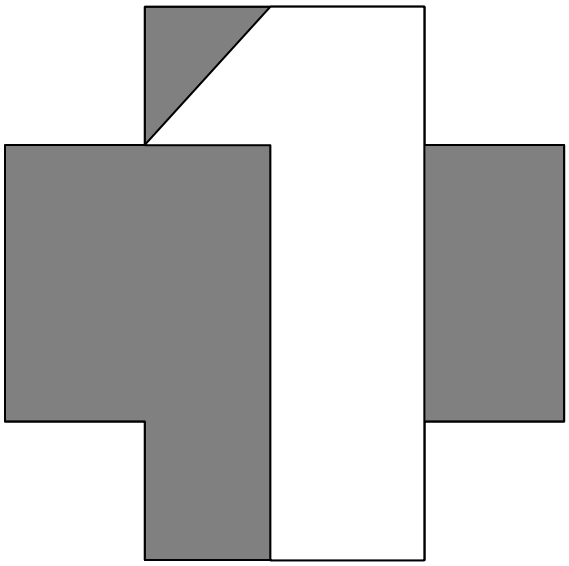
GLOBAL PRODUCT DEVELOPMENT

TEAM 7 – PLUS 1 INC.



DESIGN REVIEW 2

Soraa Kim
Youngil Shin
David Hsu
Marius Klippel
Swarup Patra
Woon-Yong Choi

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EXECUTIVE SUMMARY

The aim of *Plus 1, Inc.* is to identify and tackle global issues through their practice of exceeding expectations while generating environmentally friendly concepts. The latest project of the team has been to develop an innovative product whose internet-ready aspect allows the existence of a closed-loop economy.

Plus 1 is dealing with the the so-called "last mile" problem. International parcel delivery services are characterized by rapid market expansion, but as public sector inefficiencies are perpetuating, private parcel services must adopt low-cost models in order to remain competitive. Typical cost distributions indicate that final delivery costs make up about 45% of carrier costs, causing many major carriers to focus attention on the "last mile" problem, which is composed by unattended households and high costs of delivery to multiple locations.

Plus1's solution would be *a* Fully-Operational Network with an *Automated Package Receiver (Aupare): Aupare* enables people that are not at home during the day to receive packages using a network with delivery companies and an eclectic mix of retailers.

Delivery to *Aupare* is available as an option during checkout from a store in the retailer network. The customer has three choices: delivery with inspection & validation, delivery with notification, delivery without notification. The network checks for compartment availability of the customer-specific *Aupare* system. Upon confirmation of compartment availability, a specific compartment is assigned to that delivery for an estimated delivery date, and a unique, one-time-use code is generated for access to the specific *Aupare* system. The package is delivered to the specific *Aupare* system and the recipient can get it out when arriving at home.

Compared to earlier solutions by other companies, *Aupare's* uniqueness lies in combining its functions with using internet readiness and serving it to urban households.

The identified main customer will be office workers at the developed East Asian (primary) and European markets (secondary market), who live in apartment buildings. But by building a network and offering advantages to more than only the recipient of a package also delivery companies, retailers and companies/landlords that run apartment buildings are customers. Having several parties who benefit from the product gives the possibility to establish a sophisticated pricing model.

The Market size is 1.88 million on our primary market and 8.7 million for secondary market. After considering all factors the set target is 0.25% for the first one year, which is 4700 for the primary market. Risks although unavoidable when entering a new market, but because of the planned cooperations and subsidies, the financial risk is contained.

1. INTRODUCTION

1.1 Company Background & Core Competencies

Plus 1, Inc. is a team of six engineers from three countries that was formed by World Innovative Technologies (WIT) to identify and tackle global issues through the generation of environmentally friendly concepts. The team's latest task is to develop an innovative product whose internet-ready aspect enables a closed-loop economy. The composition of *Plus 1* is as follows: Woon-Yong Choi (M.E.) and Youngil Shin (M.E.) from Seoul National University; Soraa Kim (I.E.) and Marius Klippel (I.E.) from the Technical University of Berlin; and David Hsu (M.E.) and Swarup Patra (I.E.) from the University of Michigan.

