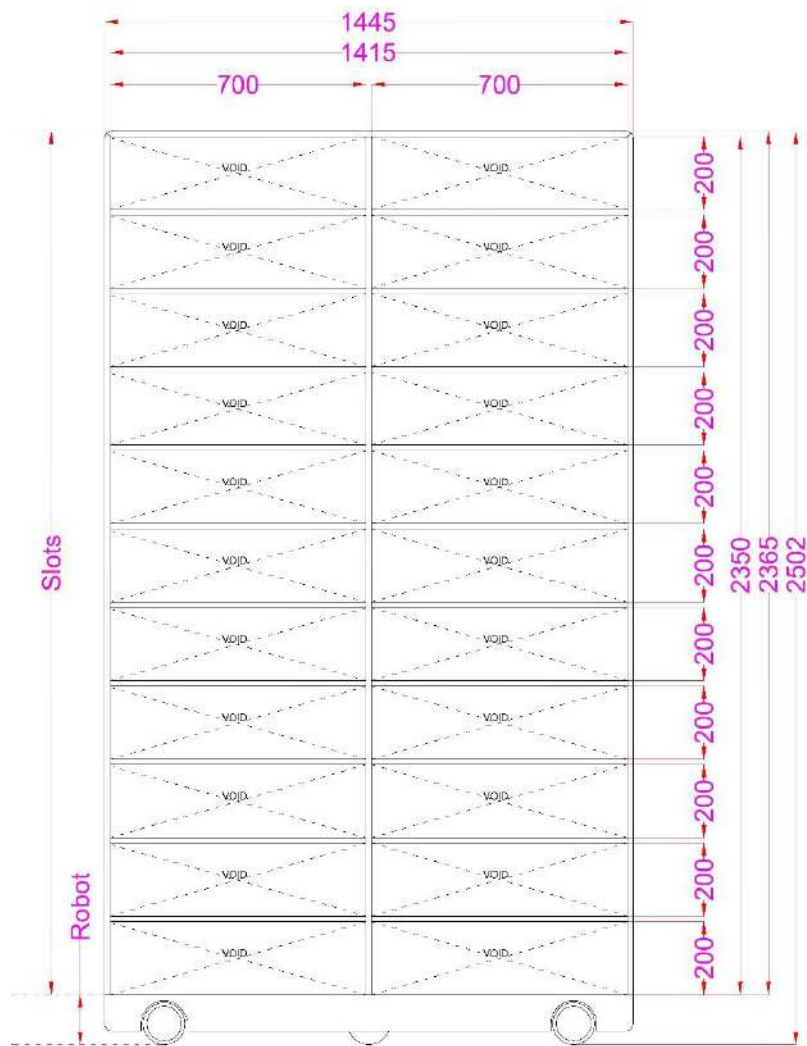
The inspiration was to create a temporary storage that is easy to assemble and dismantle and which can be attached to an AGV (automated guided vehicle). The racks are made of 2mm thick aluminium sheets that are either clamped, slotted or screwed to other panels. The bot is also slim enough to fit below the rack. At any point of time if a bigger space is needed then any tray can easily be removed to create a bigger space except the anchor trays which are colour coded.

The idea is to reduce human effort at the fulfillment centres. Products will be scanned and loaded on to the racks at the receiving centre, which will then be directly loaded on to the trucks. After arriving at the facility these smart racks will simply

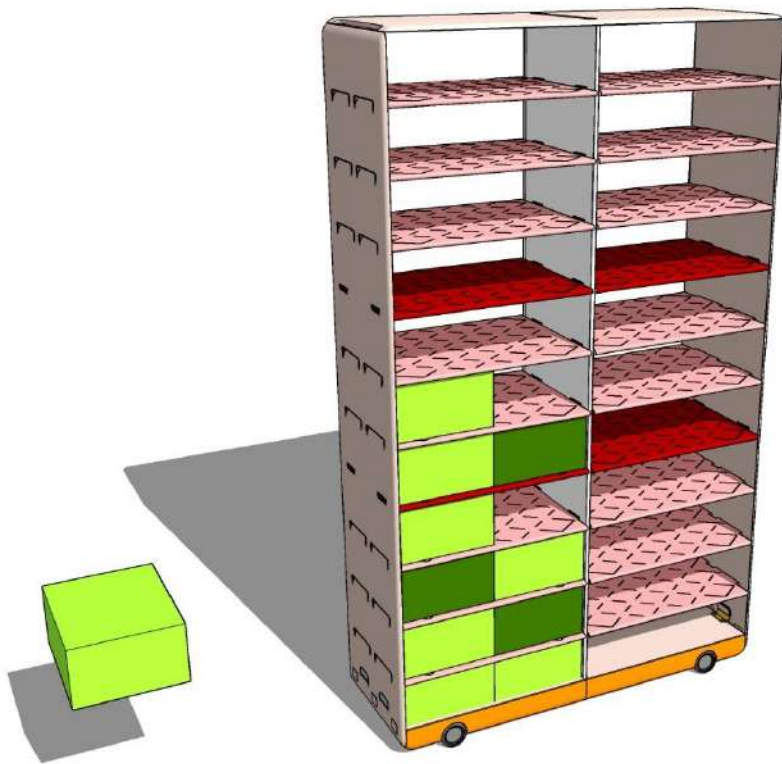
auto-unload and move to the designated storage spot based on the pre allocated instructions by the WMS.



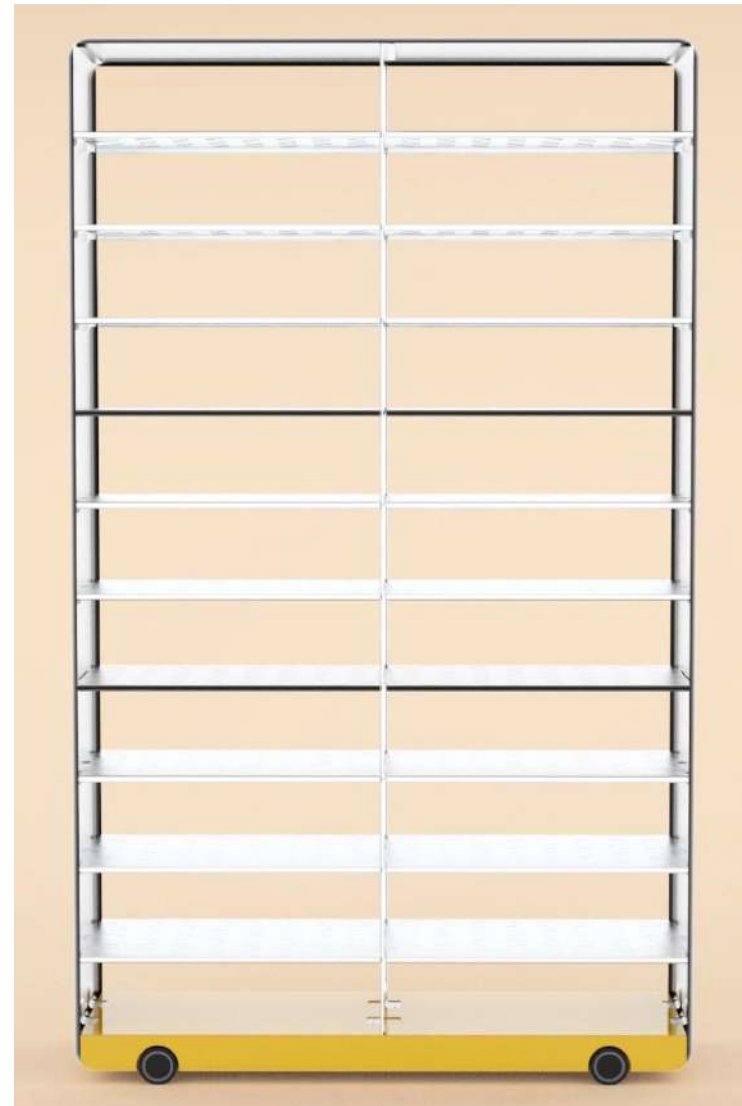




- P1, P2, P3 and P4 are the parcels.
- 15 mm is the additional boundary
- Elevation of the rack that shows the vertical dimensions with the bot at the bottom.

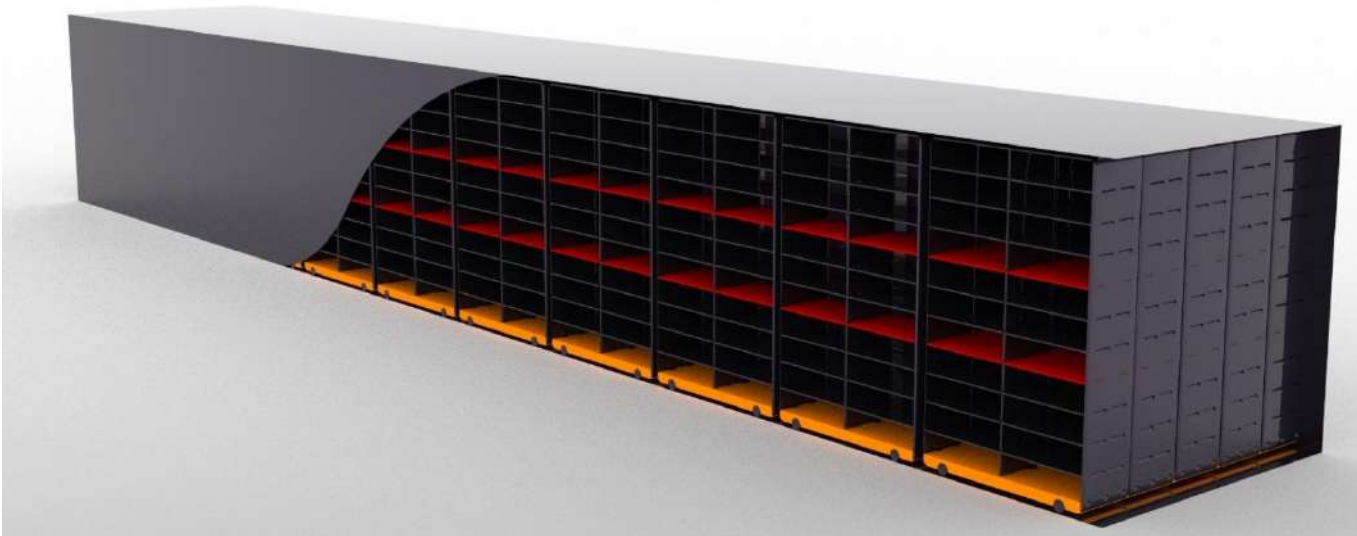


The above image shows how the parcel size has been used to create the rack dimensions.

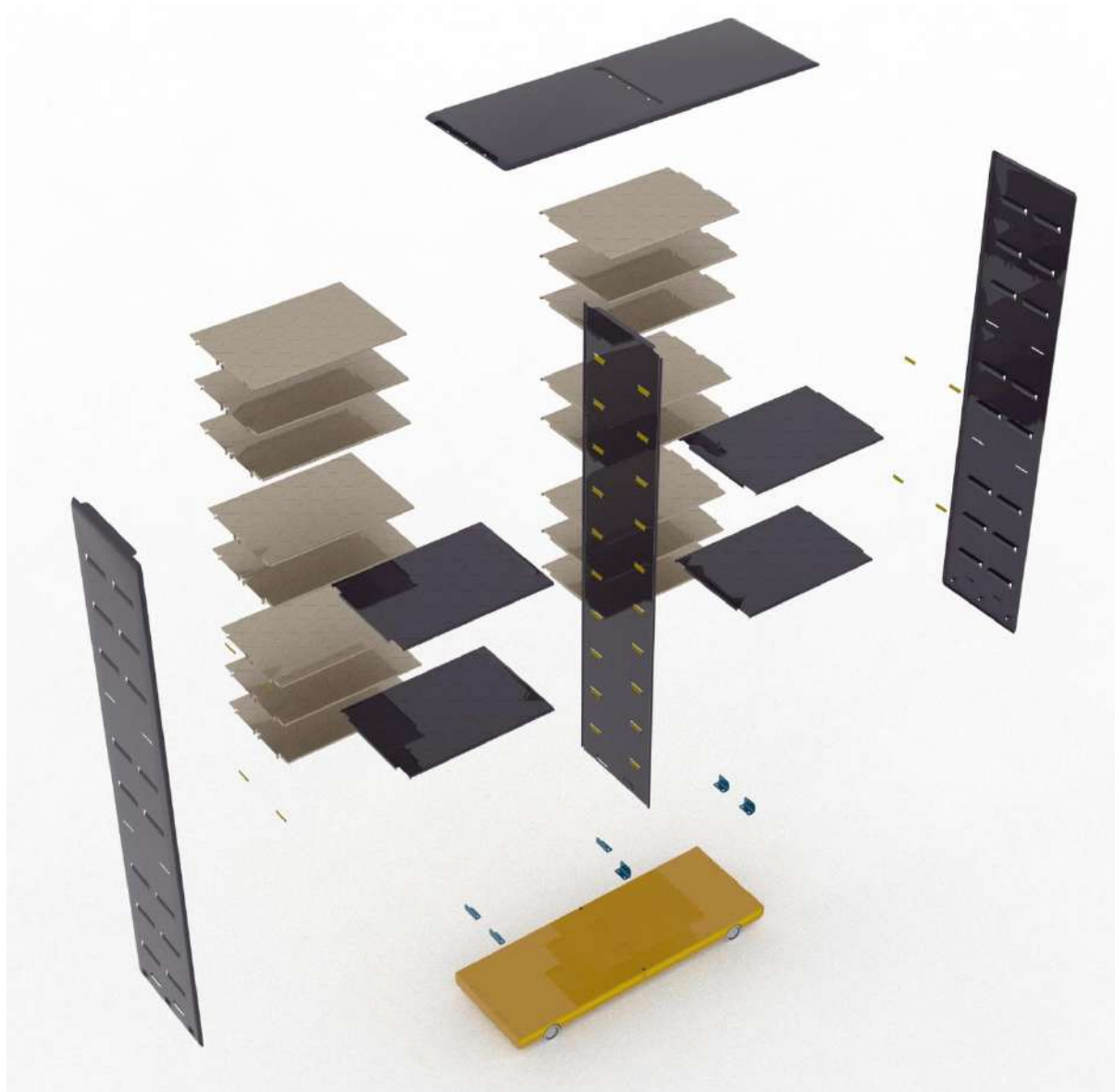


16764											2591
1	2	3	4	5	6	7	8	9	10	11	
12	13	14	15	16	17	18	19	20	21	22	
23	24	25	26	27	28	29	30	31	32	33	
34	35	36	37	38	39	40	41	42	43	44	
45	46	47	48	49	50	51	52	53	54	56	57

It is clear from the image that in a container of length 55' that Amazon uses, a maximum number of 57 such units will fit. Each of the racks contains 22 slots. Therefore, the total number of parcels should be $2 \times 22 \times 57 = 2508$ unit (ideally).

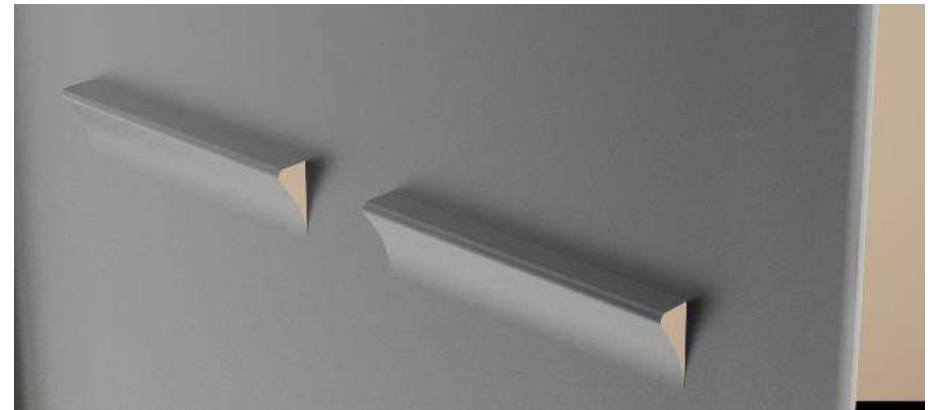


This is how an Amazon container in the inside should look with the smart racks.



This is an exploded view of the rack showing the side, top and anchor panels in black colour. The remaining trays has a brown shade. The AGV bot is orange in colour. The vertical central panel in black houses the slots and pass through clamps to hold the trays in place.

This render shows the side panel form the inside of the rack. It is curled on all its sides. The bumps are the press-cut projections that hold the trays. The stamp-cut holes towards the centre both from the bottom and the top are the slots for the clamps which will hold the anchor trays. The bottom right render shows the side panel from the outside.

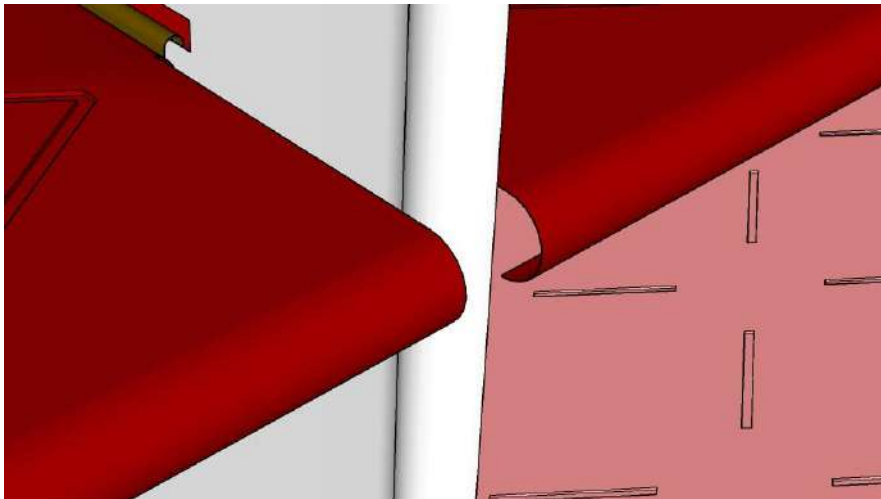
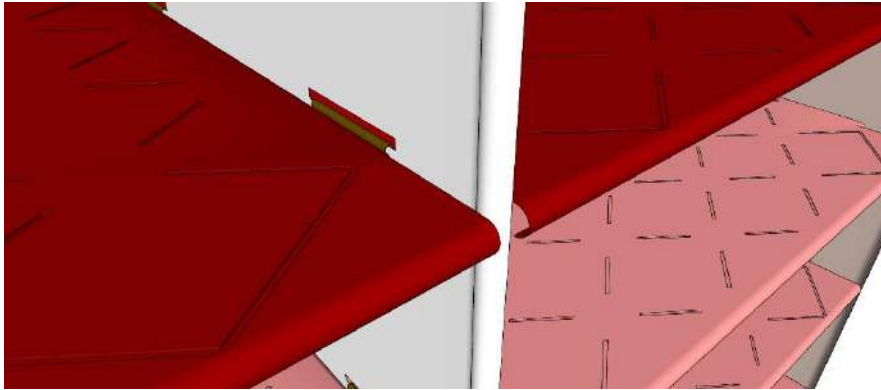




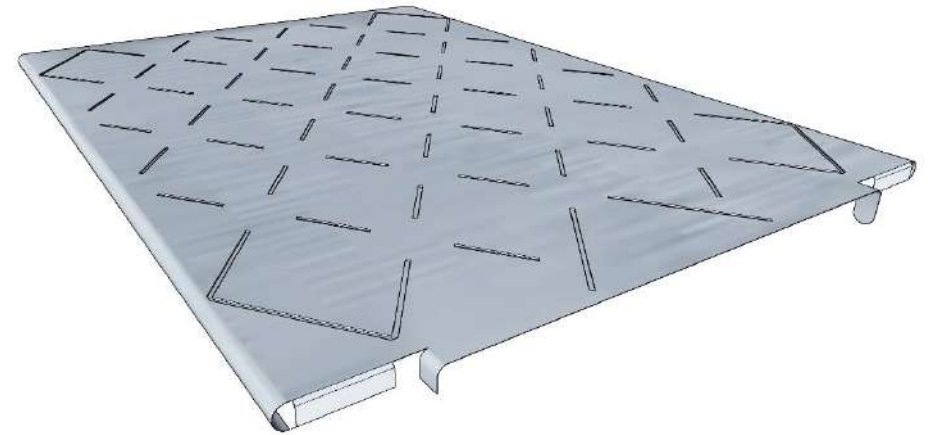
These renders show how the side panels and the top panel is simply joined by nut and bolts.



These renders show that the trays have a pattern. The patterns are actually small regular depressions, which will provide strength to the aluminium plate.



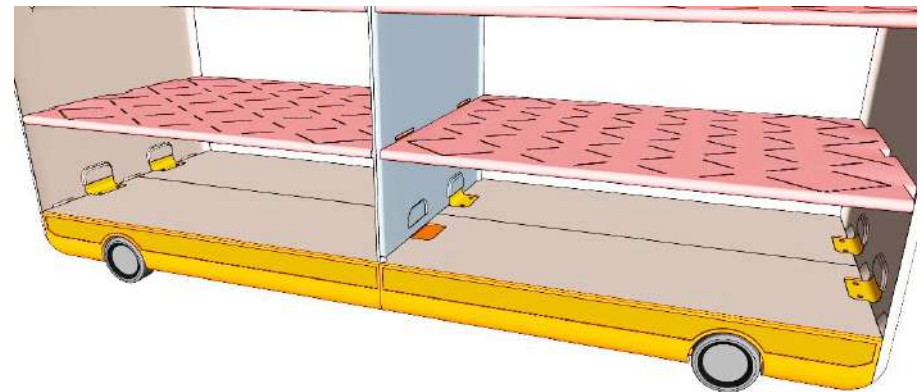
The image shows the tray edges are curled to provide edge strength.