Plus 1 will divide tasks according to each member's core competencies. Internet-ready aspects will be led by Marius, a computer science specialist; market research and needs analyses will be conducted by Soraa and Swarup, with their I.E. backgrounds; and, mechanical design and structural analysis will be performed by Woon-Yong, Youngil, and David due to their backgrounds in mechanics, materials, and design.

1.2 Project Overview

Several project ideas were proposed and analyzed as *Plus 1* considered various corporate and consumer needs. Professional consultation at a conference in Seoul, Korea then helped the team converge their ideas to one final concept.

The chosen project aims to increase efficiency in the parcel/package delivery industry. Within this industry, a significant portion of recipients are absent during first delivery attempt, and many packages must therefore be re-delivered. This scenario is not only inconvenient for recipients, but is also expensive and time-consuming for delivery companies. Hence, *Plus 1* proposes an automated parcel acceptance system that targets recipients living in private apartment towers containing at least 50 households.

2. NEEDS IDENTIFICATION & PROBLEM STATEMENT

2.1 Ideas Considered – Reaching a Consensus

Plus 1 identified various consumer needs before reaching a consensus on its project idea, and considered multiple solutions were before settling upon a final design. The team's other leading ideas are briefly described below in *Fig. 2.1*. (*Detailed data given in* Appendix A*)*The *Package Receiver,* chosen by group consensus, has the added advantage of addressing customer requirements on two fronts: parcel delivery and package receipt.

	Ease of Manufac-turability	Marketable	Time Saving	Contribution to closed loop econ-omy	Internet Ready Benefits	Is it a global is-sue?	**Total**
Weight	*3*	*4*	*3*	*5*	*5*	*4*	
Smart Parking	11	20	23	18	22	21	**466**
Crib for babies	26	16	15	14	20	18	**429**
Package receiver	20	22	27	27	25	21	**573**
Alarm Clock	10	20	23	17	15	18	**411**
Pet Feeder	19	16	19	11	20	11	**377**

Figure 2.1 – Needs Identification based on collective consensus

2.2 Problem Statement[1]

International parcel delivery services are characterized by fierce competition and rapid market expansion. Protectionist policies for public carriers, however, have perpetuated public sector inefficiencies while retarding private sector growth. As a result, private parcel services are forced to adopt low-cost models in order to remain competitive.

Typical cost distributions indicate that final delivery costs make up 45% of carrier costs, causing many major carriers to focus attention on the "last mile" problem. While some of these measures, such as the 2004 UPS initiative to saving fuel by minimizing left turns in delivery routes, have met with reasonable success, they do not directly address two main issues of the "last mile" problem: 1) unattended households (requiring re-delivery) and 2) high costs of delivery to multiple locations.

Public data on re-delivery costs indicates that 30% of home deliveries require multiple delivery attempts. Shippers leave another 30% of packages at the door in the absence of recipients, where they are subject to theft and weather damage, and up to 30% of mail-order packages are returned. In addition, a 10% increase in package delivery volume raises costs by approximately 8%, a percentage that will only continue to rise with fuel costs. Estimating that a third of re-deliveries require a third attempt, these numbers indicate that 32 % of final delivery costs are due to re-delivery. If we assume that 30% of final delivery costs are due to fuel costs, delivery companies can save 4.5% of total delivery costs from fuel savings alone.

In brief, the problem statement can be summarized as follows: *To minimize inconvenience for recipients and final delivery costs for delivery companies by using internet ready*

[1] All data in this section has been cited from the Roundtable on International Parcel Delivery held in Paris on October 6th, 1996 by the Committee on Consumer Policy. Organization for Economic Cooperation and Development (OECD), http://www.oecd.org/LongAbstract/0,3425,en_2649_33703_2385269_1_1_1_1,00.html

features to enable automated, around-the-clock parcel acceptance capability.