The top image shows the edge of tray that will attach to the side panel and the bottom image shows the edge of tray that will be clamped to the central partition support.

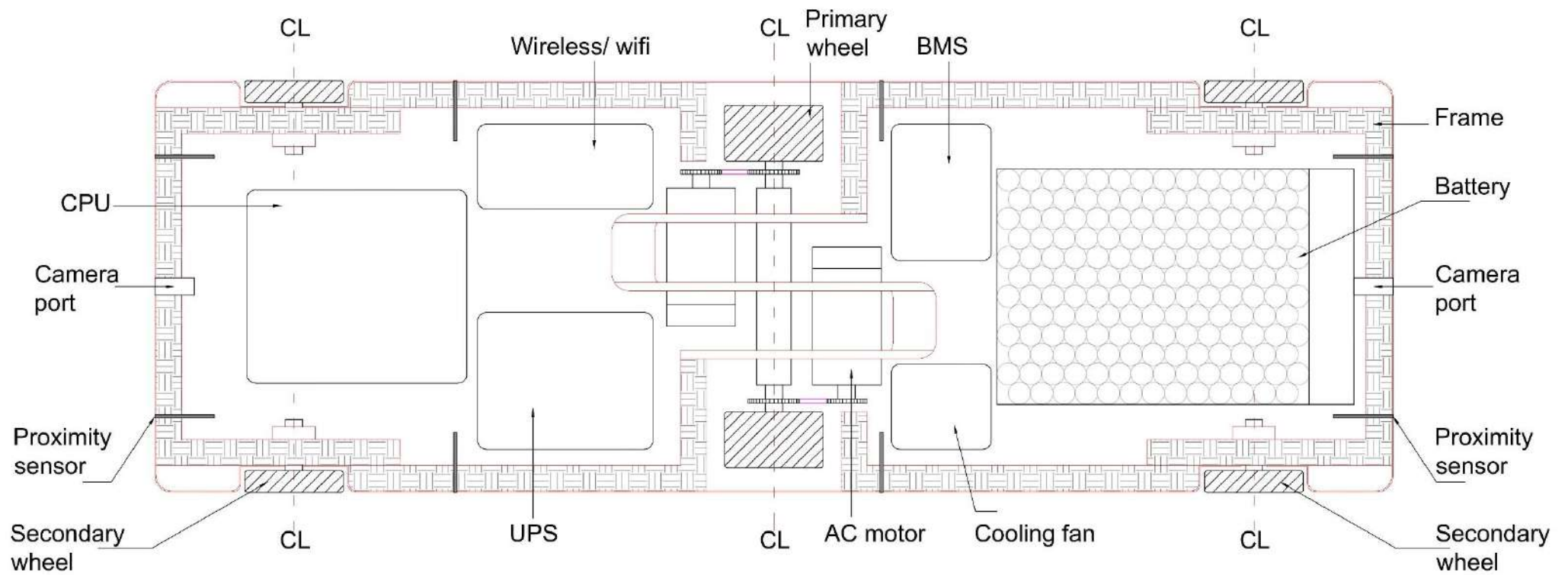


The renders and the image show how the side panels are attached to the bot. The top render shows that the side panel is attached to the bot with two screws on either side, with the central port as a camera hole. The bottom left image shows the 'L' clamps with one end mounted to the bot with screws and the other end inserted in a slot that has been press cut on the side panel. The central panel is also joined in a similar way with the 'L' clamps fitted on the either side.

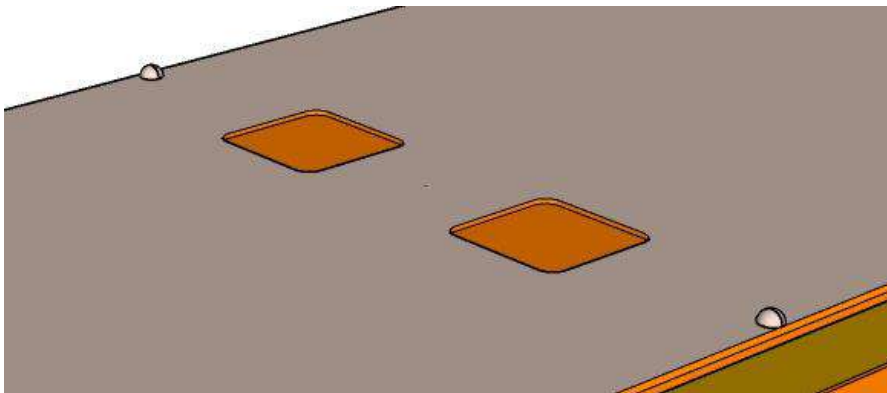
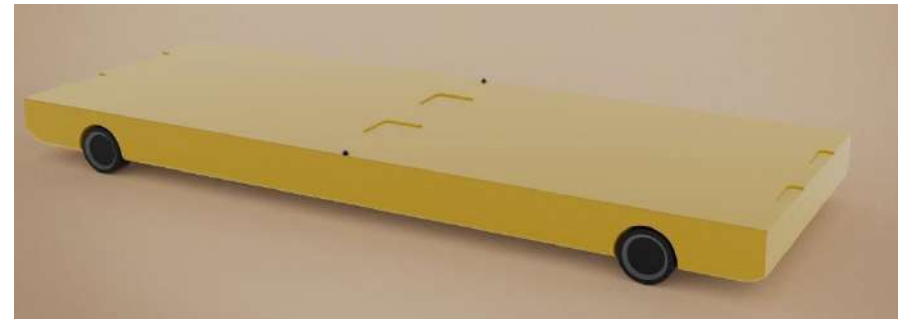
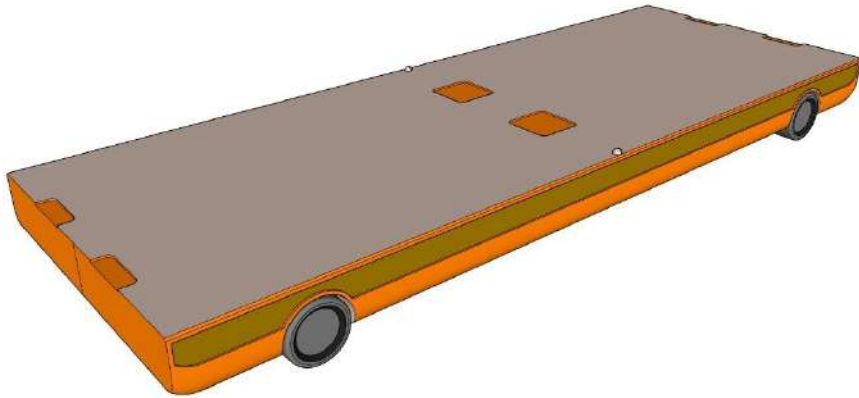




The left rendered image shows the 'L' clamp connections of the central partition cum support. The top right render show that the central panel is held in place with a hump on the bot (black tot). This hump is transversally placed, as the central panel is curled on its either edge opposite to each other.



Technical packaging of the bot



The top image is of the bot with the mount positions for the 'L' clamps. And the bottom image shows the two humps for positioning and retaining of the central partition.



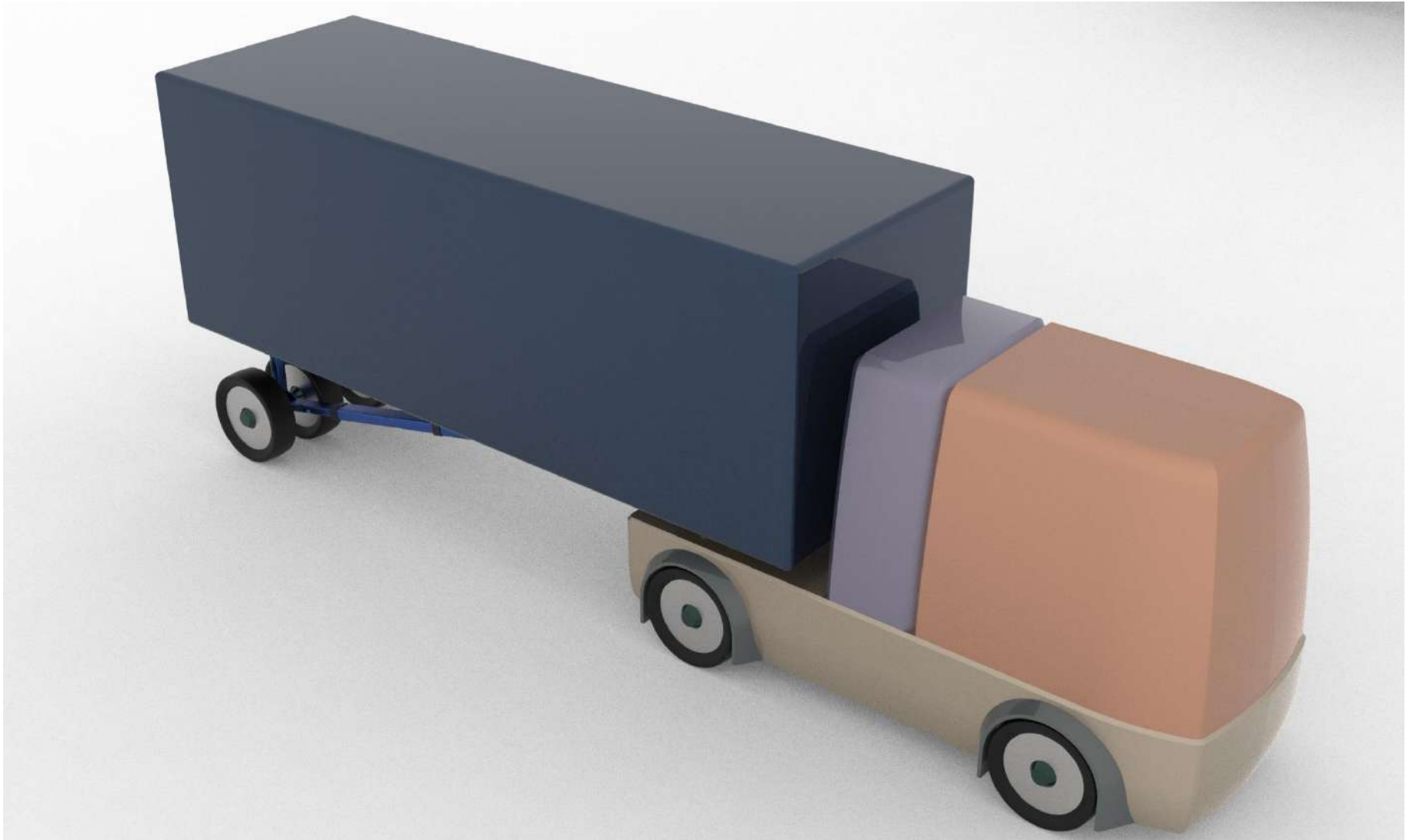
21. CONCEPT – 2 (TRANSFORMING PARCEL VEHICLE)

21.1 ABOUT

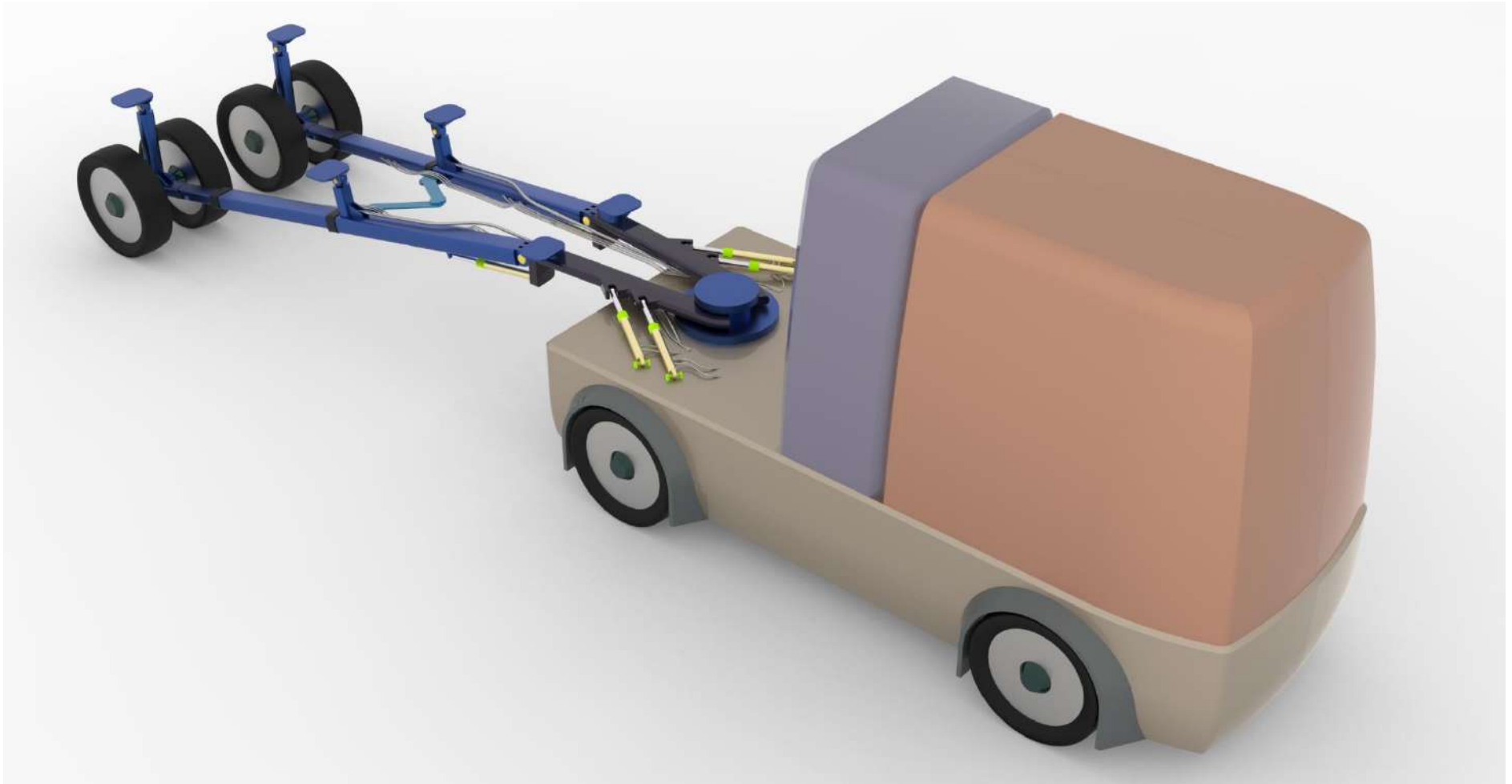
As the name suggests, this concept is about creating a vehicle platform that can be resized and refit to various situations. During the research I found that these logistics companies such as Amazon use vehicles that are of different size for different distance of travel. Naturally such establishments either have to maintain or lease various categories of vehicles to fulfil their needs and requirements.

In this concept I have tries to address that area through design.

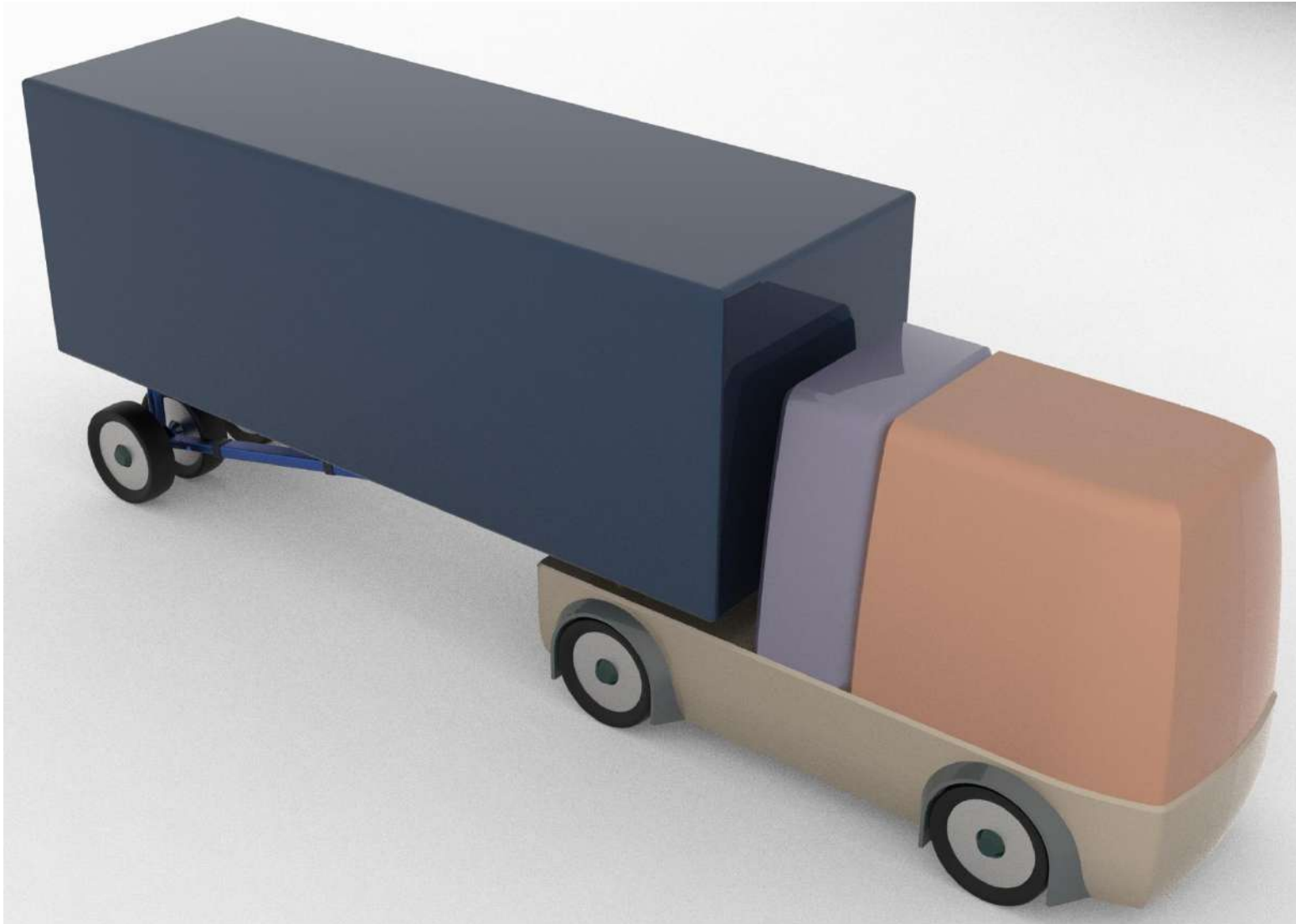
The idea is to design a vehicle that can be reconfigured to fit with multiple operations.



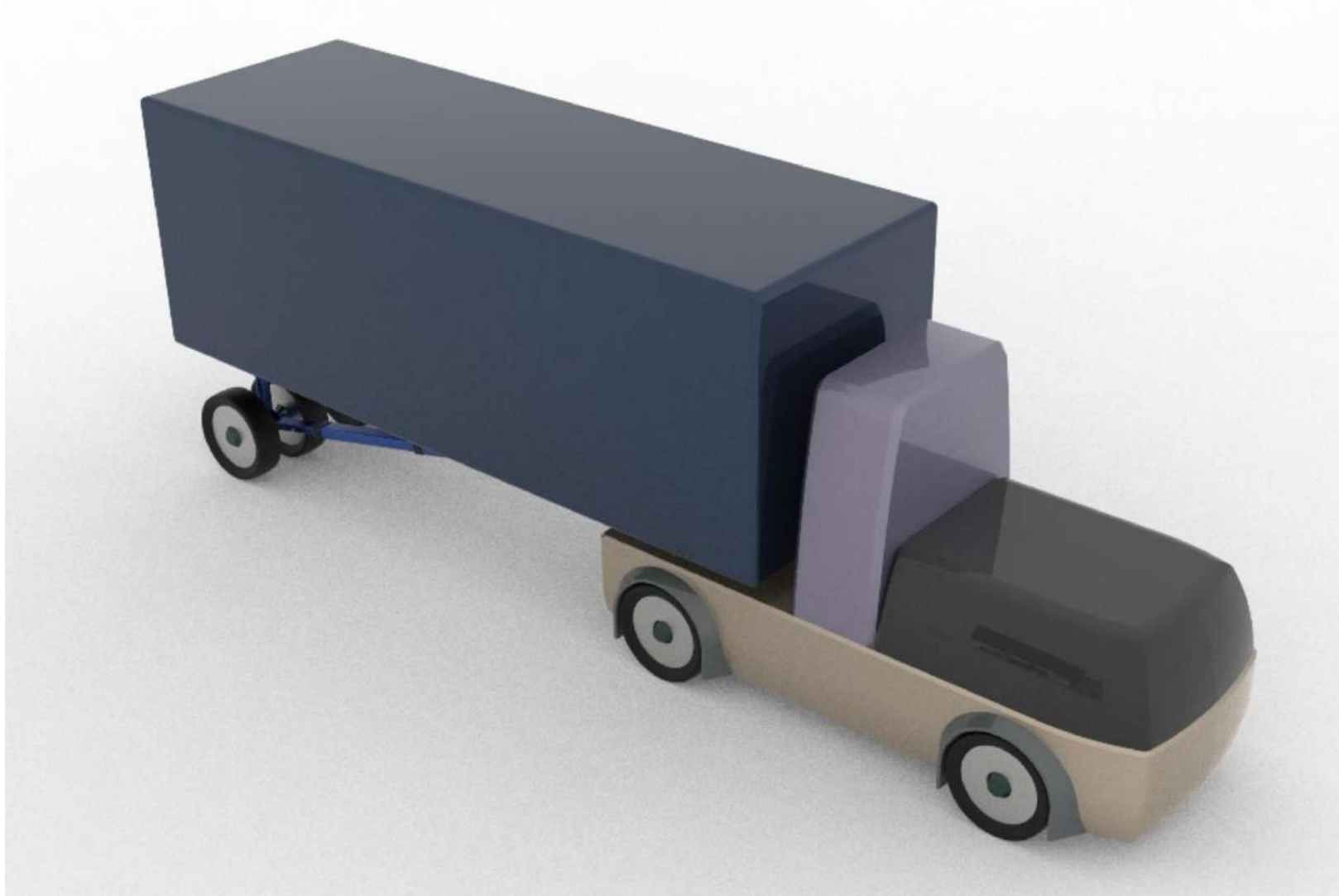
This is basically a platform exploration based on the need of logistics. I have tried to create a modular system.



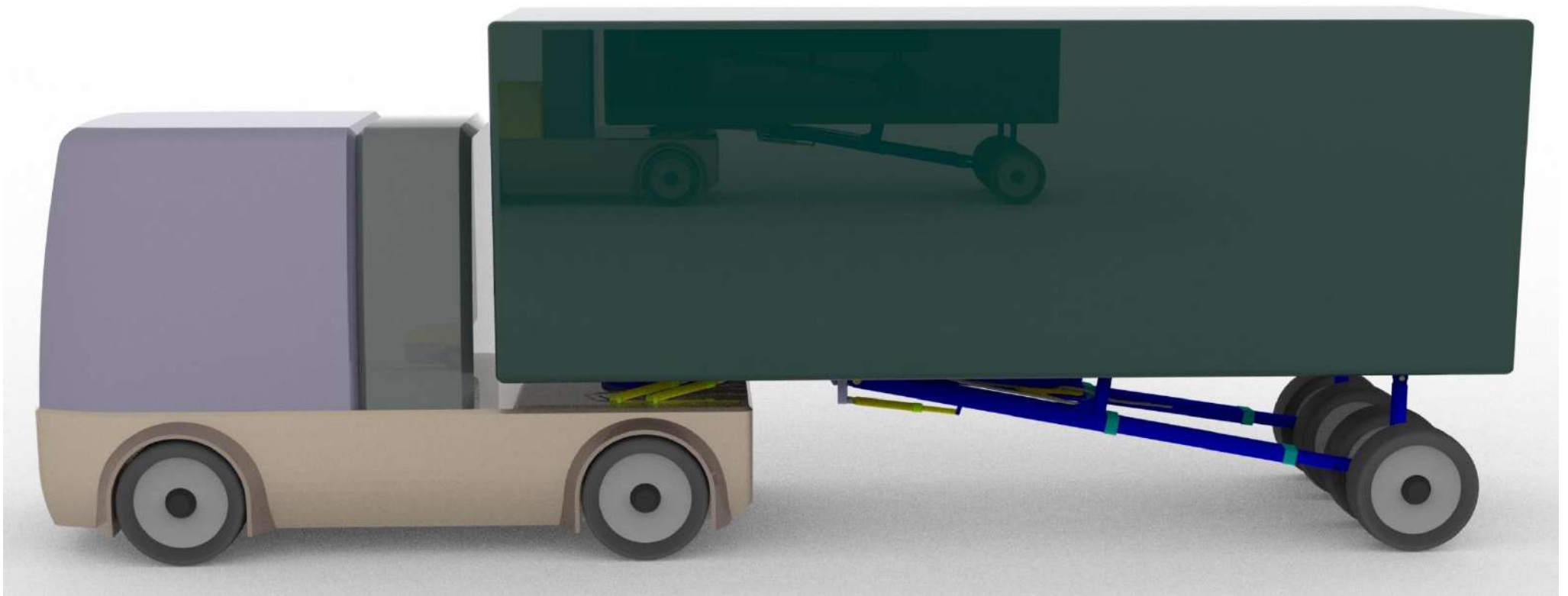
The above image shows how and where the expandable unit will be attached to the modular unit for transport.



This render shows how a cargo trailer is attached to the vehicle



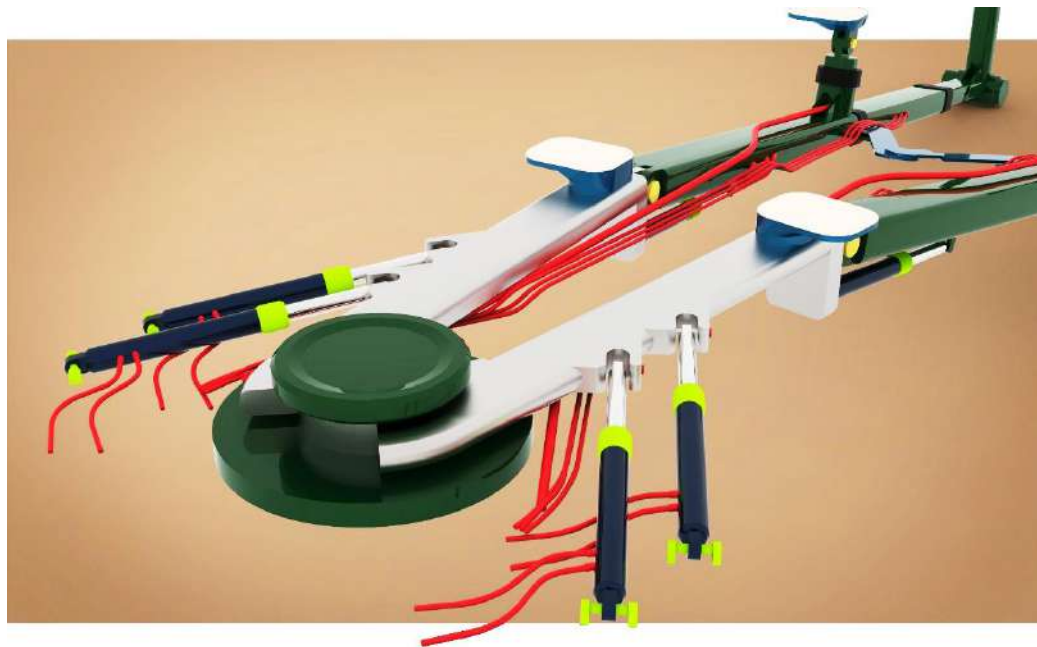
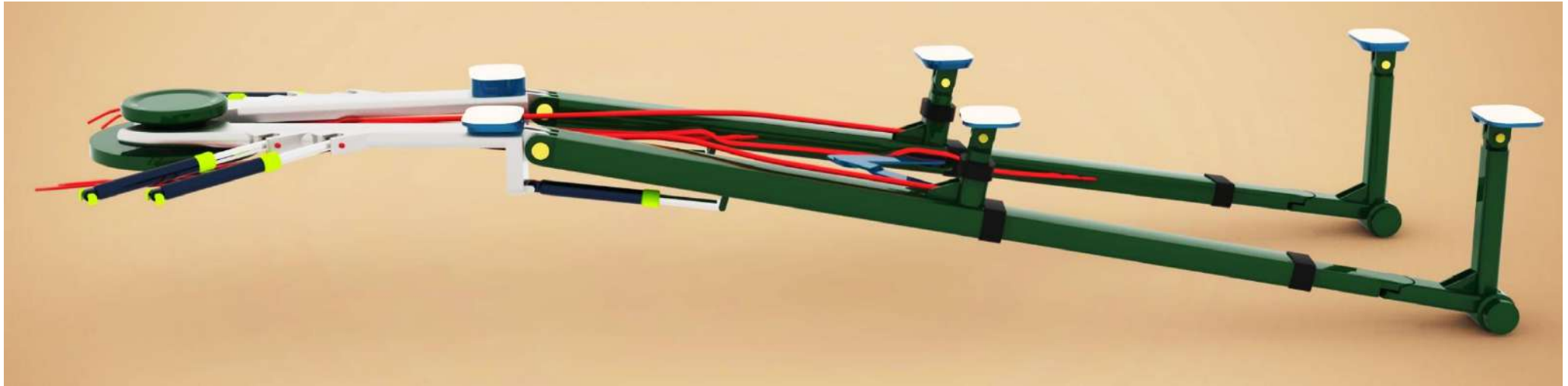
Here the idea is to switch between the manual mode to the automated mode.



The elevation shows the modular setting of the vehicle. Starting from the left is the cabin/ command centre, behind it is the additional battery pack/ rest cabin, at the bottom is the core drive and power system, the black box is the trailer and the below it is the flexible mechanism.

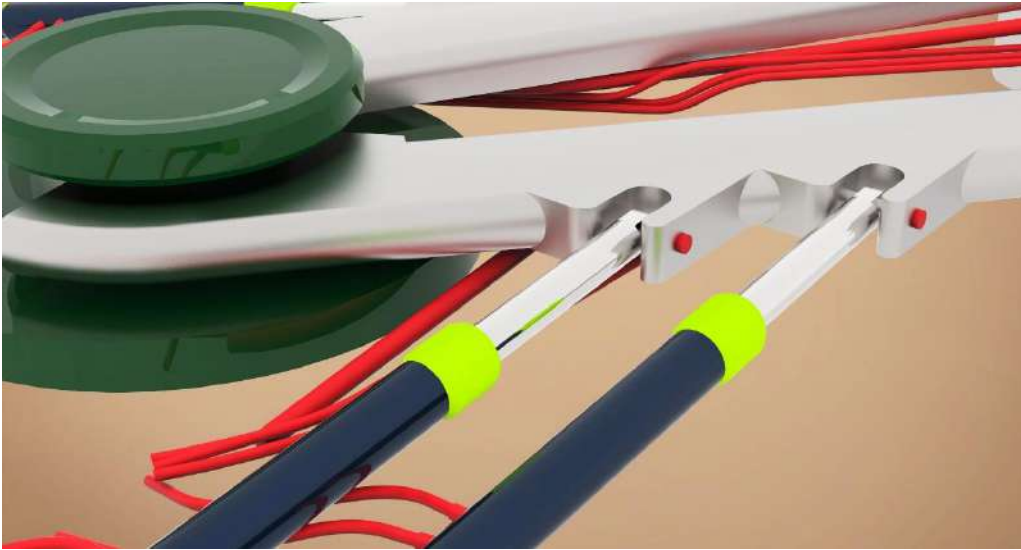


The above render shows the mechanism of the expansion and contraction which is based on the hydraulic system.

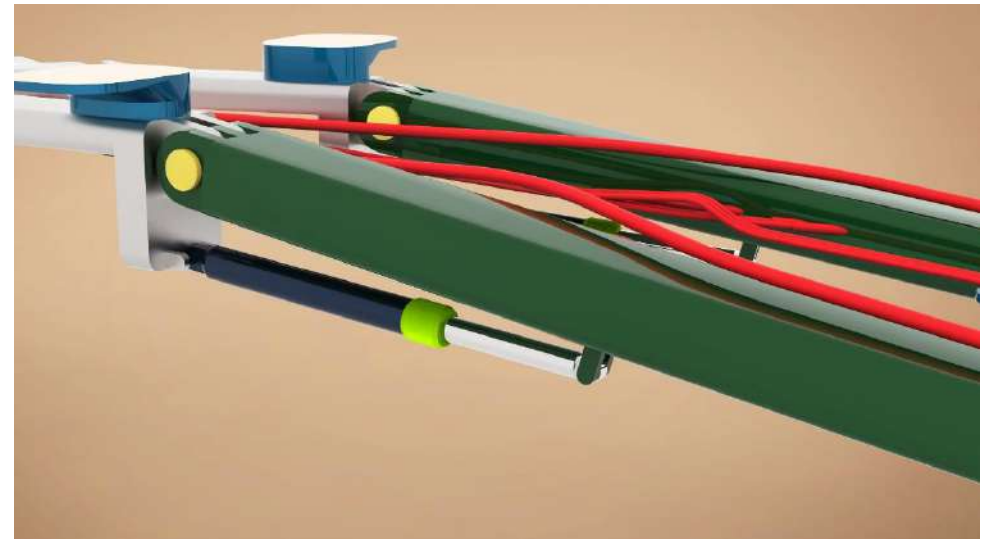
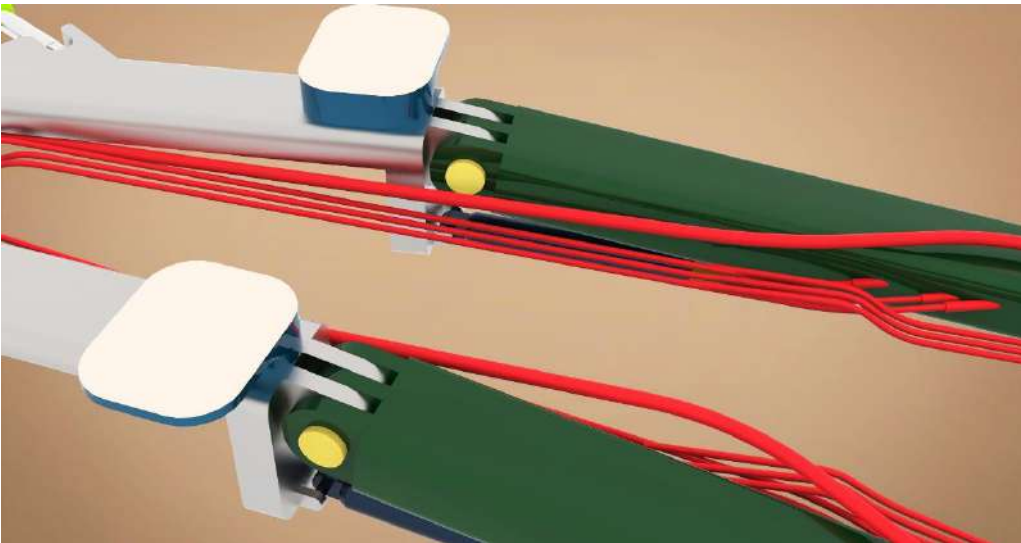


The image on the top shows the full transforming mechanism of the vehicle. Here the green longitudinal part is the hydraulic extension arm that is responsible in increasing or decreasing the overall length of the vehicle.

The image to the left shows the double hydraulic system that is responsible for opening or closing the extending arms. It also shows the central pivot point and the trailer mount.



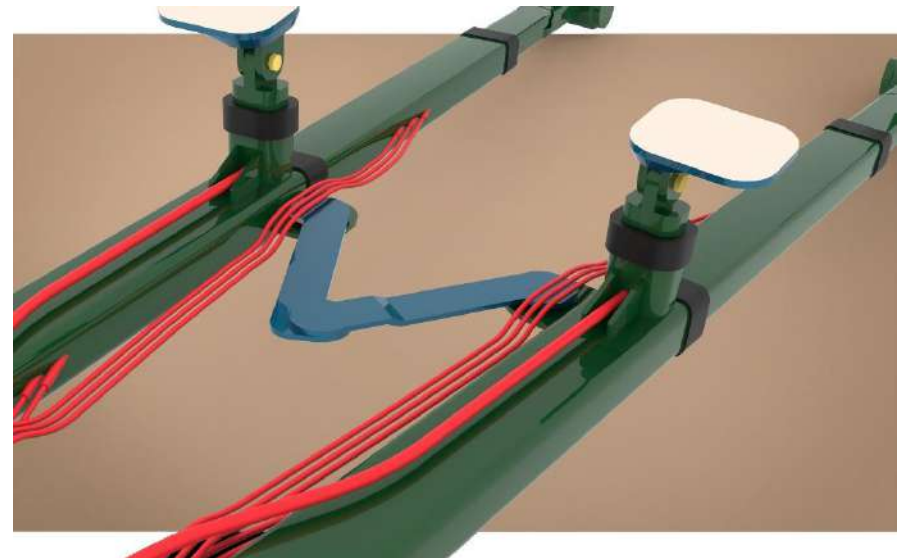
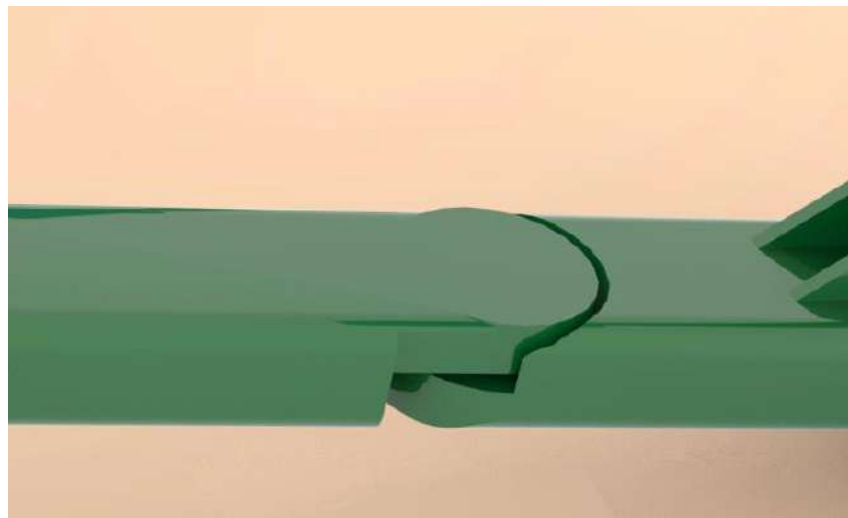
The render on the top left is of the junction points of the hydraulic system. The render at the bottom shows the vertical hinge and the second set of resting pods. It also shows the hydraulic pips in red. The render in the bottom right shows the hydraulic unit that initiates the expansion or contraction.





The image on the top left shows the rear support for the trailer which is transferred directly to the rear set of wheels. The render below shows the pin joint that will allow horizontal rotation of the wheel that might occur due to the central widening and retraction of the extension arms.

The image at the bottom right shows the central connection between the extension arms.



LIST OF IMAGES

1. Warehouse management system -
<https://www.optiproerp.com/what-is-warehouse-management-system/>
2. Robotics and automation platform
<https://discourse.ros.org/t/the-highest-cost-performance-mobile-robotic-platform-for-individual-developers/27198>
3. Integration and Connectivity System
<https://www.cdata.com/>
4. Mobile platform and application
<https://dcs.aero/product/mobile-barcode-scanner-handheld-nautiz-x2/>
5. Fulfillment centre
<https://www.shipbob.com/blog/differences-warehouse-fulfillment-center/>
6. Receiving and inventory management
<https://fulfillmen.com/easy-guide-to-warehouse-receiving/>
7. Storage type
<https://www.efulfillmentservice.com/2017/06/fulfillment-center-defined-pros-vs-cons/>
8. Storage type
<https://blog.unex.com/how-to-setup-micro-fulfillment>
9. Order processing, packaging and labelling
<https://idsfulfillment.com/return-processing>
10. Shipping and carrier management
<https://corlettexpress.com/whats-the-difference-between-freight-management-and-logistics-management/>
11. Technology and automation
<https://insights.samsung.com/2015/09/30/wearable-barcode-scanner-delivers-transportation-efficiency/>
12. Workforce management
<https://www.jll.co.in/en/trends-and-insights/workplace/how-warehouse-design-is-putting-employees-first>
13. Dabbawala
<https://indianexpress.com/article/cities/mumbai/mumbai-daddawalas-survey-8278055/>
14. AmazonGo
<https://www.supermarketnews.com/store-design-construction/amazon-go-goes-smaller>
15. Transporting equipment
<https://www.lencrowforklifts.com.au/news/different-types-of-material-handling-equipment-used-in-warehouse/>

22. FEEDBACK

During the final jury following was some of the feedback that I received,

1. Removing the concept of fulfillment centre is not possible because it is a point of revenue generation for the brand.
2. Most of the research is focused on the internal operations of a fulfillment centre, so the final outcome should have been about a vehicle that operates internally.
3. The justification for a variable platform vehicle is not valid.
4. Lack of focus as I have tried to address multiple areas
5. The concept ideations do not match the research

23. SYSTEM DESIGN

23.1 Existing system

The flow diagram shows the existing set of operations involved in the fulfilment of an order.



When a customer places an order a pick task is generated by the centralized Warehouse Management System, and a picker is assigned. The picker then stows an empty manual cart to collect all the products as per the order. The list of products is displayed on their handheld device which is also a barcode scanner.

The picker then collects all the products as per order in a tub and takes them to the parking area. She/he collects multiple products for different orders.

Then the products are brought to the packing station where a different person scans and puts the products in boxes of different sizes. She/he then seals the pack.

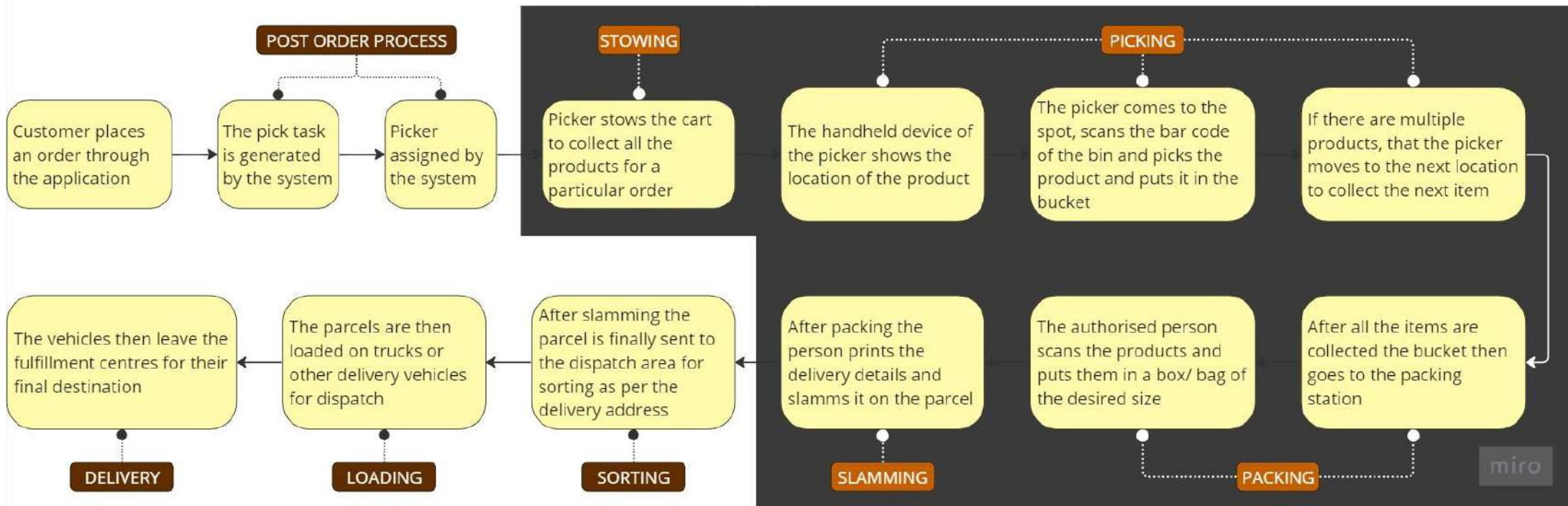
The next station where this parcel goes is to the slamming station, here the printed order details with the delivery address

are put on the box. It is then scanned and sent to the sorting station.