2.3 Internet ready aspects enabling a closed loop economy

Plus 1's Automated Package Receiver, to be marketed as *Aupare*, utilizes its internet-ready functions to allow receipt of packages regardless of the intended recipient's location or availability. This allows parcel delivery companies to reduce delivery volume by up to 40%, and "closes the loop" through delivery truck fuel savings. Thus, *Aupare* clearly satisfies the project's internet-ready and closed-loop requirements.

3. MARKET ANALYSIS

Although final delivery costs are a relatively recent issue, over 20 companies already offer solutions to the "last mile" problem. These solutions fall into three categories: independent package receivers (IPR), which are package-receivers built for individual households; retail aggregators (RA), which are essentially designated retail outlets that collect parcels for delayed pickup; and automated aggregators (AA), which are specialized, automated acceptance centers serving entire neighborhoods. (*See* Appendix B *for patent search results*)

Aupare attempts to combine the best features of all three categories while minimizing their flaws and weaknesses. Consumers are first given the option of sending to *Aupare* during checkout at participating merchants. Upon selection of an *Aupare* delivery, consumers select the service they require (delivery with inspection and validation, with merely notification, or without any action at all). Then, the system estimates package size, and checks the target system for available spaces on the anticipated delivery date. Upon system receipt of a package, recipient retrieval will be allowed for the next 48 hours without penalty. This concept provides the convenience and advanced functionality of an IPR, but avoids its higher installation and operating costs. It provides the storage space flexibility and modularity of an RA/AA, but provides greater privacy and security than the RA design, eliminates the traffic congestion and distance inconveniences of both, and mitigates potential logistical problems inherent in any large-scale aggregator design.

Since the Asia-Pacific region sees the largest number of parcel shipments in market pieces per day, densely-populated, highly developed East Asian cities will be *Aupare*'s primary market. And Europe, with its population of well over 320 million, has been chosen as the secondary market because of its potential to become the world's biggest parcel delivery market in the coming decade.

Aupare's target markets are characterized by dense populations residing in apartment blocks (defined as multi-unit, high-rise apartment buildings), high-speed internet connections, and large commercial retail chains. The East Asian market is distinguished by larger apartment blocks, faster internet speeds, smaller average parcel sizes, and a cultural fondness for complex, hi-tech gadgets; the Western European market by somewhat slower broadband

speeds, larger average parcel sizes, and a need for simpler user-system interaction. Before large-scale introduction of the *Aupare* concept, however, the Banpo region of Seoul, South Korea will be used as a pilot market. This region, centrally situated in Seoul, contains smaller, older "matchbox" buildings that are due to be demolished and replaced by large, new apartment blocks in the near future. Sitting next to affluent neighborhoods and close to business and commercial centers, a revitalized Banpo is likely to attract wealthy professionals willing and capable of making full use of *Aupare*'s services.

Based on data from a consumer behavior database, it is estimated that two-thirds of households are unable to accept parcels during the first delivery attempt. Since over 60% of the densely populated, East Asian urban population lives in apartment blocks, *Aupare*'s primary market size is estimated at 40% of the developed, East Asian metropolitan community. The number of unattended households, weighted by demographics and annual parcel numbers, yields 0.06 parcels per household, per day. Combining this average with a policy of allowing parcels to remain in the system for up to 48 hours without penalty and a factor of 2 to account for peaks in demand, each system will be designed for 0.24 boxes per household, per day. Thus, a 50-household apartment block would require 12 boxes, which is around the minimum size necessary to merit installation of *Aupare*.