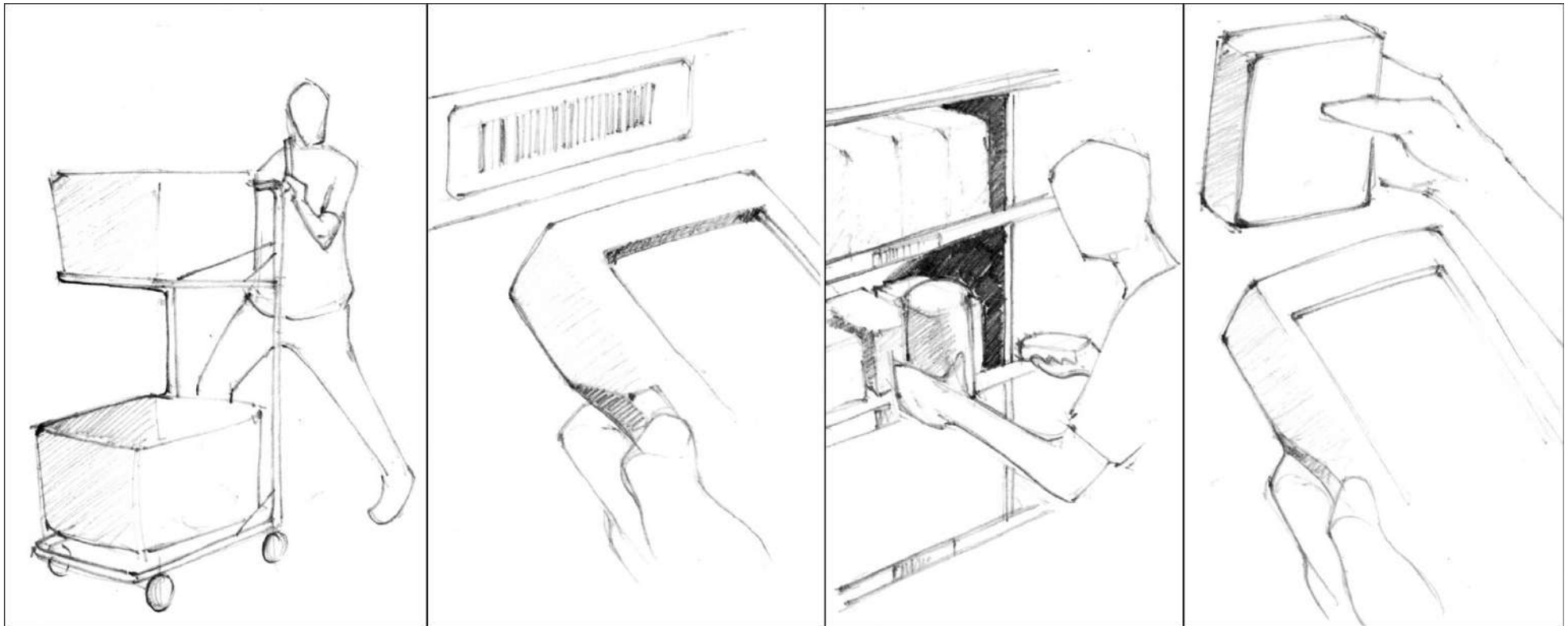
Here the boxes are sorted and arranged according to the delivery address. They are then arranged and loaded on trucks or other delivery vehicles for dispatch, which then go to the respective addresses of the customer.

This diagram shows the actions taken by the authorised person in every step to accomplish the operations.

The idea is to create a new system by clubbing operations and reducing steps. The portion of the flow chart highlighted in dark grey are the steps that can be merged or removed to save time of operation and design a new system.

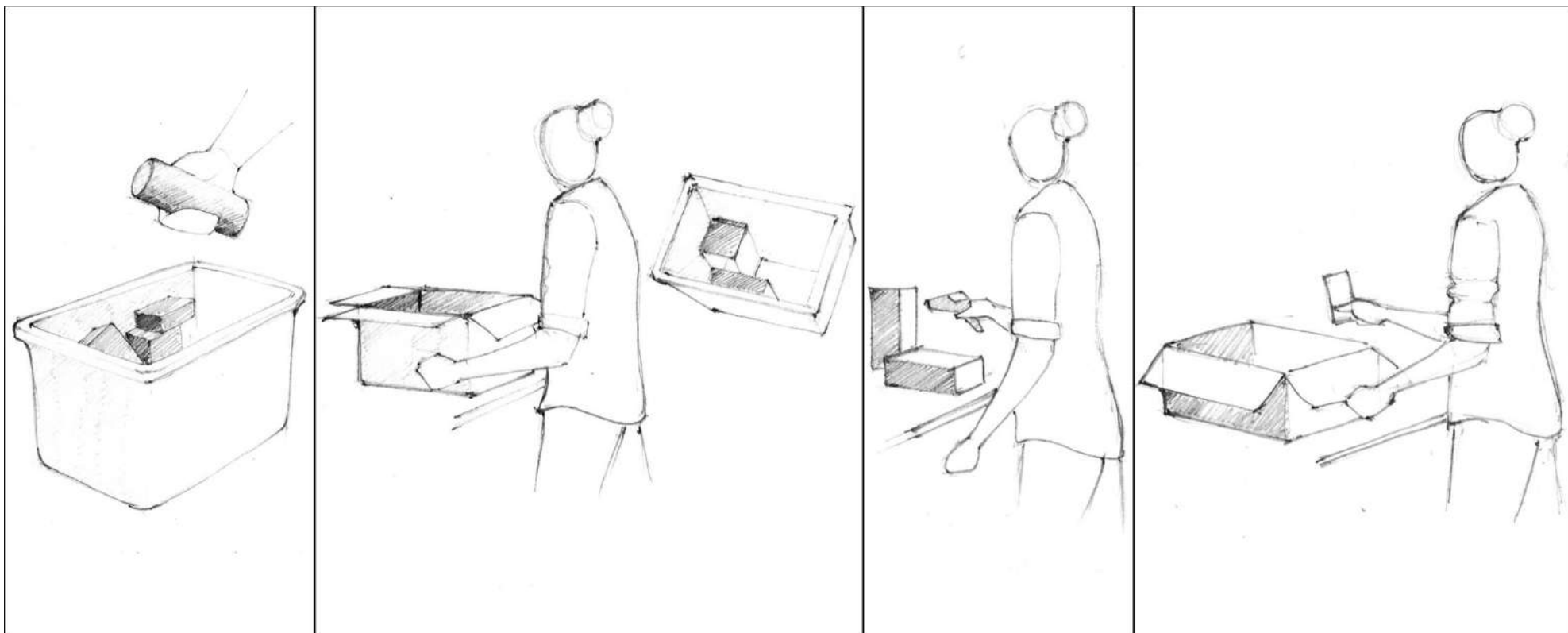


23.2 Actions



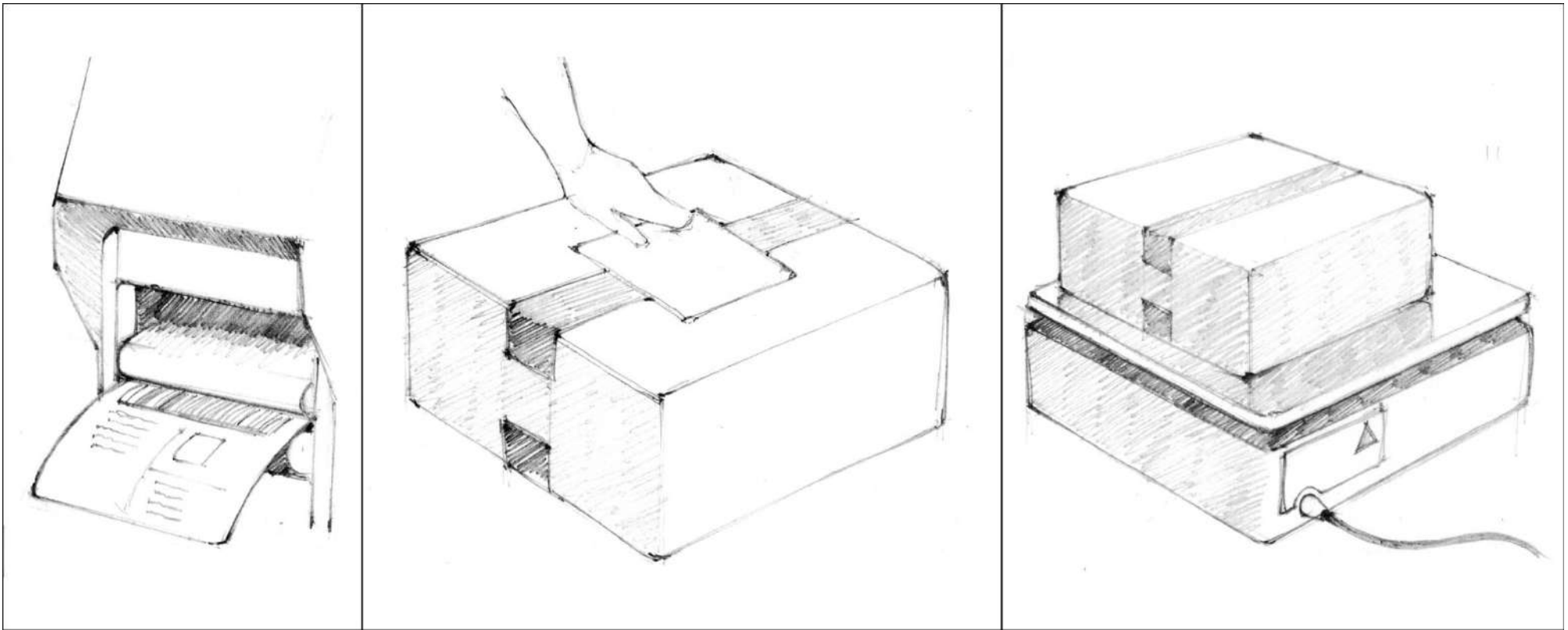
1. The picker is stowing the cart in the storage area to collect the products as per order.
2. Then he scans the bar code in the rack
3. Then he picks the product from the rack/ bin
4. After that he scans the barcode of the product

Note: The points from 1 – 4 are as per the steps of operation as shown in the sketches



5. After scanning the products, the picker collects them in a plastic tub
6. Then she/ he takes them to the packing station where another authorised person prepares the carton to pack the ordered items.
7. Here she scans each product and simultaneously keeps them inside the box and seals it with tape.

Note: The points from 5 – 7 are as per the steps of operation as shown in the sketches

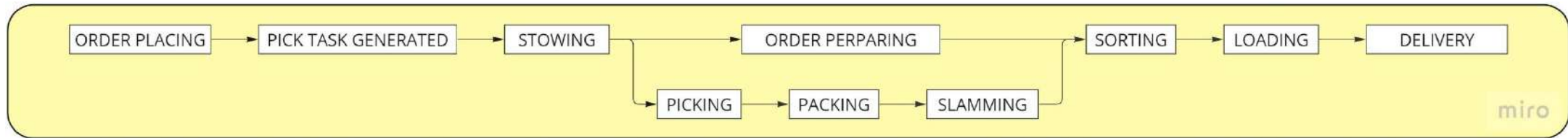


8. After packing the products in the carton, it is sealed with paper tape
9. Then the person prints the delivery details and slams it on the package
10. Then the parcel is weighed and sent for sorting and dispatch

Note: The points from 8 – 10 are as per the steps of operation as shown in the sketches

23.3 Proposed system

The flow diagram shows the existing set of operations involved in the fulfilment of an order.

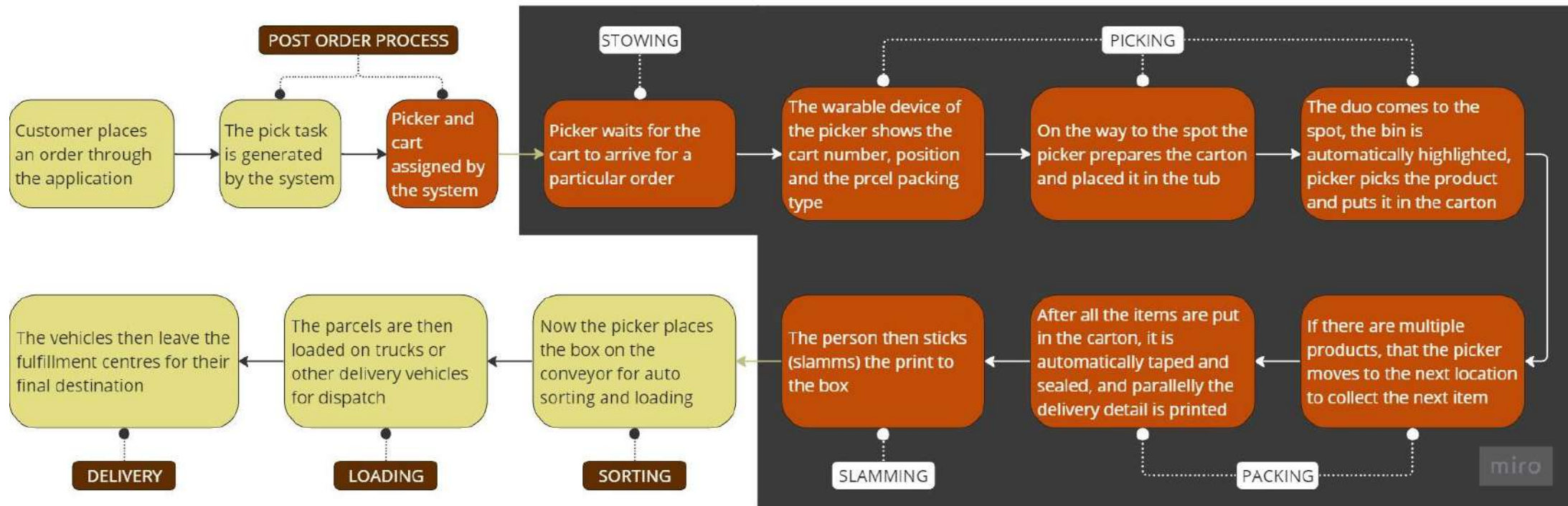


The idea here is to come up with a system which has the same operations but some of the operations are clubbed together in a single step.

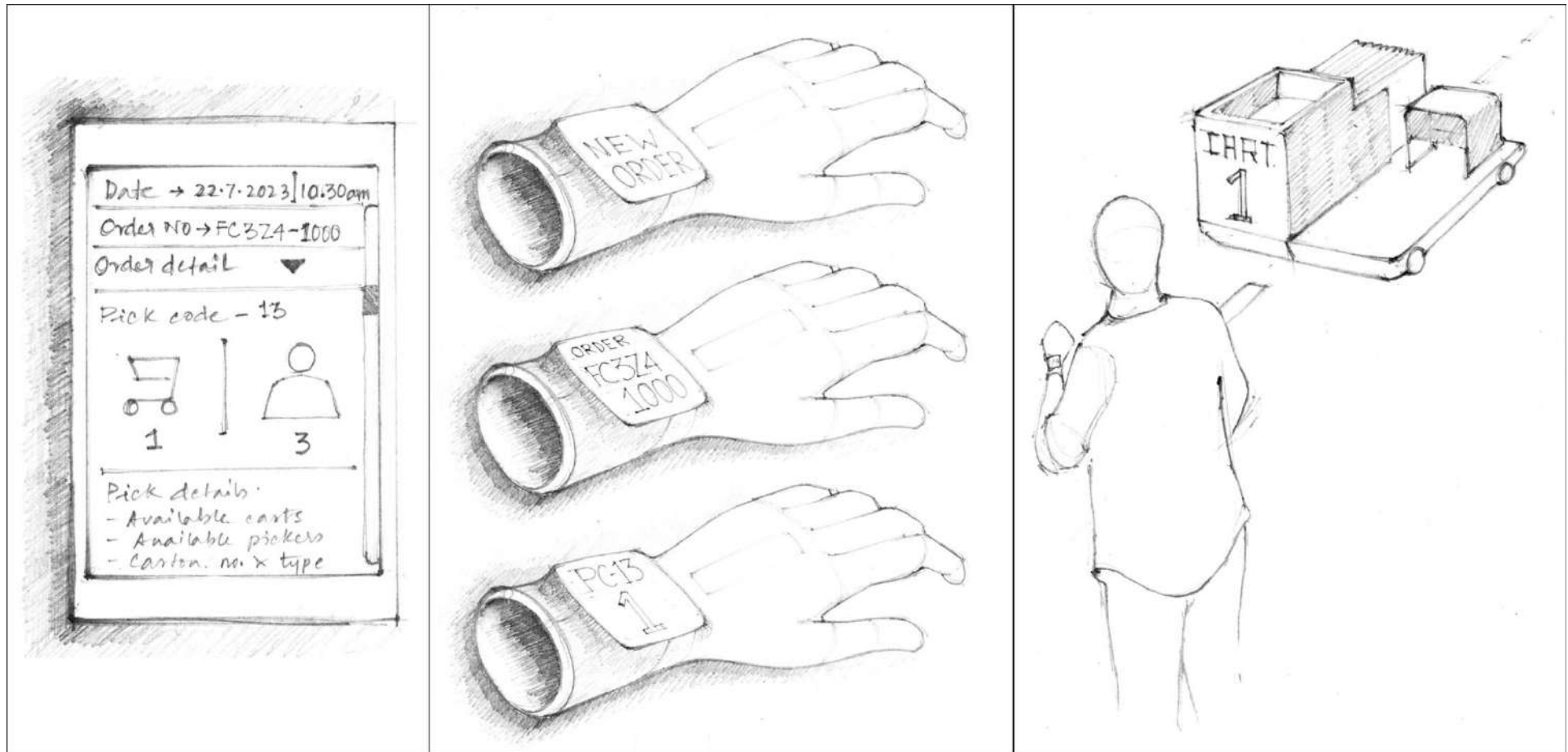
1. This should reduce the time of performing the individual operation.
2. Time-saving should happen because the package is not being transported to different stations, which needs time
3. Reduce the number of different persons performing the operations.

This diagram shows the actions taken by the authorised person in every step to accomplish the operations.

The portion of the flow chart highlighted in dark grey and the steps in red have been changed according to the new system. But the major steps are the same.