Development of the *Aupare* concept would ideally be a joint venture between WIT, a major private parcel carrier, and several large retail chains. Use of the system would concentrate demand for participating retailers while saving costs for parcel carriers, and subsidies from their profits could allow basic *Aupare* shipping costs to be cheaper than ground shipping. Subsidized deals and public demonstrations could be arranged to promote the product and kick-start market demand, but eventually *Aupare* will sell through its convenient, secure, user-friendly features and cost-saving concept.

4. PRODUCT ENGINEERING

4.1 Task Clarification & Requirements List

After identifying functions and requirements for *Aupare*, *Plus 1* established the following product tasks: 1) establishing a connection between *Aupare* and the recipient 2) enabling video and audio communication 3) receiving the package 4) securing and storing the package and 5) enabling validation of package receipt and generating secure data linking the package to the recipient. Using these requirements, *Plus 1* identified primary product requirements (*Figure 4.1*) for *Aupare*'s final design.

Requirements List for Aupere					
1	*Geometry*	**5**	*Force*	**10**	*Recycling*
	I. Capability to store large parcels		I. Sufficient to move the parcel		I. Sustainable material
	II. Parcel size within 500x500x500 mm				
	III. Parcel's weight:within than 10kg	**6**	*Energy*	**11**	*Costs*
			I. Electrical energy		I. Within the GPD budget of $600
2	*Material*				
	I. Non toxic	**7**	*Control*		
	II. Sustainable		I. Using buttons and internet	**12**	*Schedule*
	III. Protect parcels from impact				I. Milestone 1 - First design review, October 5
		8	*Operation*		
3	*Safety*		I. Operated by delivery person		II. Milestone 2 - Second design review, November 6
	I. No damage to parcels during handling		II. Remotly controlled using a computer or mobile phone		
	II. Protect parcels from theft				III. Milestone 3 - Global design exhibit, December 2-8
4	*Ergonomics*	**9**	*Maintenance*		
	I. Easy to use		I. Long-term usage		
	II. Aesthetically pleasing		II. Capability to change module		

Figure 4.1 – Requirements list for Aupare

4.2 Functional Analysis

Having established a requirements list, *Plus 1* created the following four functional modules:

Communication: When a courier dials an apartment number, *Aupare* will establish an internet connection with the recipient, allowing audio and video communication between the courier and recipient. Sub-modules will consist of a camera and microphone, and the *Aupare*-courier interface will include a keypad and screen for inputs and instructions.

Inspection: Before accepting a package, *Aupare* will allow the recipient to inspect the package. This module achieves its functionality through real-time video and a broadband connection. It will be enabled by a custom software package with a friendly user-interface.

Acceptance: When the courier places a package into *Aupare*, the system must accept, store, and secure the package. This module receives and stores packages with a mechanical forklift design, and uniquely identifies the storage chamber with the recipient's apartment number. Once the parcel is accepted, security features will protect the package until retrieval by its intended recipient.

Validation: After securing a parcel, *Aupare* notifies the recipient and requests an electronic signature for the courier. The recipient will then validate the transaction and sign off. Upon validation, the system grants the recipient access to the package chamber with his/her unique PIN for package retrieval.