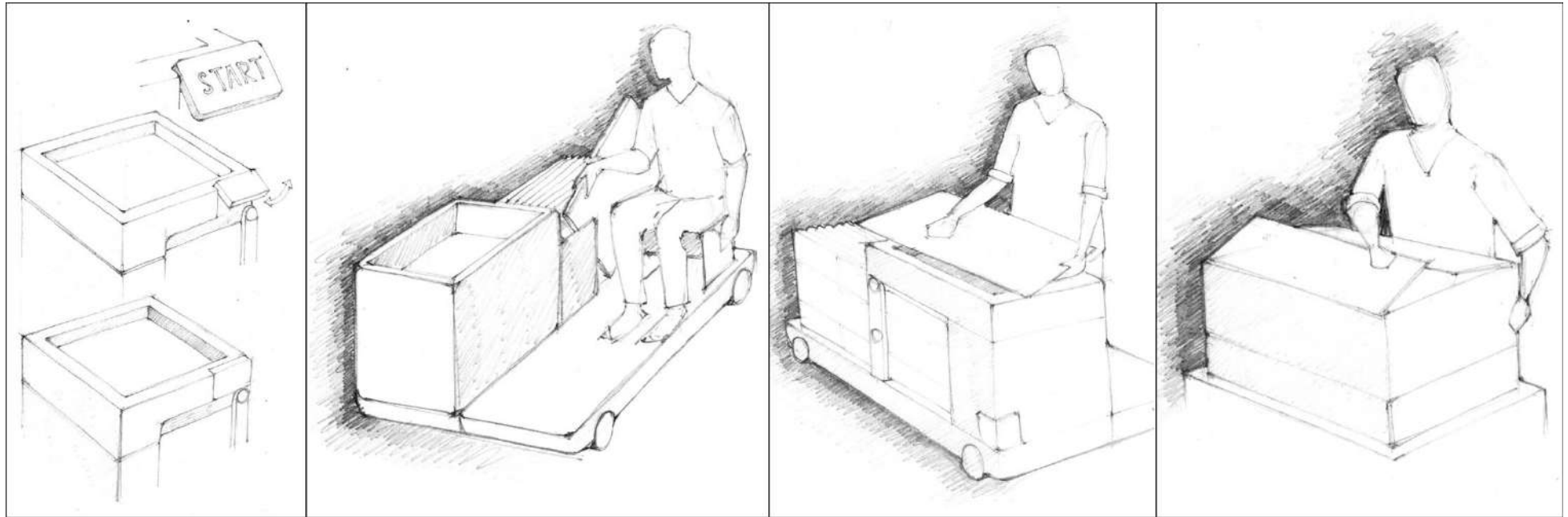


23.4 Actions



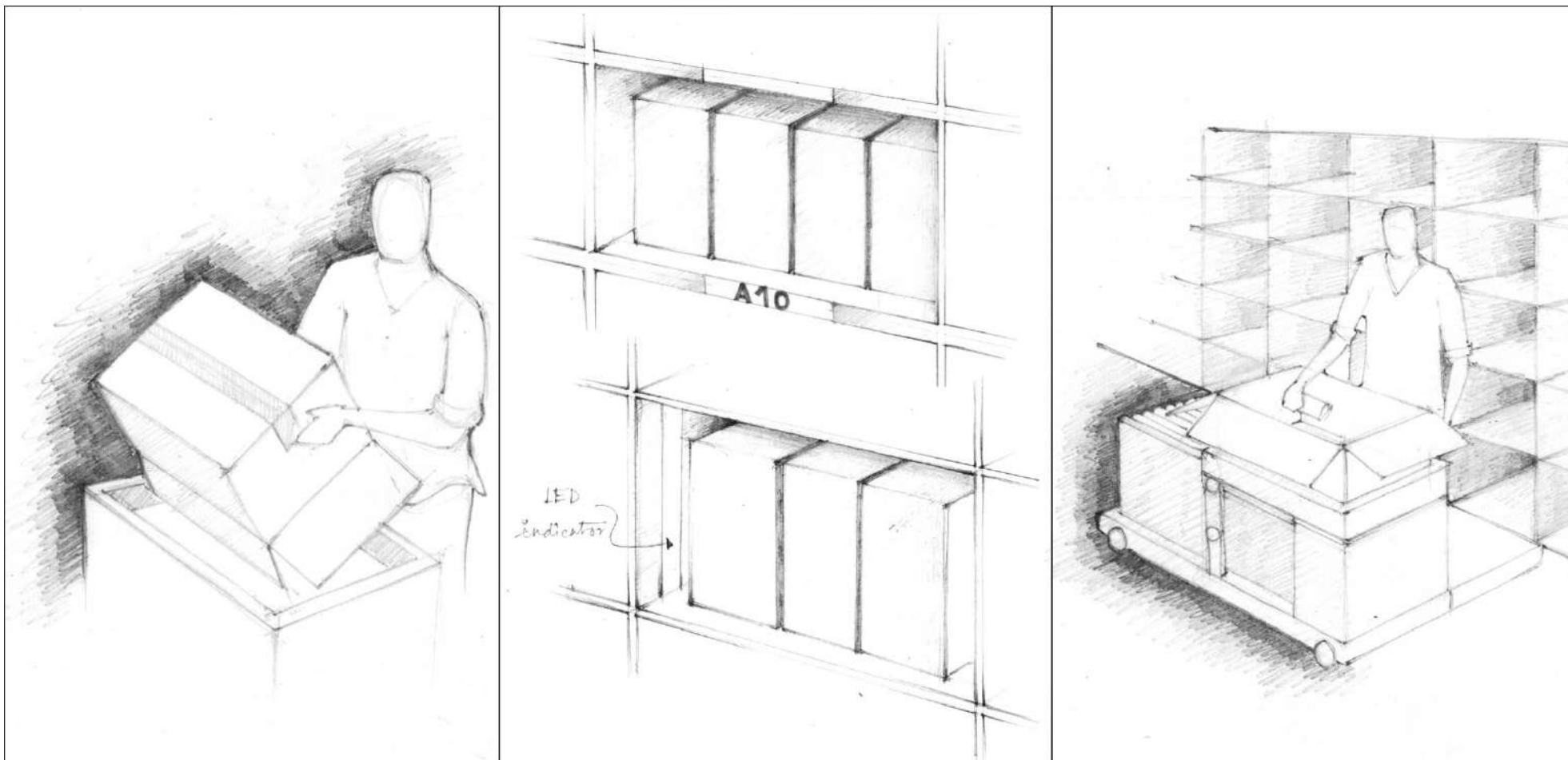
1. The system assigns a cart and a picker for a particular order after the picker logs in
2. The update goes to the wearable device of the picker.
3. The picker waits for the cart to arrive to her/ him

Note: The points from 1 – 3 are as per the steps of operation as shown in the sketches



4. After the cart arrives near the picker, she/ he boards it, then presses the 'START' icon on the touchscreen
5. Then the duo moves towards the first product to pick from the storage area, the cart is auto-guided by the navigation system
6. While on the way, he pulls out an unfolded carton from the stack
7. He then starts folding the carton and preparing it for packing the products

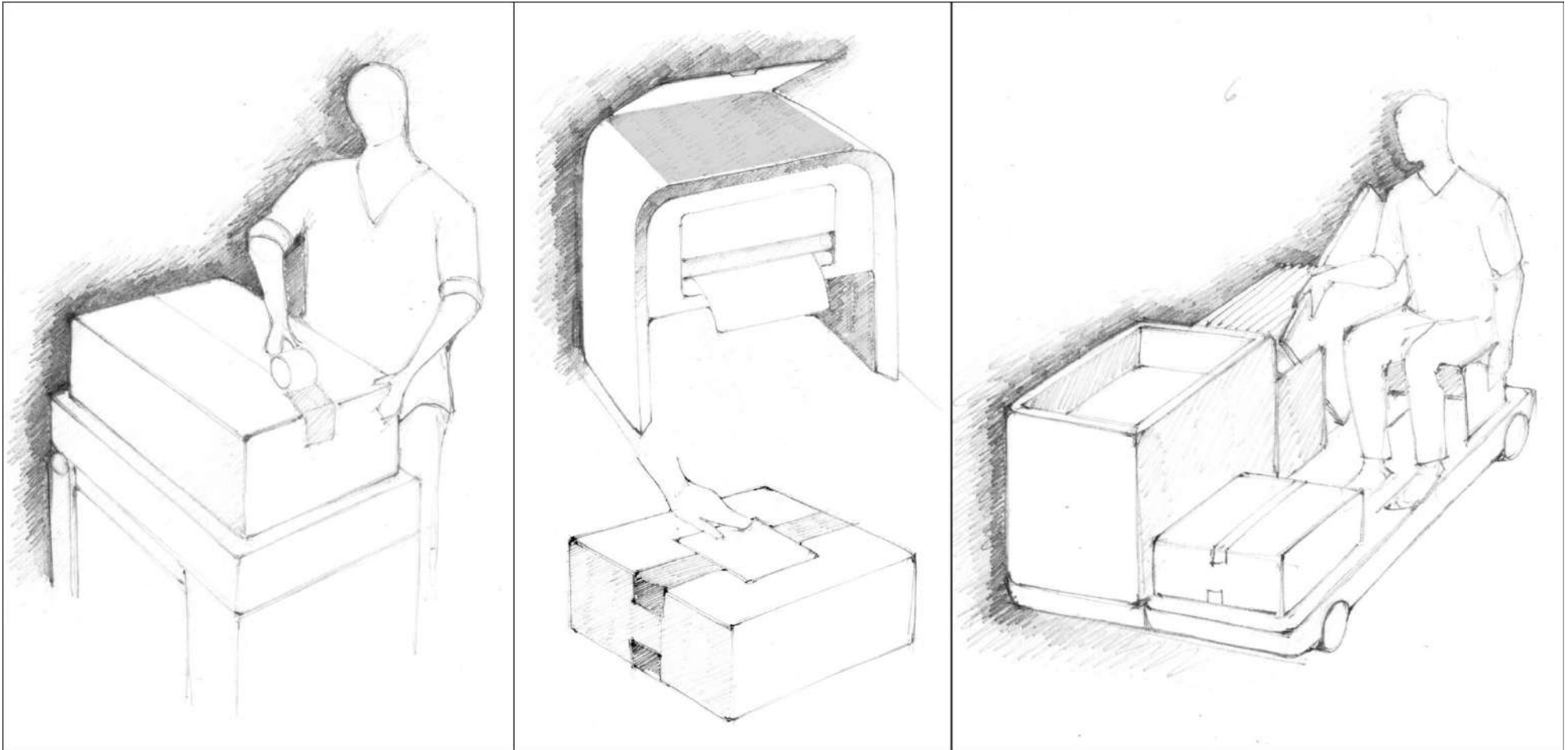
Note: The points from 1 – 4 are as per the steps of operation as shown in the sketches



8. After folding the carton, he manually tapes one end of it and puts it on the weighing machine
9. Then the cart arrives at the spot where the desired rack is either highlighted by a glowing LED or there is a rack

number displayed on the screen which he matches and picks the products

Note: The points from 1 – 3 are as per the steps of operation as shown in the sketches

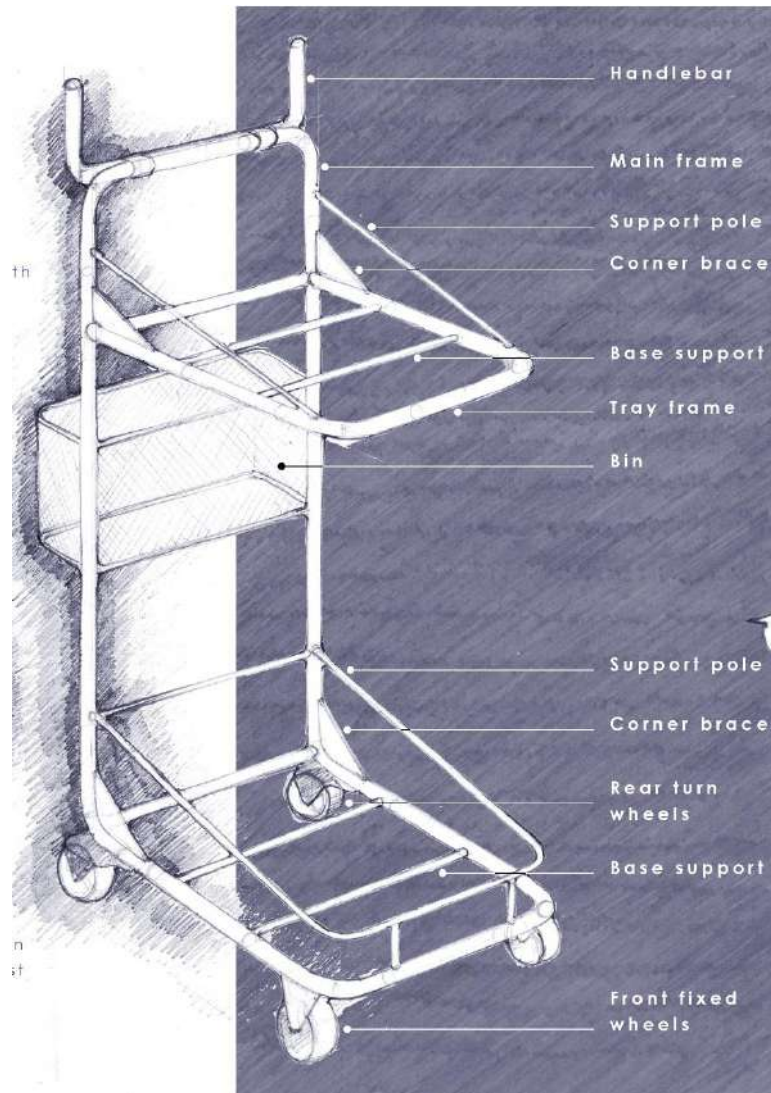


10. After all the products are picked and put in the carton, he then tapes it and slams the printed delivery detail
11. Then he puts the parcel aside on the cart and starts with the next order

Note: The points from 1 – 3 are as per the steps of operation as shown in the sketches

24. MOBILITY SOLUTION

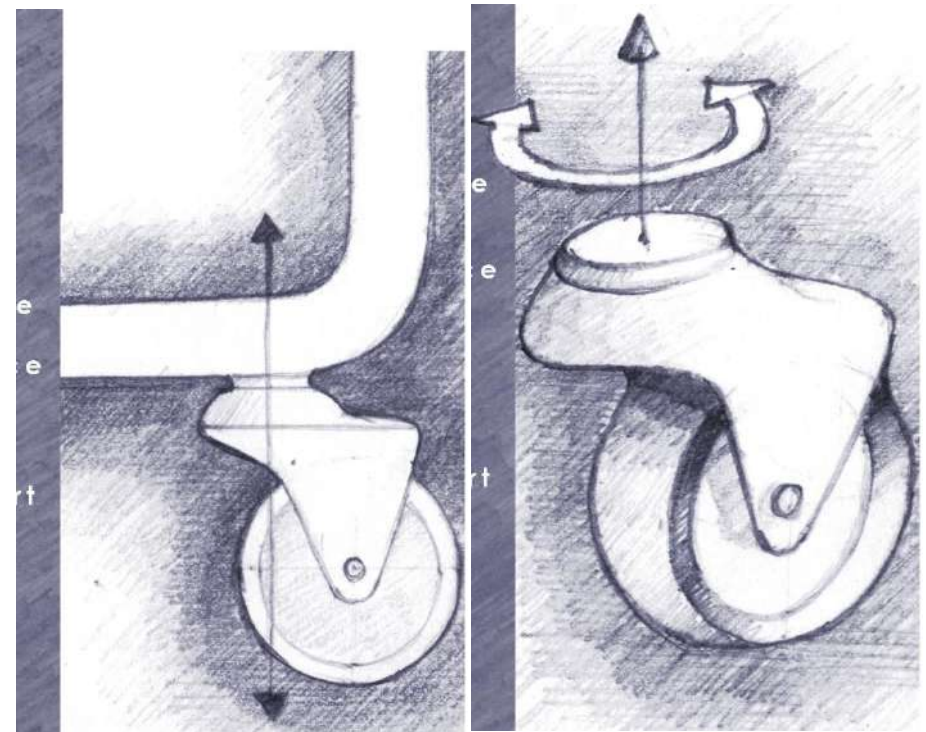
24.1 Product study

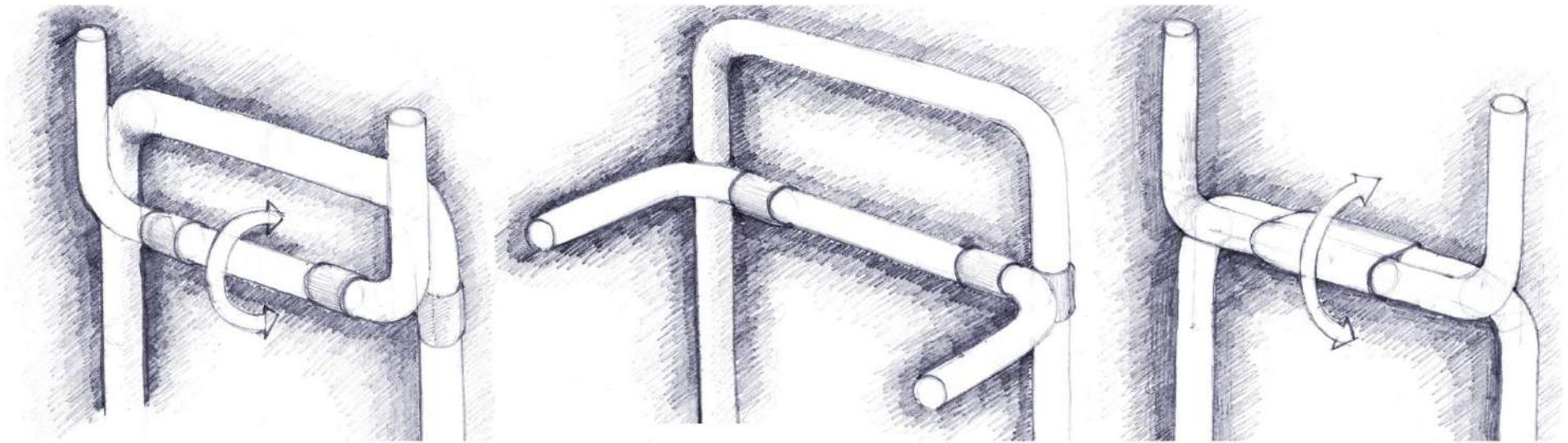


The adjoining sketch shows the various parts of a manually operated trolley that is human-powered. The cart is made of stainless steel.

The rear wheels of it are pivoted to the frame so that it rotates freely. This feature also can be difficult sometimes. Specifically, when the trolley is loaded, it is difficult to manoeuvre because the maximum load is directly on the rear wheels.

The front wheels on the other hand are fixed, they can only roll and not rotate on an axis.

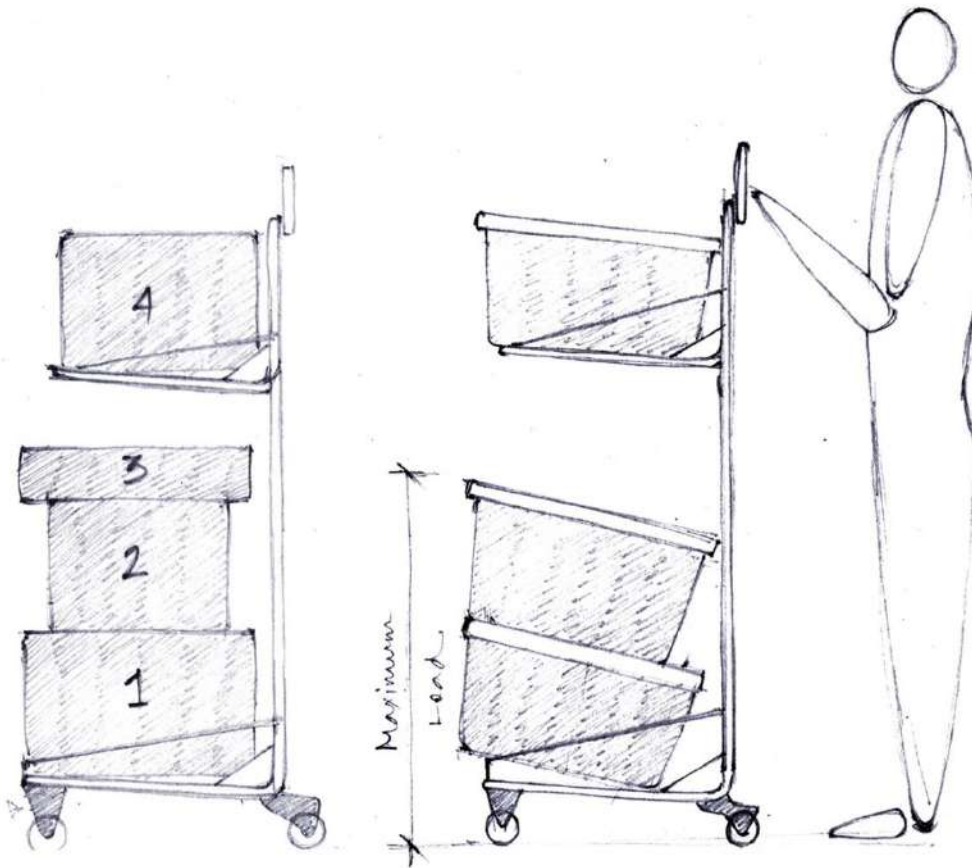




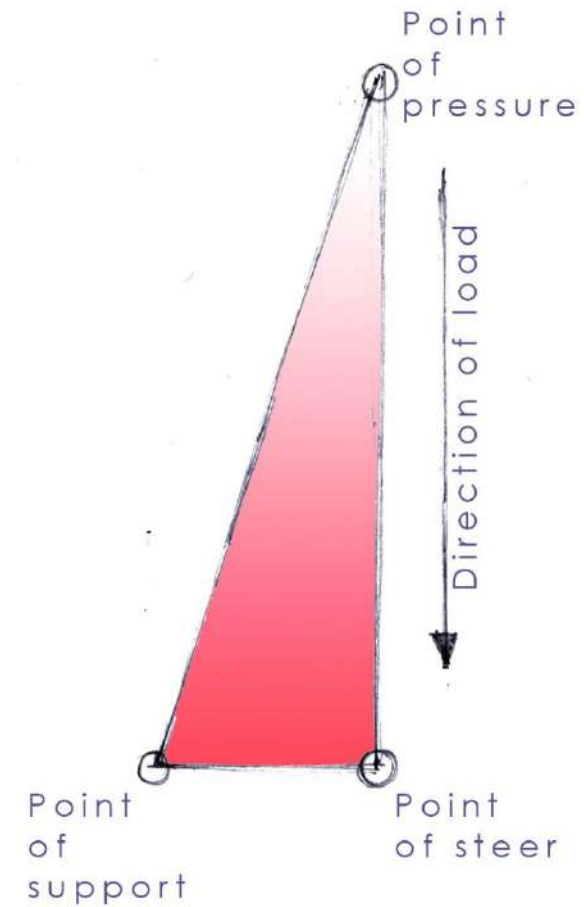
The adjoining sketch shows the handlebar of the trolley and how is it attached to the main body. The handlebar can be rotated depending on the need and requirements of the picker.

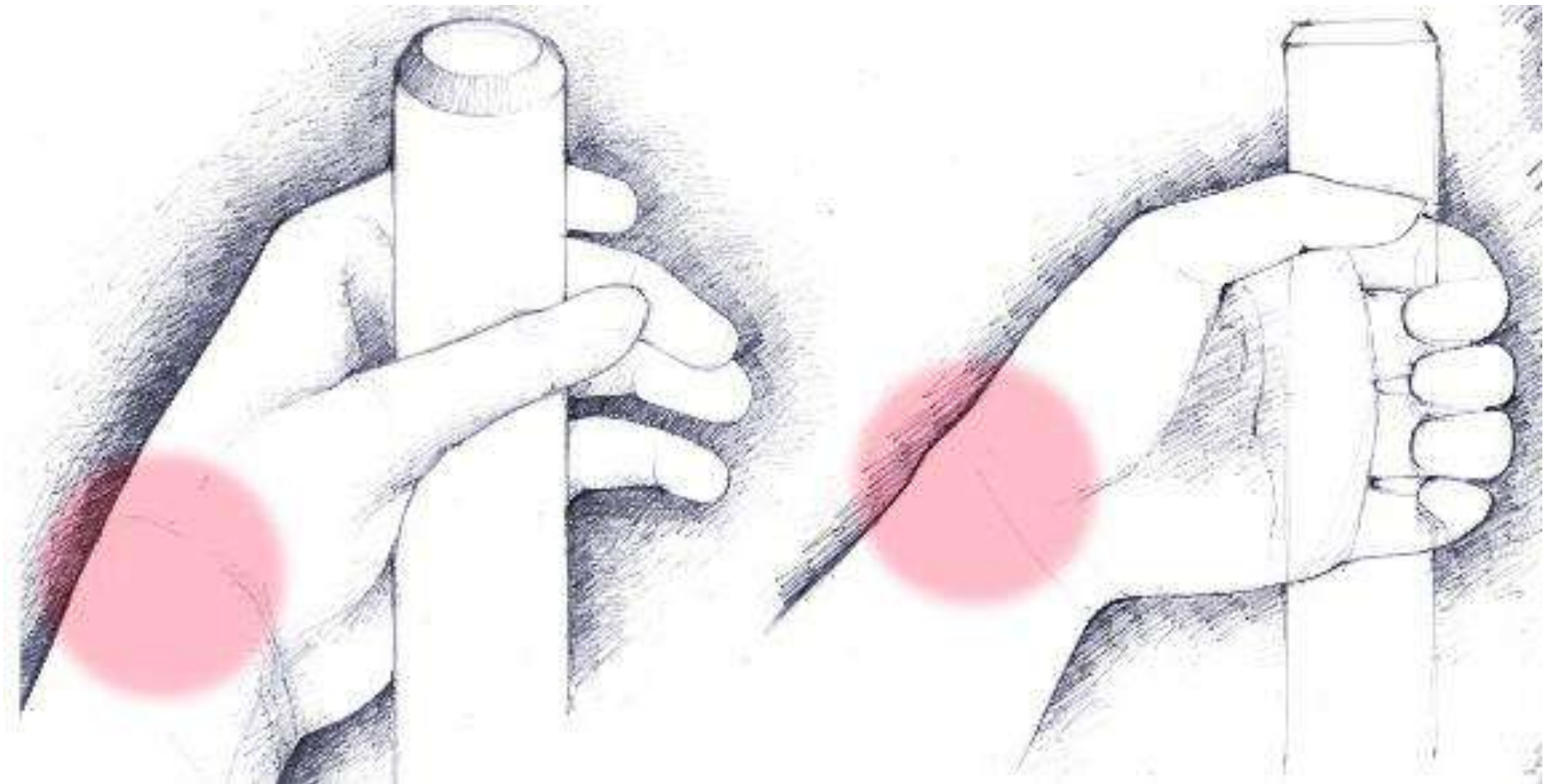
24.2 Load study

of manoeuvre and the point of pressure/ control falls on the same axis.



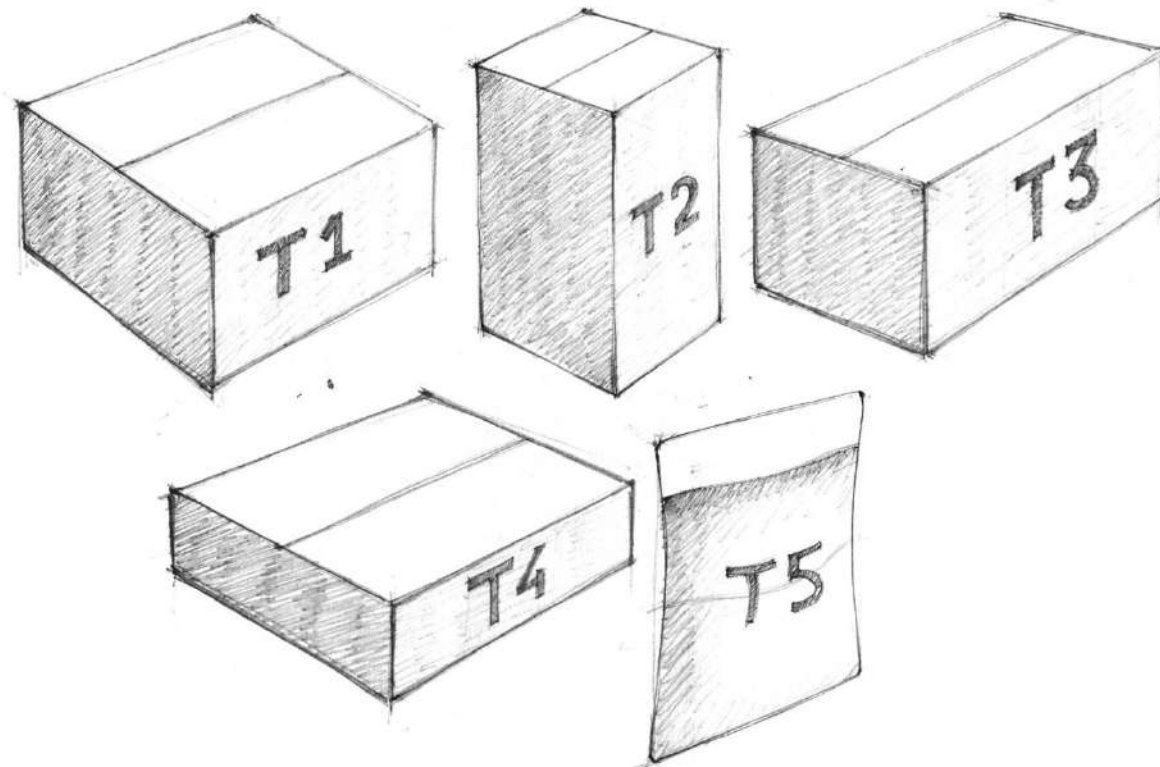
In the above sketches, it can be seen that the load is towards the bottom of the trolley and the person has to push it at the topmost portion of the trolley. This is difficult because the point





The above sketches show the portion of the hand (wrist) that will be affected over prolonged use of such a loaded trolley because the wrist is pushing an uncomfortable amount of load at an improper angle.

24.3 The volume of the package



The volume of the different packages will be different and so will the box sizes. This challenge can be tackled by simply assigning every picker a range of volumes of the parcel and a specific bot.

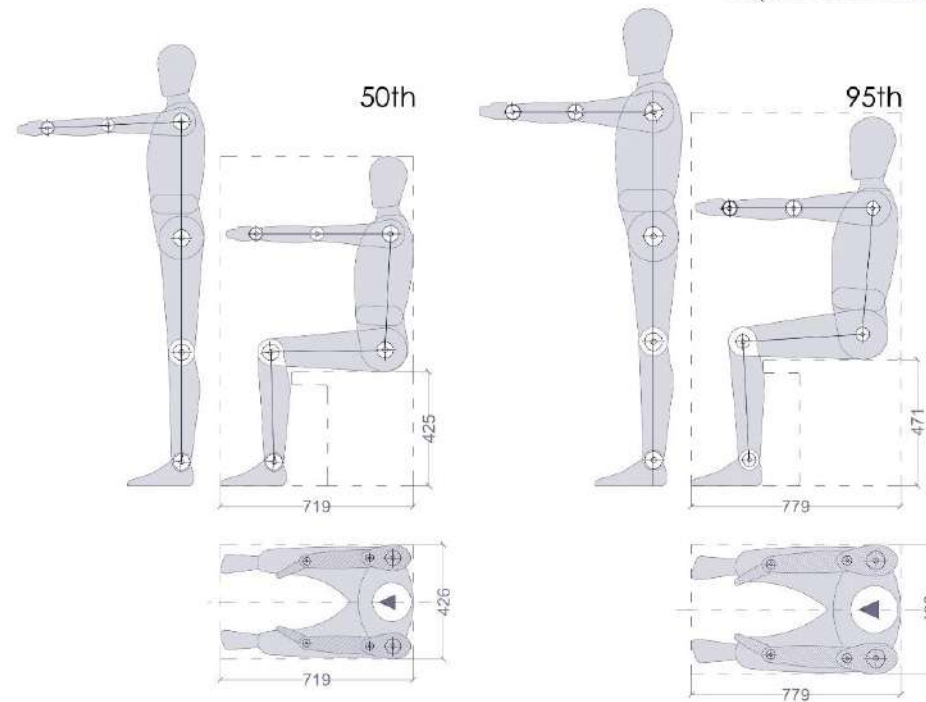
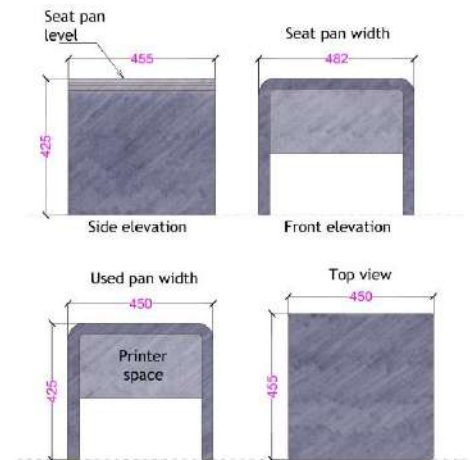
24.4 Anthropometric study

The anthropometric data were used to design the stool for the picker, the stool also has an integrated printer for printing the delivery details of the customer

INDIAN Anthropometric Dimensions

Debkumar Chakrabarti

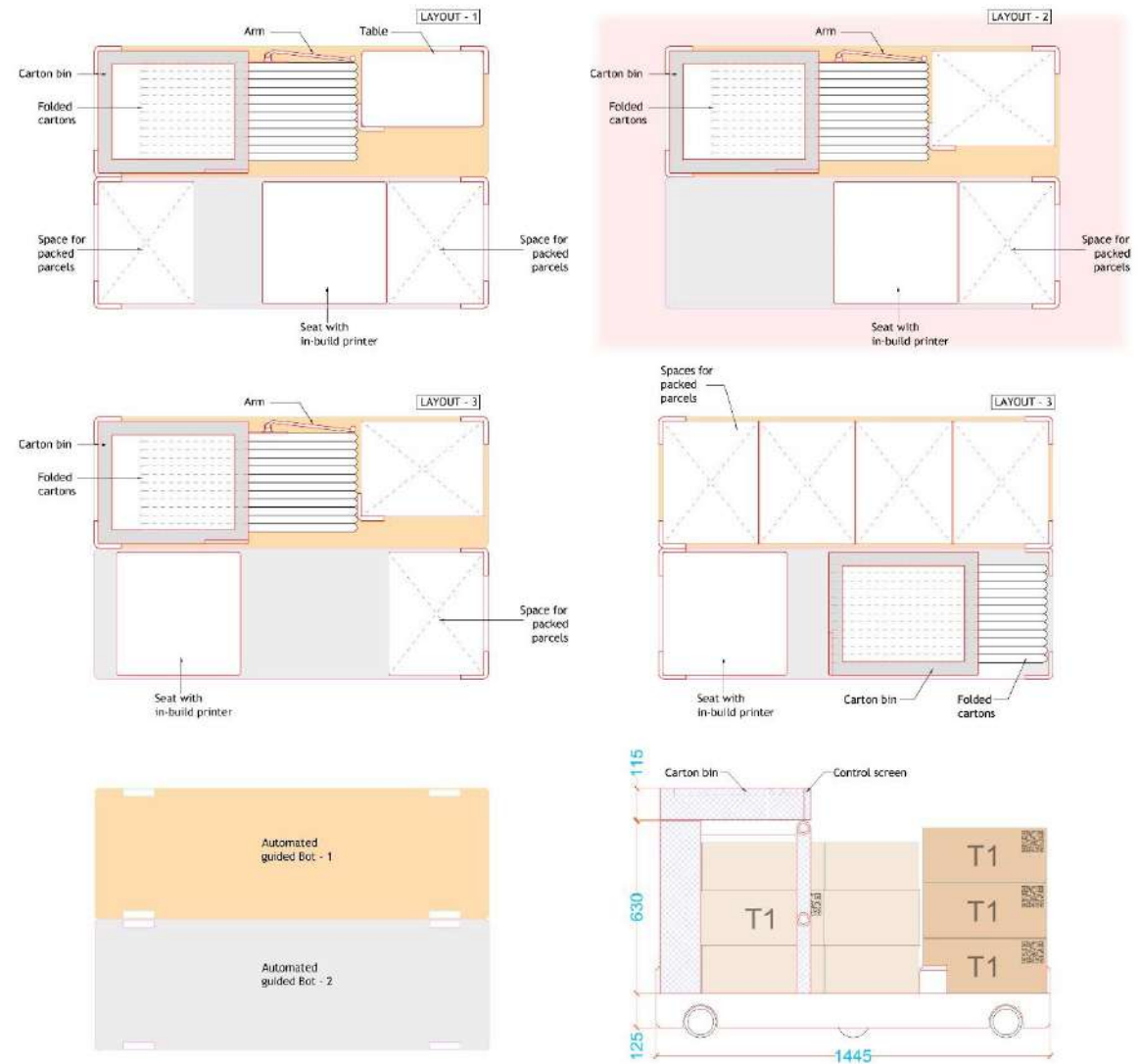
MEASUREMENTS	PERCENTILE		REMARKS		TYPE	
	50th	95th	FROM	TO		
SEAT DIMENSION (PAN & SEAT HEIGHT)						
1	Total height	1648mm	1781mm	Floor	Top of head	Height
2	Erect sitting	837mm	905mm	Seat pan	Top of head	Height
3	Knee level	519mm	567mm	Floor level	Top of knee	Height
4	Elbow to elbow closed	409mm	489mm	One side	Other side	Width
5	Hip (width)	331mm	405mm			
6	Buttock to popliteal	455mm	512mm	Buttock	Popliteal	Depth
8	Popliteal height	425mm	471mm	Floor level	Popliteal	Height
9	Buttock to front foot	719mm	779mm	Back	Front foot	Depth
10						



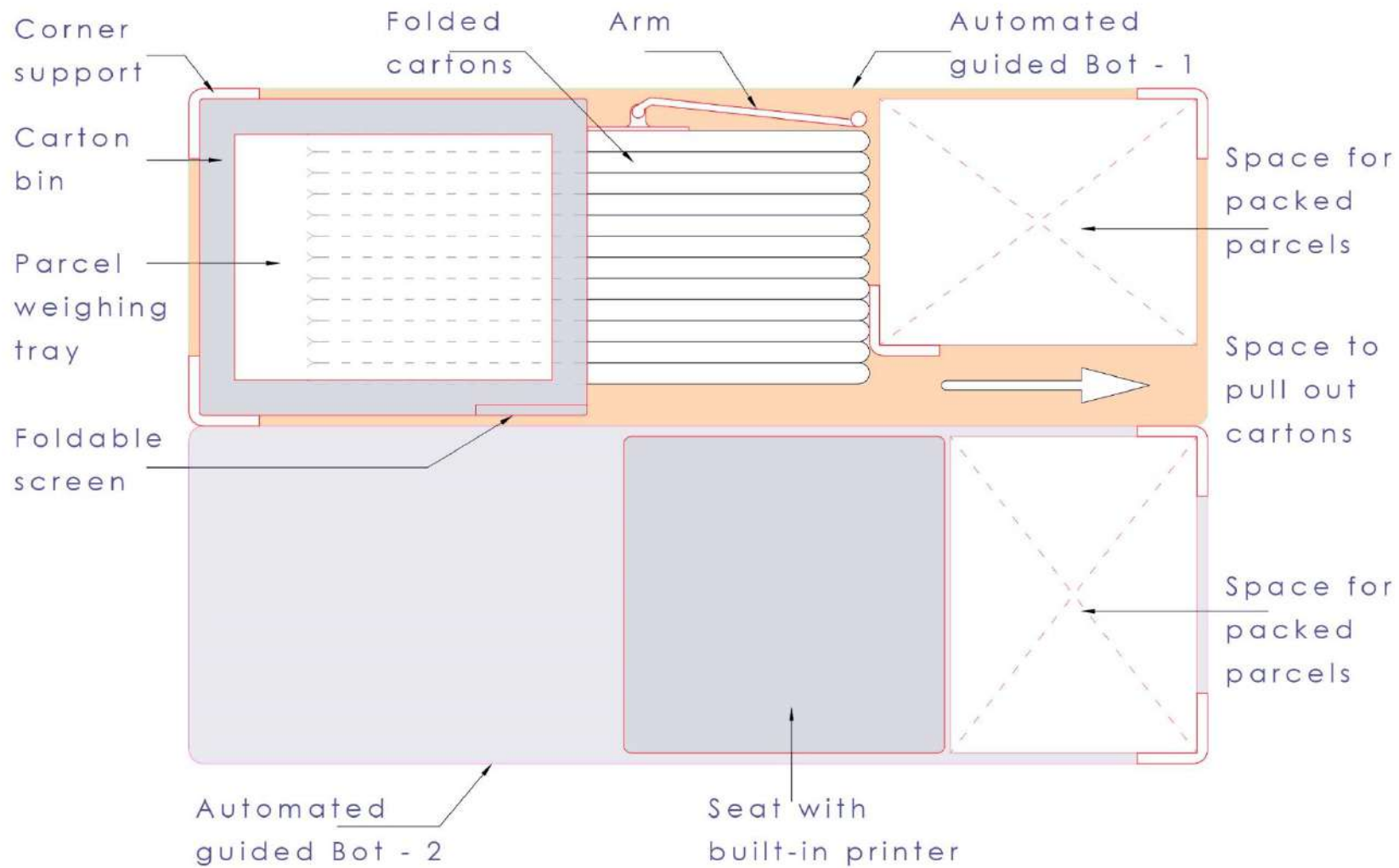
The anthropometric data was used to determine the size of the stool that also houses the printer

24.5 Layout study

I tried to explore the adjacent layouts based on the requirements.