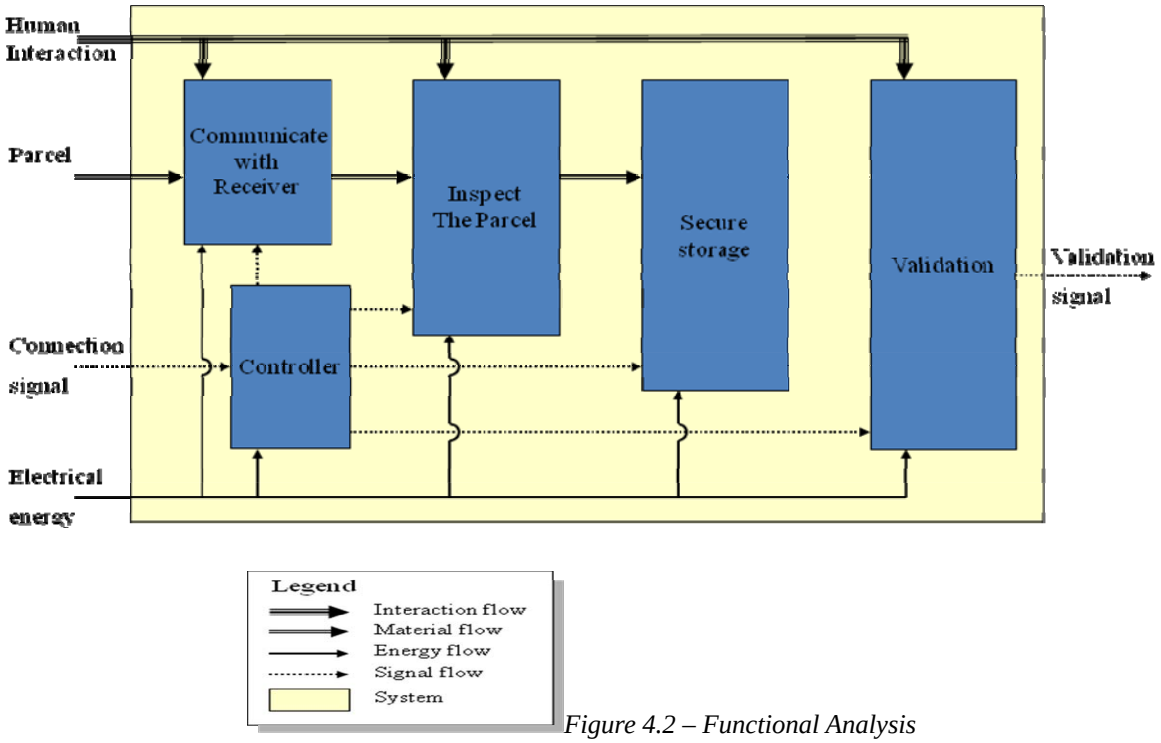


Figure 4.2 – Functional Analysis

Figure 4.2 above illustrates the functional analysis in pictorial form, identifying key elements and the relationships that exist between them. *Appendix C* contains a storyboard of how the *Aupare* concept would succeed in a real-life situation.

4.3 Design Alternatives

Plus 1 developed three design alternatives with the same basic functionalities before settling upon a final concept. The team considered different package acceptance methods, and debated the relative merits of serving single homes vs. apartment complexes. Security was also a key concern. *(Refer to* Appendix D *for detailed working principles and morphological selection. Refer to* Figures 4-6 *in* Appendix E *for design alternative sketches.)*

Design Alternatives 1 & 2 targeted single houses, common in towns and suburbs, and involved freestanding structures mounted outside the main door of the house *(Figure 4, Appendix E)* or mounted inside and accessible from the outside through a window (*Figure 5, Appendix E)*. The team had qualms about the price and security of such a product, and therefore scaled up the product to serve multiple households instead. As a result, Design Alternative 3 was created to target apartment blocks in developed, urban environments. It would allow multiple homeowners to receive packages using the same system, and its underground design and random chamber selection would ensure package security. However, the system was deemed overly complex, and was refined step-by-step to increase feasibility and marketability.

Final Design Selection: At the end of DR1, *Plus 1* selected Design Alternative 3 using a morphological method that considered multiple solutions for the required functions (*Appendix D*). After more detailed market and engineering analyses for DR2, the team simplified ease of

installation through use of a modular, ground-level system, and simplified receipt and dispensing of parcels by utilizing a forklift and cabinet system.

4.4 Internet ready features enabling closed loop economy

Aupare's internet-ready aspects allow the recipient to remotely accept a package from any location. This, in turn, enables a closed-loop economy by allowing the delivery company to save on fuel and processing costs.