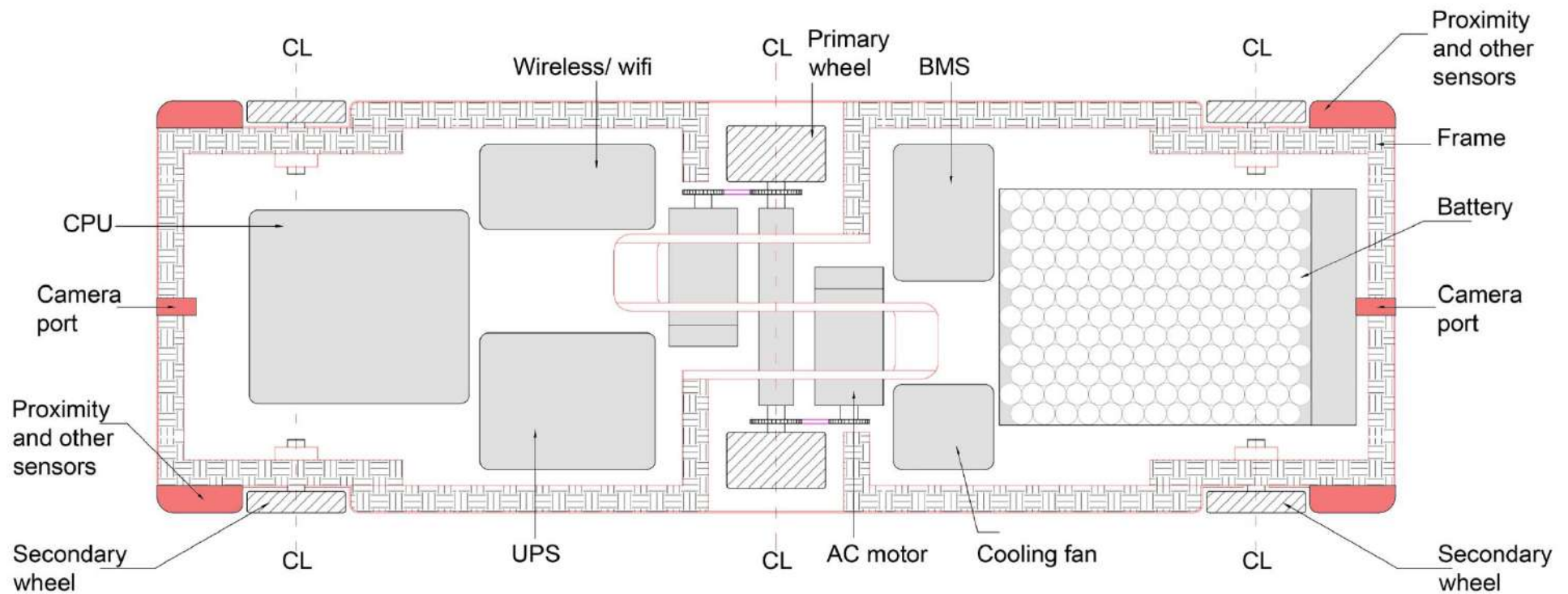


24.6 Functional layout

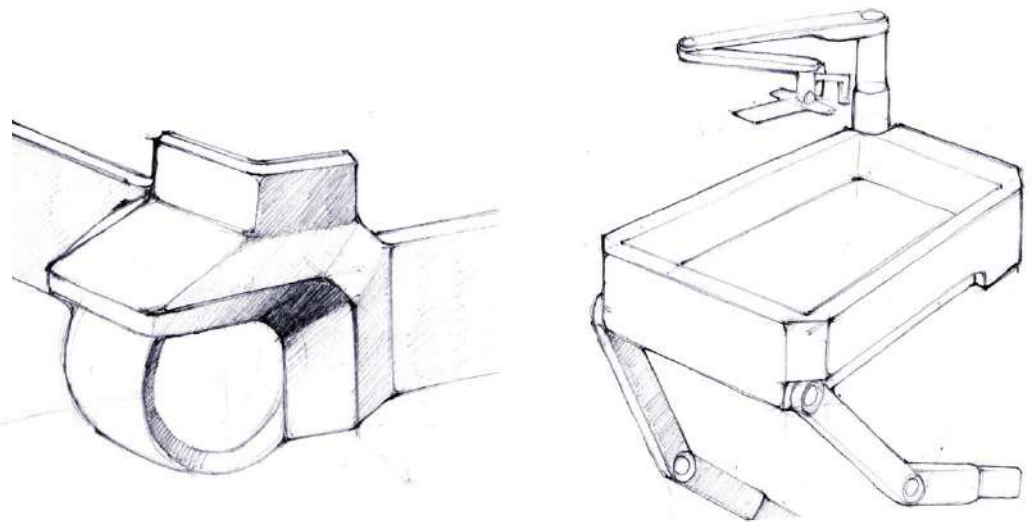
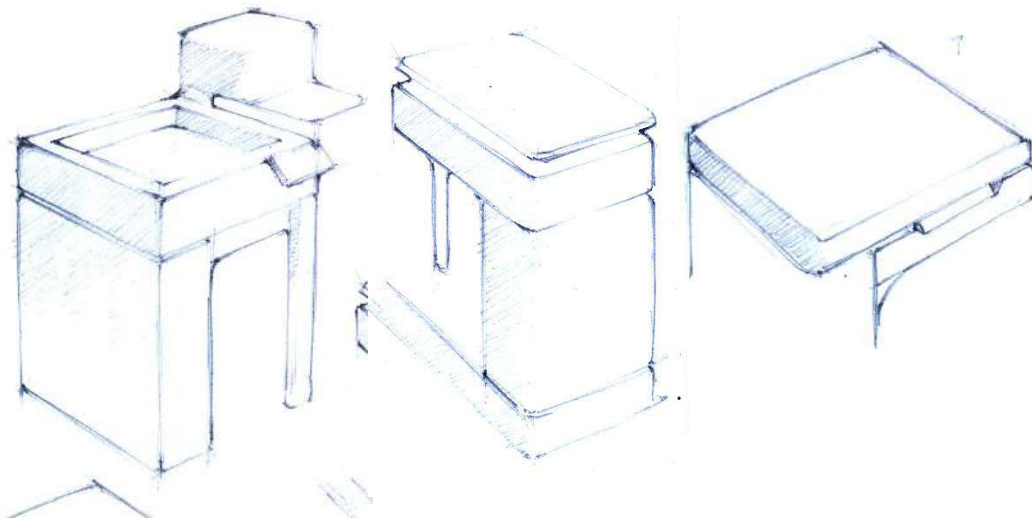
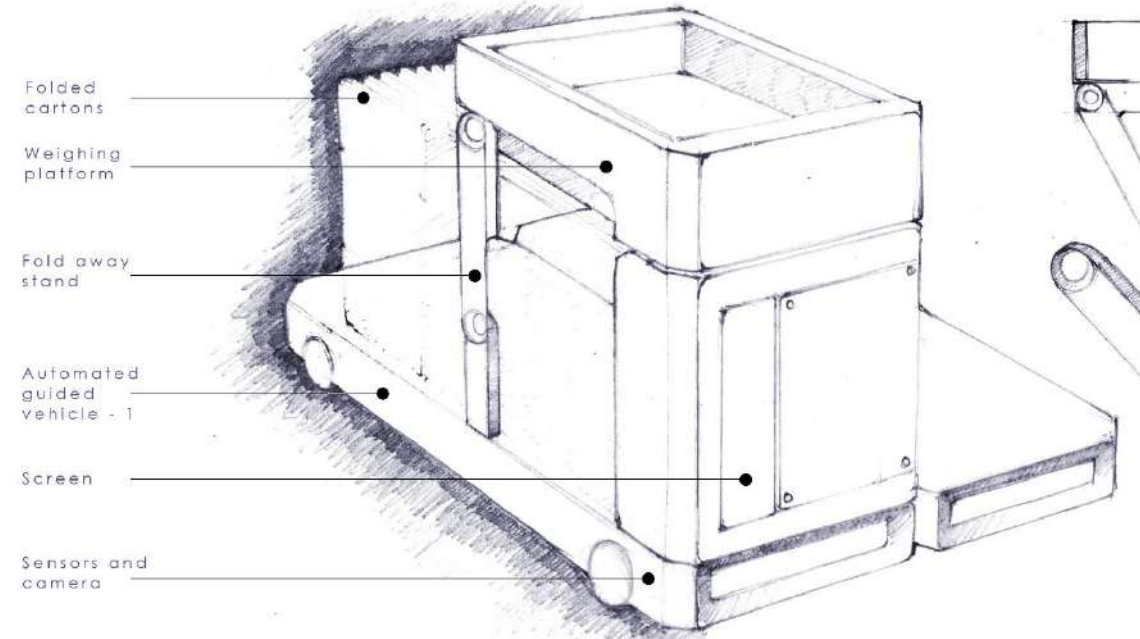
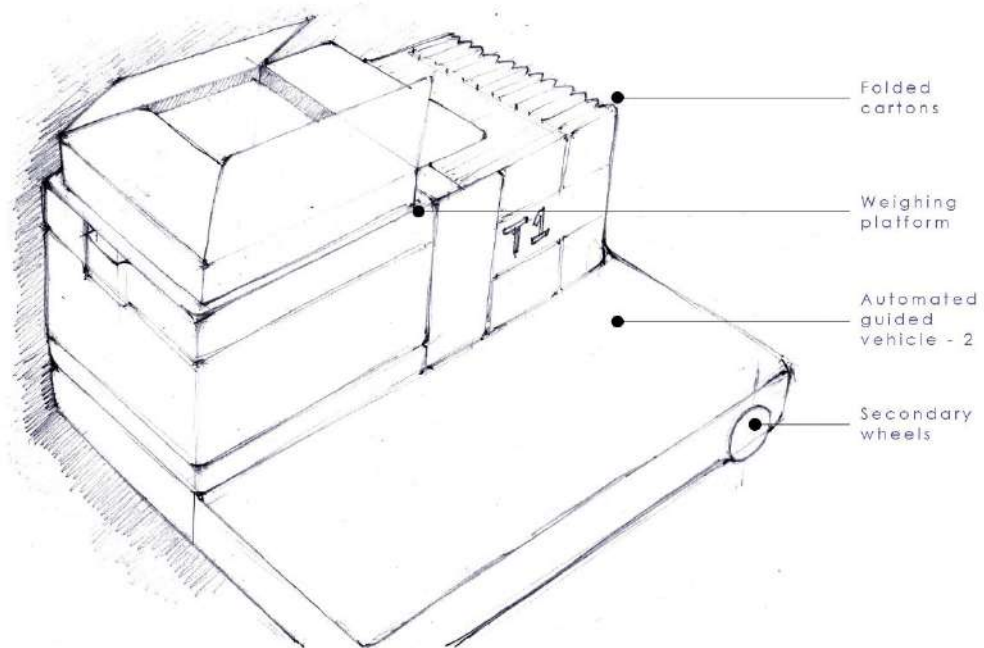


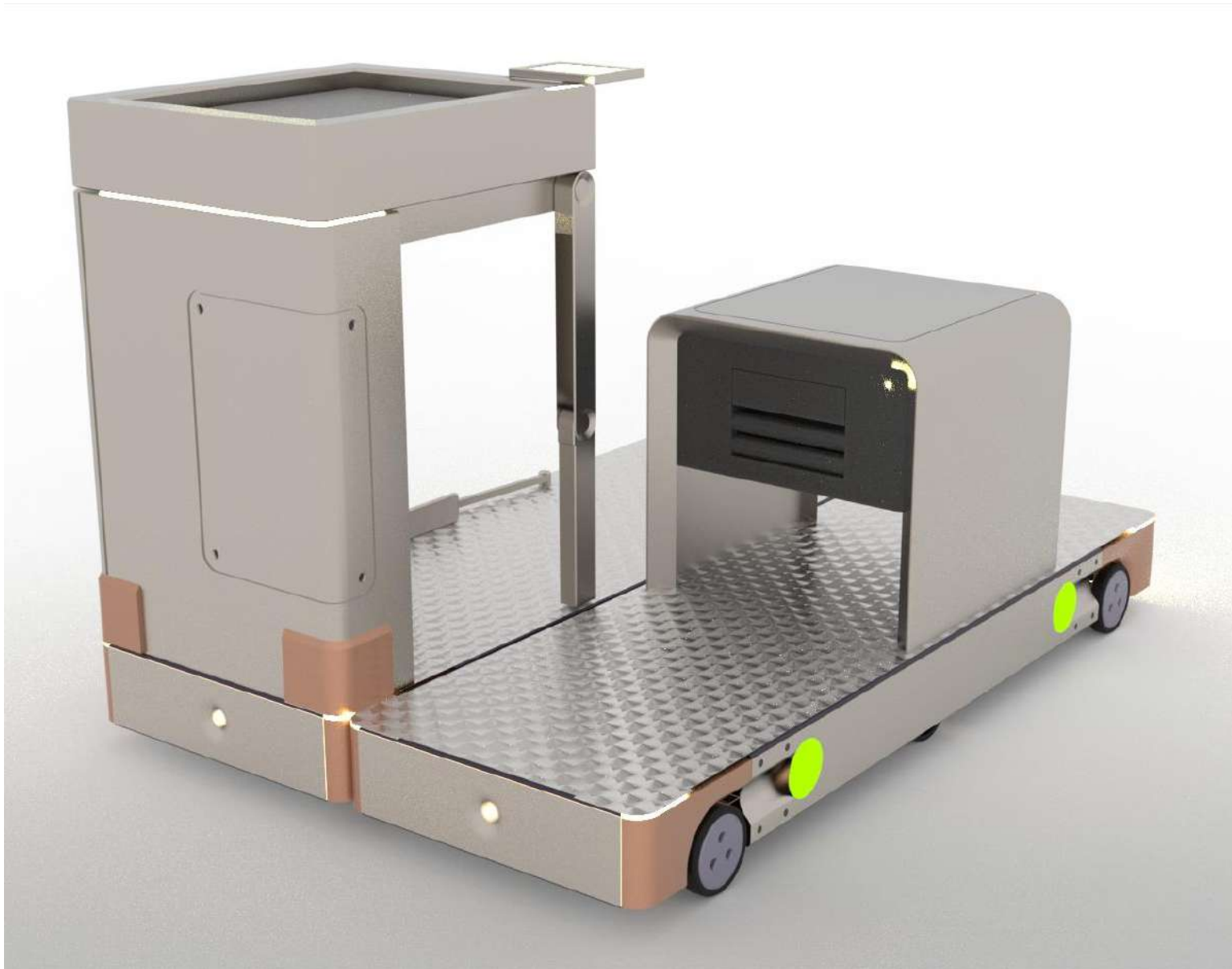
24.7 Technical layout

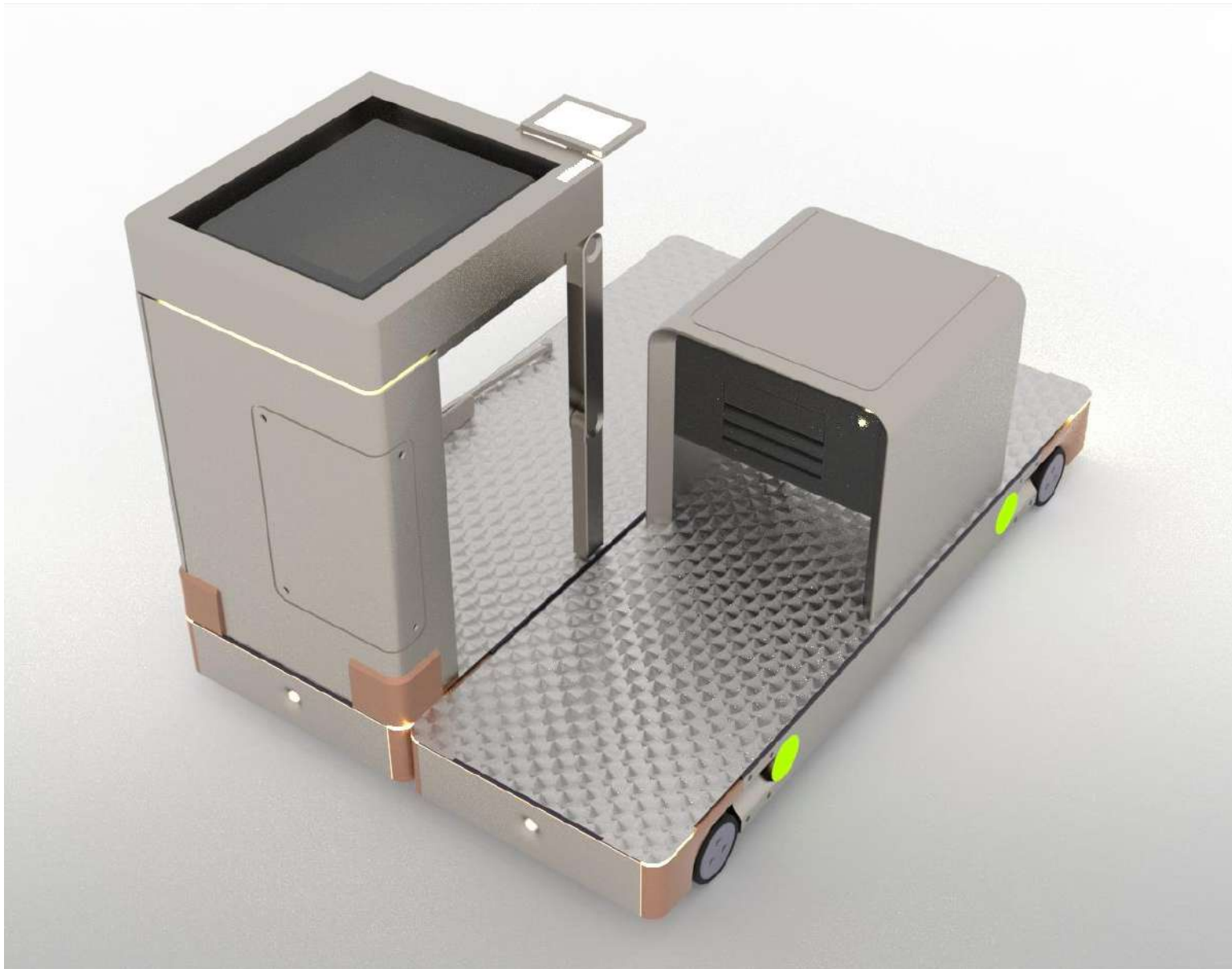
There are two Automated Guided Bots in every station. When these two bots are in pair mode then the inner wheels will be free and disengaged from the drive motors. This should allow them to function as a single unit.



25. IDEATION and FINAL CONCEPT











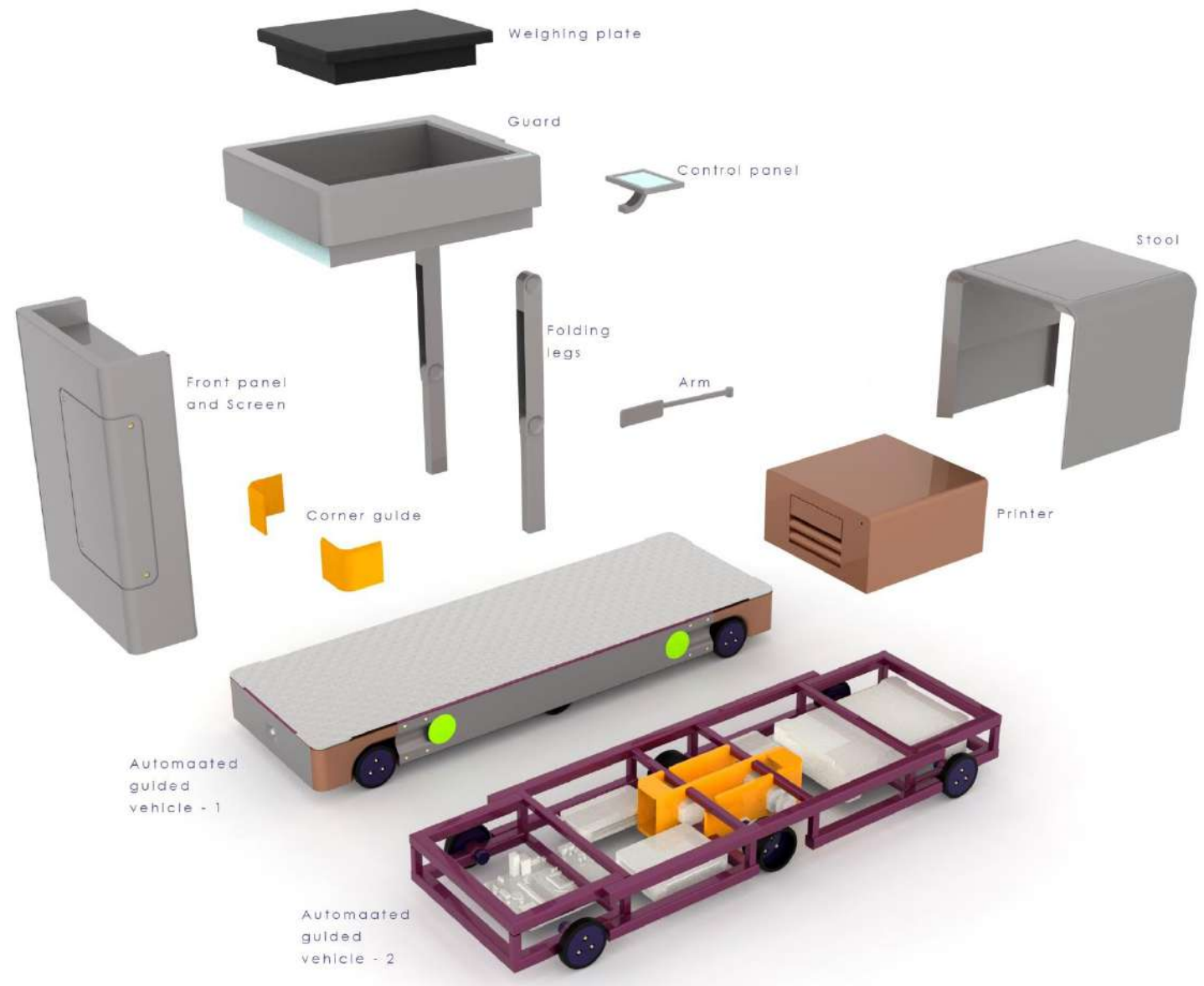




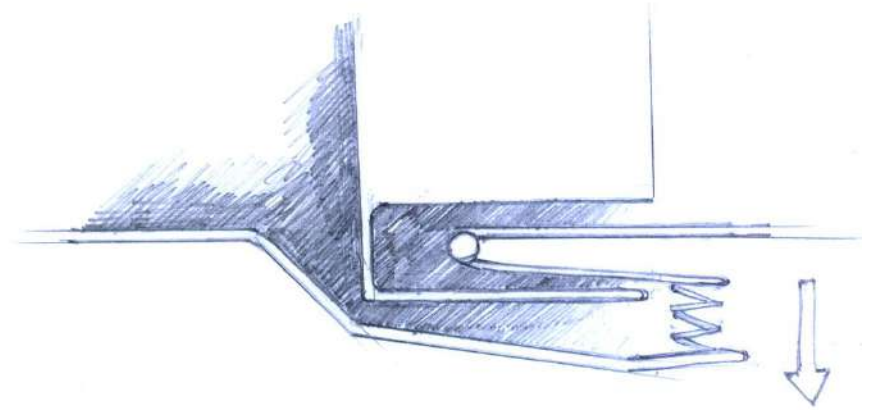
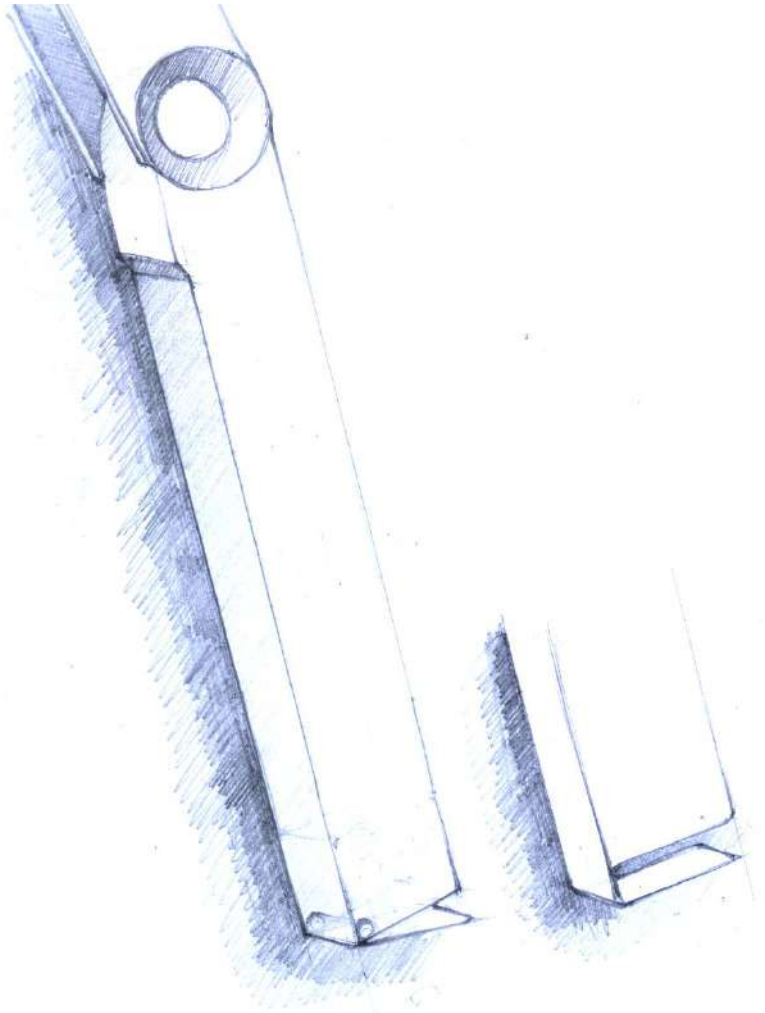




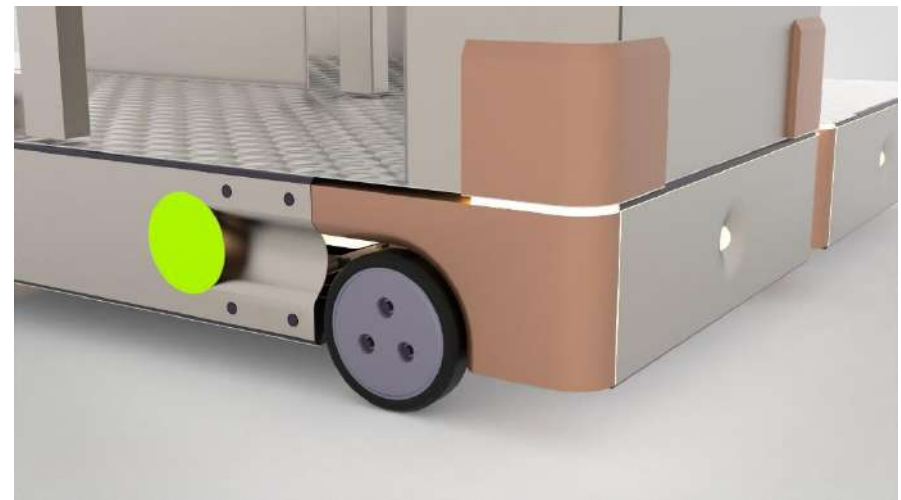
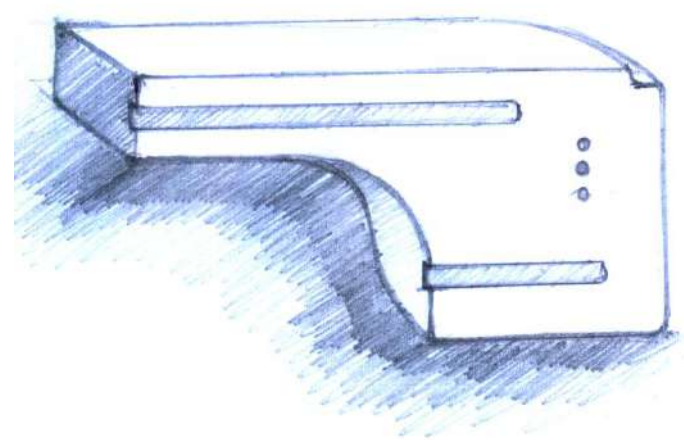
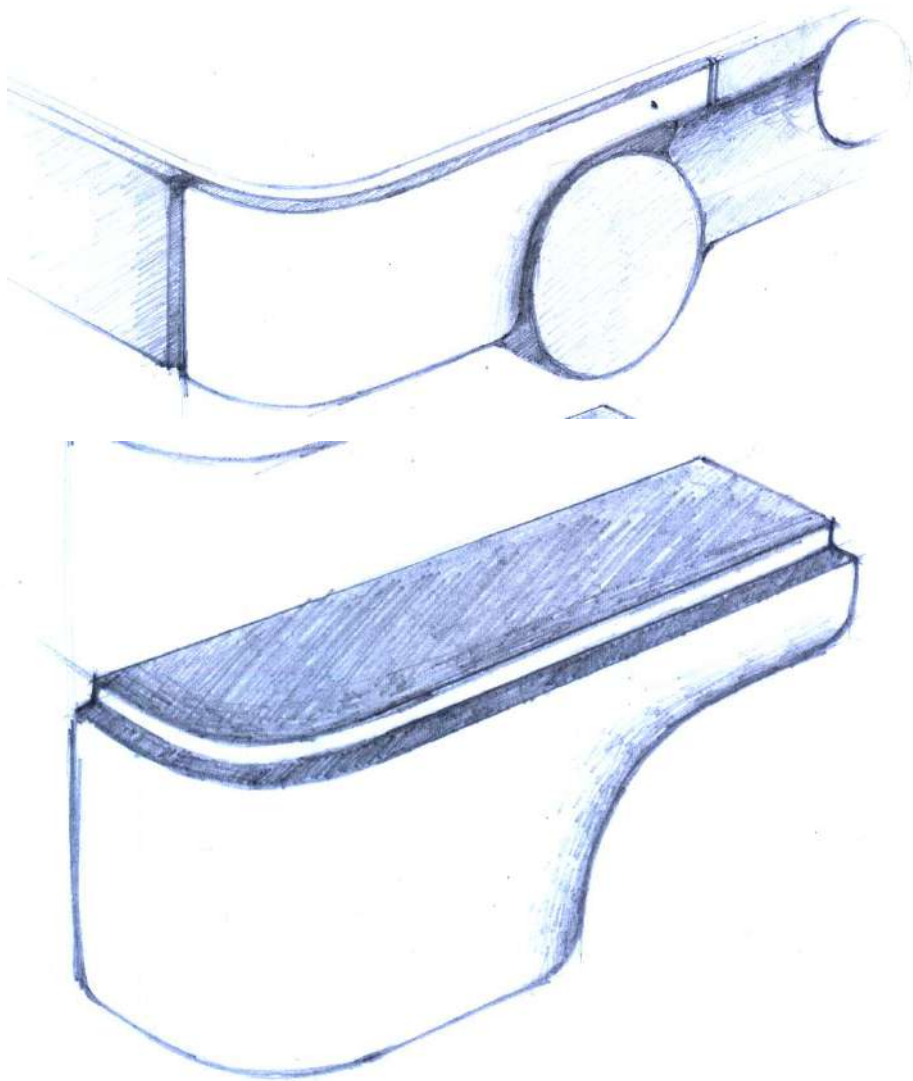
25.1 Exploded view



25.2 Mechanisms

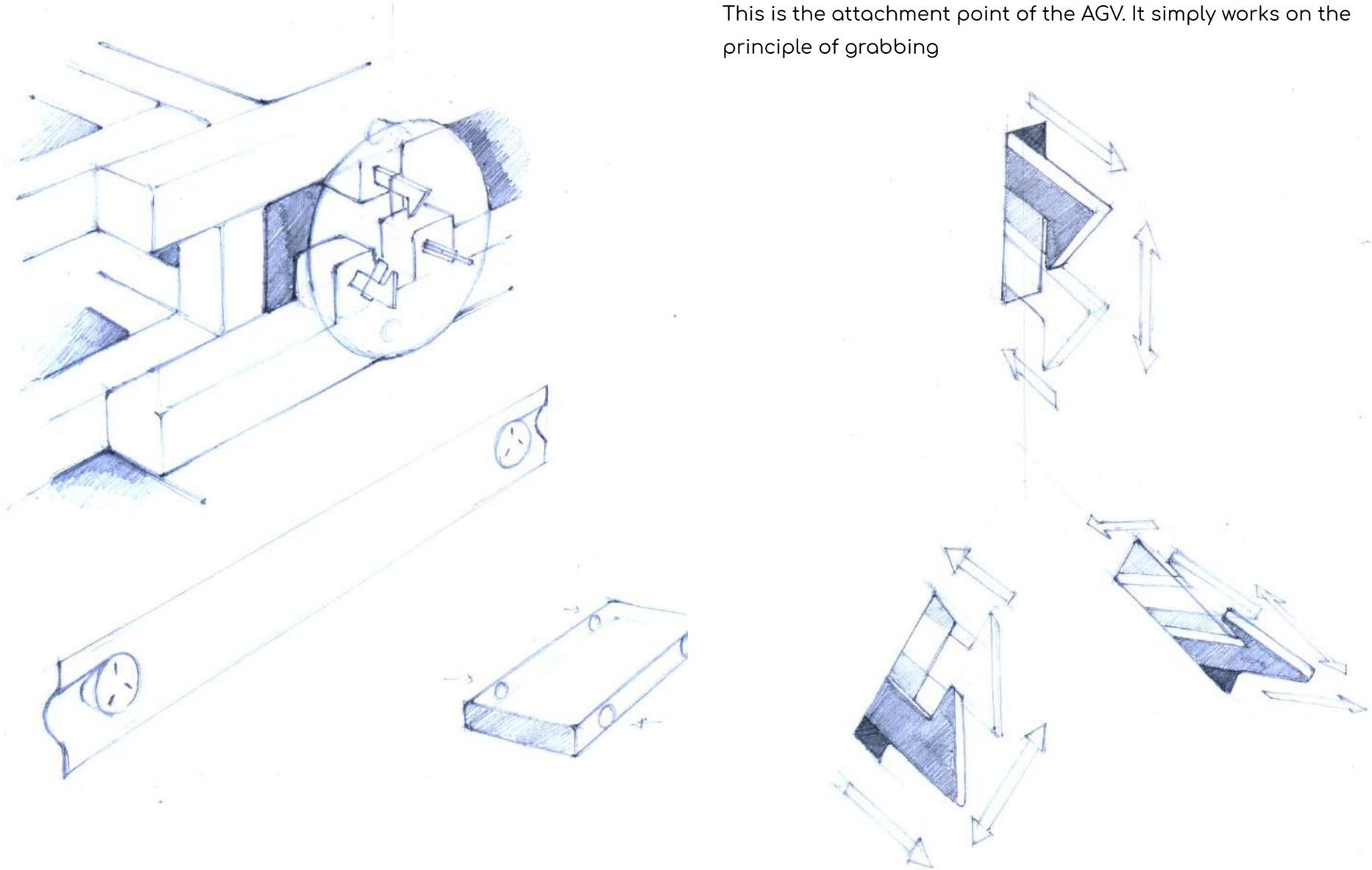


The idea is to hold the leg in one place. The spring arrangement will push the base plate of the foldable leg downwards.

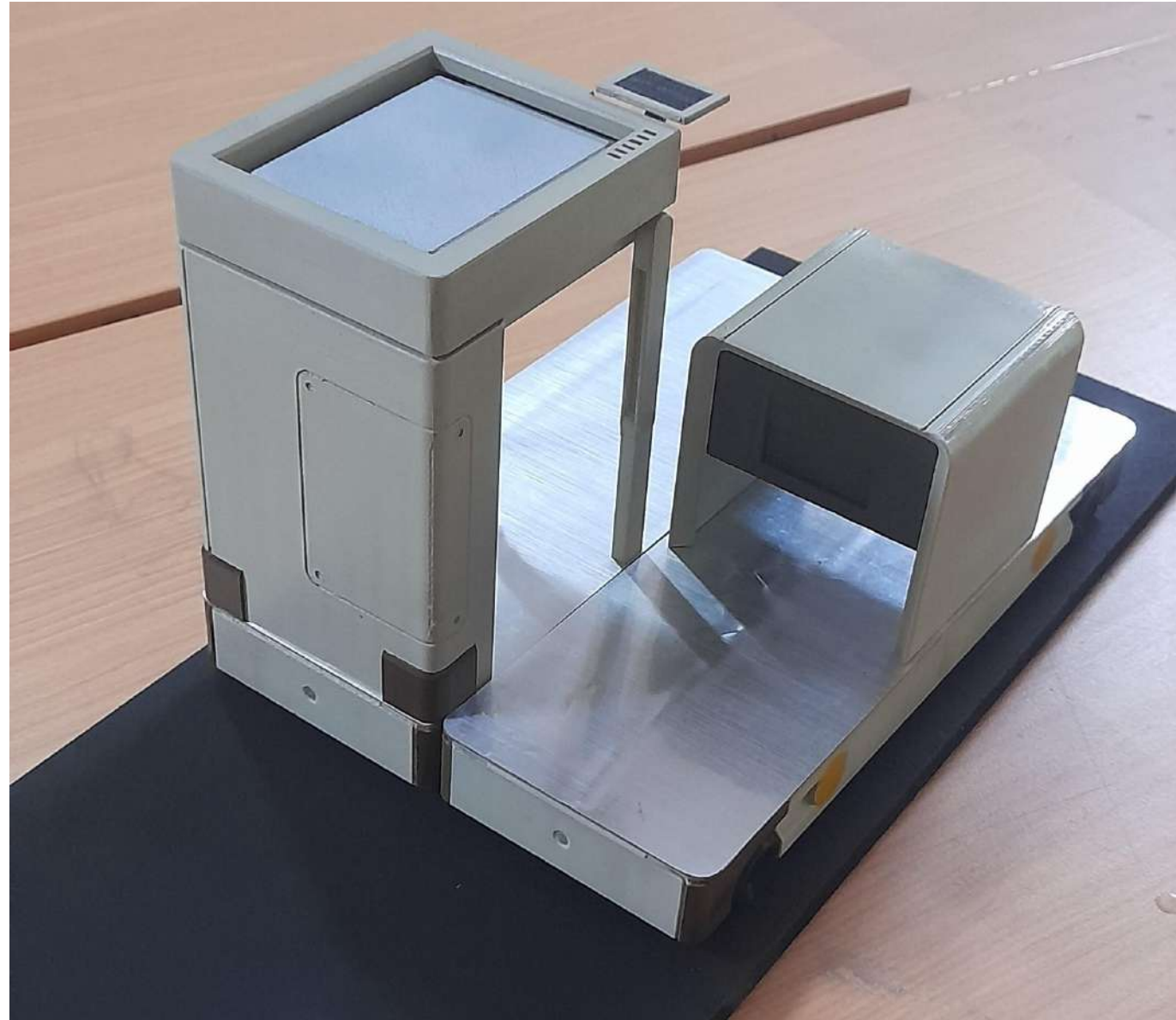


Sensor and detection module can easily be slid in and removed

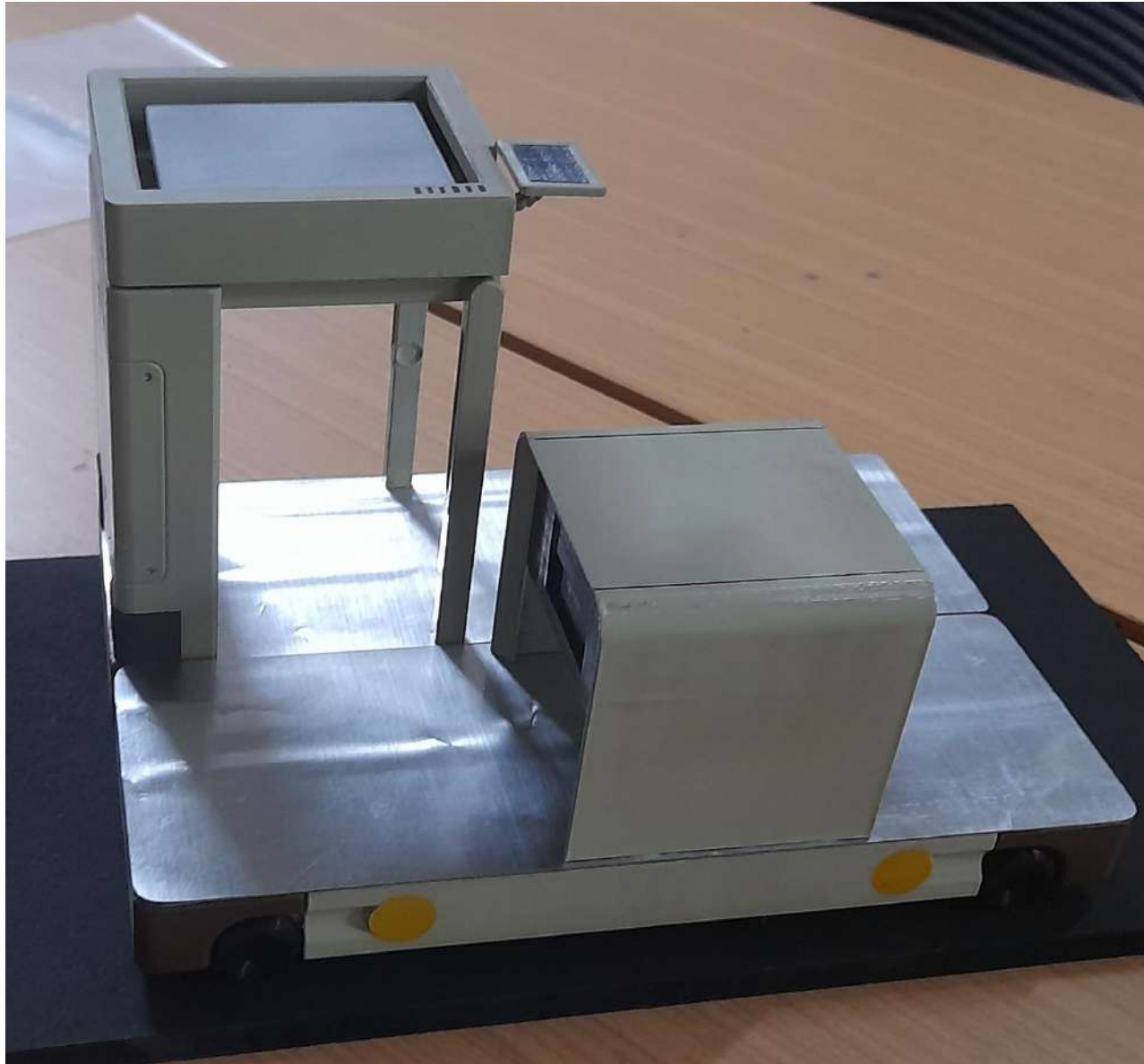
This is the attachment point of the AGV. It simply works on the principle of grabbing

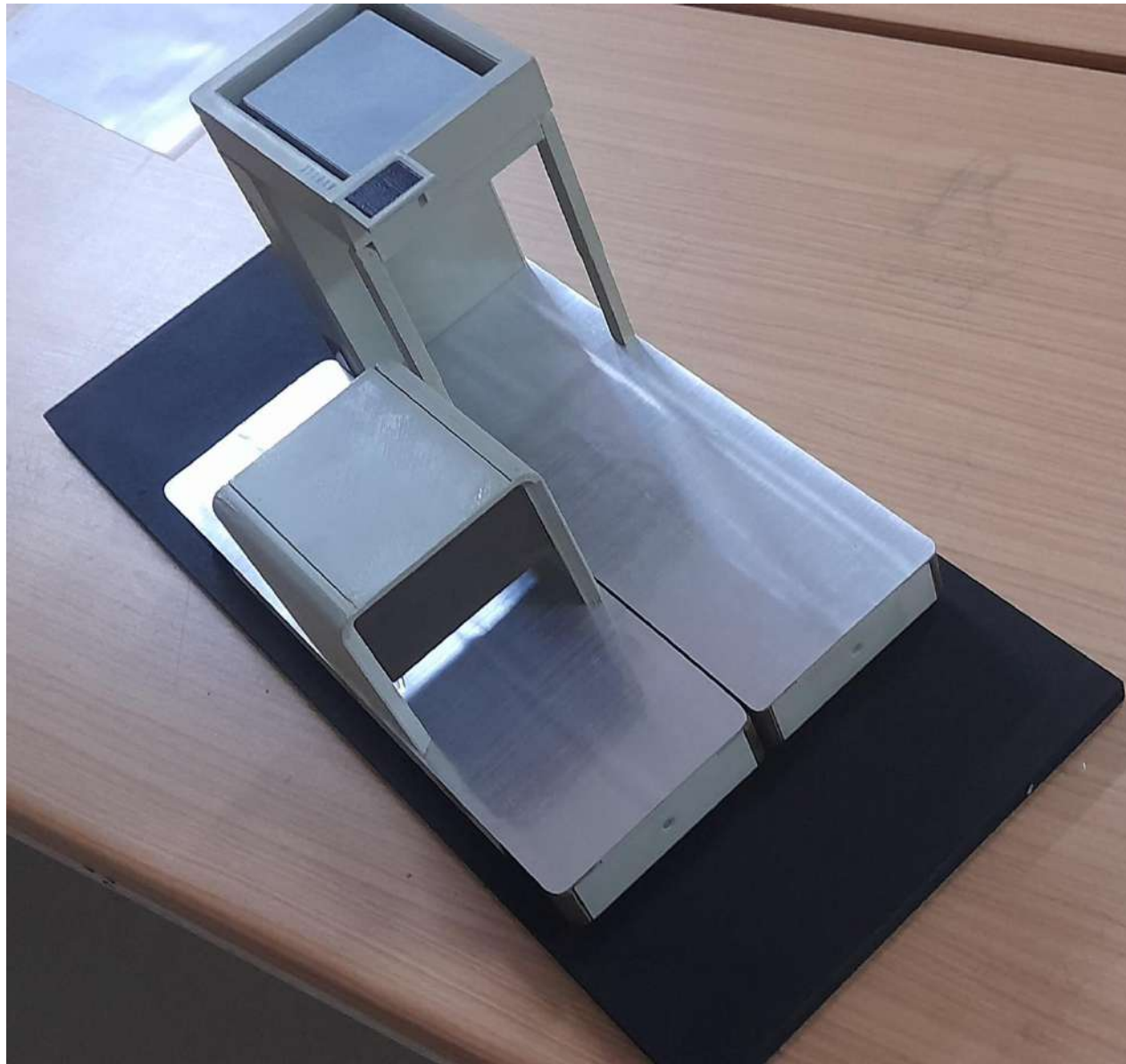


25.3 Physical model











Thank you