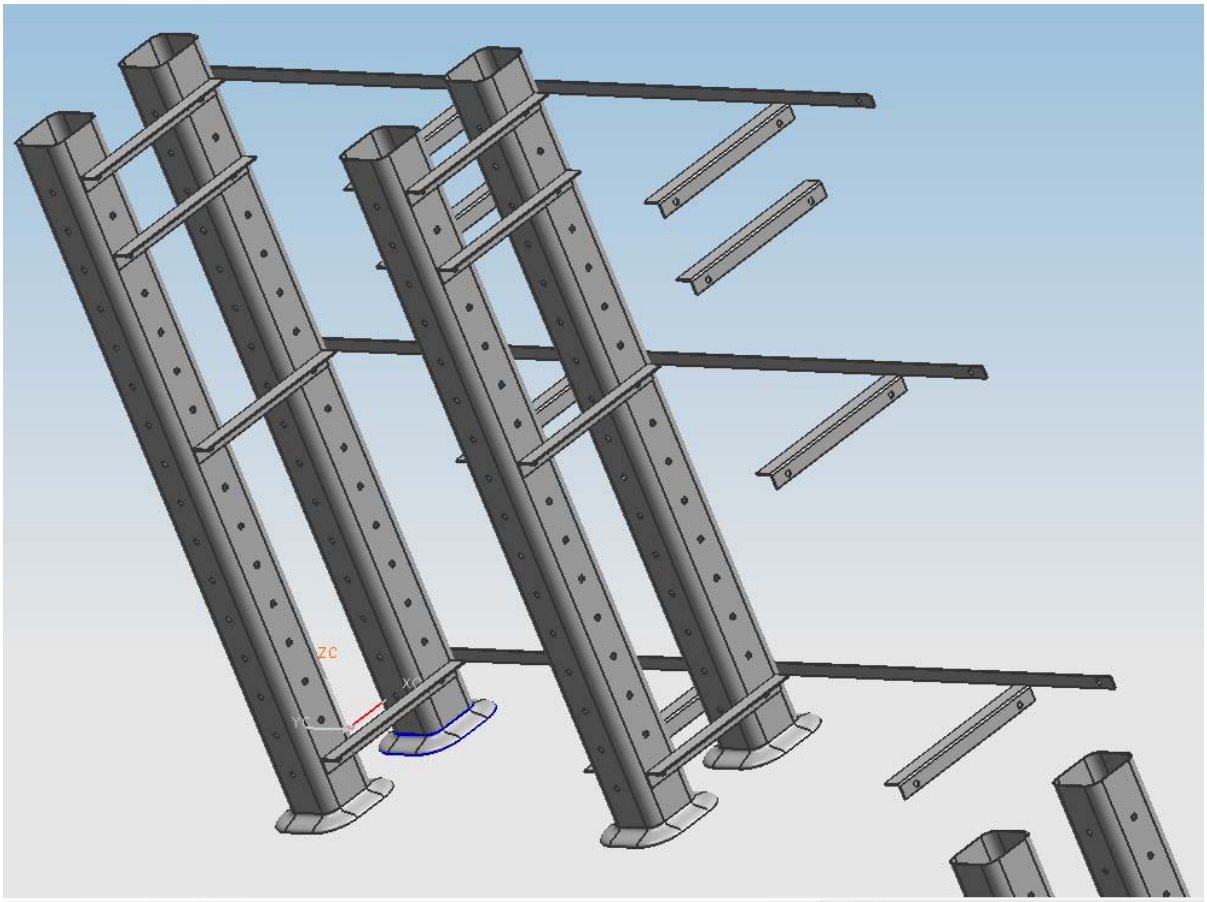


Figure 4.2 – Cabinet system

4.5 Platform Product Structure

Aupare's core element can be divided into three main units: the cabinet (*Figure 4.3*), the forklift (*Figure 4.4*), and the motion system (*Appendix I*). The cabinet is a completely modular frame whose total size can be adjusted for different buildings, and whose compartment sizes can be varied for different package sizes and different markets. Each parcel storage compartment has adjustable rails designed to hold a removable metal plate on which packages will be stored. The forklift is a lightweight system designed to move the cabinet's metal plates to and from each compartment. And, the motion system moves the forklift and packages between the cabinet and the user-access panel. It utilizes pulleys to move between the matrix of compartments, and uses gears connected to a rack-and-pinion system to move parcels into and out of each compartment.

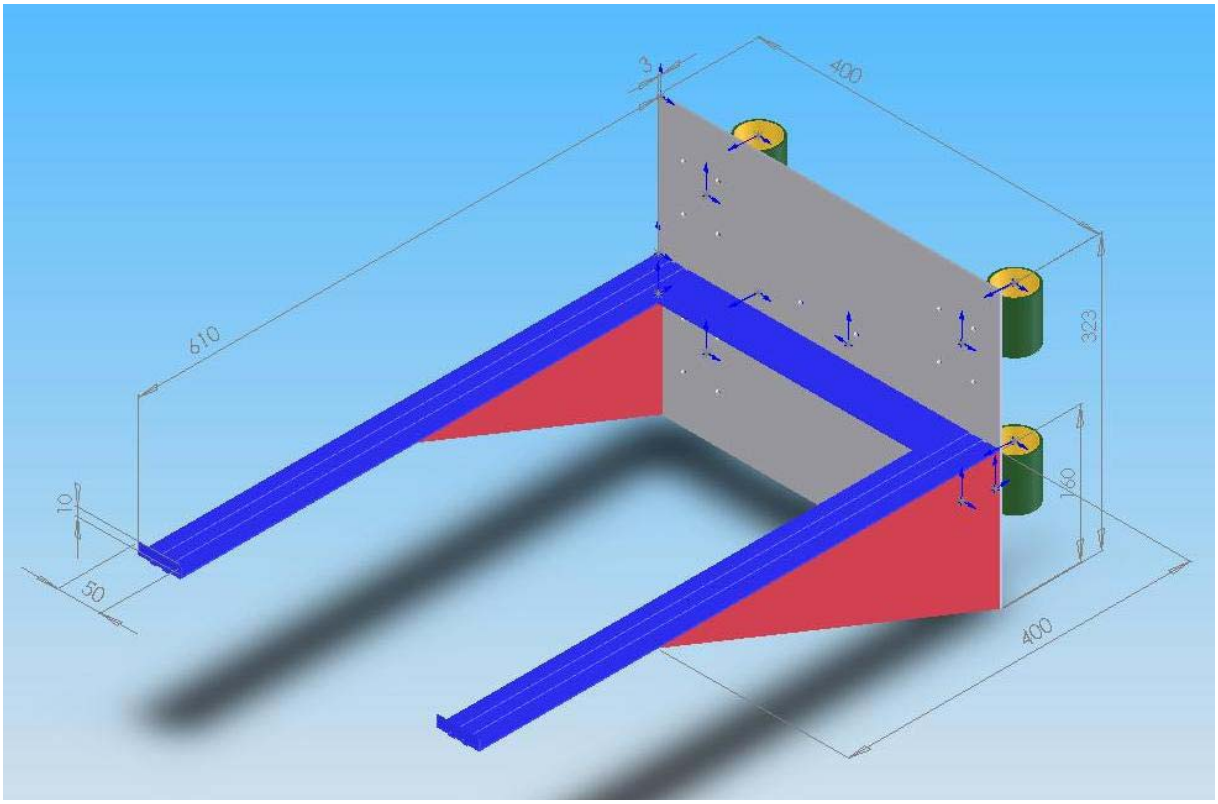


Figure 4.4 – Forklift system

Aupare's varying elements will customize the system for each specific market. For instance, in different markets the compartment size will be determined by average parcel sizes, the user-interface will be customized for convenience, the video quality will be scaled up or down due to network capability, and the retailer network will be selected based on local preferences. As a result, *Plus 1* believes that *Aupare*'s basic capabilities will be welcome and successful in all of its target markets.

4.6 Embodiment Design

Aupare's mechanical operation begins when the access door is opened to allow a courier to deposit a package. Once the package is placed on a metal storage plate held by the forklift, the access door is closed, and the forklift moves on two axes until it sits in front of the intended storage compartment. At the compartment, the fork extends forward and lowers the storage plate onto the compartment rails, then retracts and moves back to a central location. When the recipient retrieves the package, a similar mechanical is implemented to move the package from its storage compartment to the access door. (*See Appendix H, for complete part models, assembly drawings, and exploded views of the mechanical system*)

The mechanical aspects of *Aupare*, while straightforward, have many design complexities to allow for smooth, reliable, and secure operation. The access door will be of heavy steel for security, and is driven by a strong motor which locks when not in operation to guard against vandalism. A frame is chosen for the cabinet in order to maximize modularity while keeping the design strong and lightweight. The fork is designed with grooves and supports for

lightweight strength, and is fitted with a rim to secure the metal plates it carries. Pulley-cable systems will be fitted for vertical and horizontal movement in order to simplify design of differently sized systems, reliable operation, ease of maintenance, quietness of operation, and cost efficiency. The pulleys will be of the same size as the drums attached to the motors to better control motion speed, and the mounting plates moving along the vertical and horizontal axes will ride on pairs of round, hardened rods with replaceable bronze bushings. Gears are chosen for in-and-out access of parcel compartments to allow for smooth, precise, and steady movement of a potentially top-heavy system. Forklift location will be tracked by the control software, and distances will be calculated from the number of drum revolutions, which are measured using optical sensors mounted on and next to each drum. In case the forklift becomes stuck at a compartment and loses track of its precise location, the system will zero itself by moving to a preset cabinet corner marked by optical sensors. The zeroing process will also be performed periodically to rectify cable stretch.

4.7 Engineering Analysis

Smoothness of operation and reliability is of paramount importance to *Aupare*, because the system must not lose or damage the packages it handles. As a result, *Plus 1* paid much attention to important design parameters that affect the system's feasibility, mechanical stability, and reliability.

Aupare is designed for a total system load of 90 kg (60 kg load, 30 kg counter-mass), with a factor of safety of 2. Thrust/braking load is specified at 1000 N, with a factor of safety of 3. A gear ratio of 30 is chosen to allow for adequate system velocity, and the resulting gear and coupling inertia is estimated at 5.0005×10^{-5} kg•m^2 while the gear efficiency is calculated at 90%. The selected pulley has a diameter of 0.06 m and an inertia of 0.001 kg•m^2, giving us a total system efficiency of 70% and a mean system speed of 6 m/min for the specified 3000 rpm motor (*see Appendix J for motor details*). And, the selected wire rope has a diameter of 10 mm and a breaking strength of 11,200 pounds, which is more than five times the system load.

In *Aupare*'s estimated velocity profile, normal acceleration is conservatively estimated at 0.5 seconds, regular operation at 1 second, normal deceleration at 0.5 seconds, normal positioning at 2 seconds, normal peak speed at 0.2 m/s, and normal cycle time at 4 seconds (*Figure X*). Using a corresponding profile for reverse operation, *Plus 1* input the velocity profile and other system characteristics (*see above*) into a motor selection program, choosing a DC motor for price and commercial availability, a holding brake for precise positioning, and an oil seal for easy maintenance. The resulting motor, a YASKAWA SGMA J-03E*A, is a 24 volt DC motor with 0.955 N•m of torque, 0.300 kW power, 3000 max rpm, 1.91 N•m peak torque, and 8.492 inertia ratio.

Finally, the structural load-bearing capabilities of the cabinet, forklift, and motion system were checked using FEM (*Appendix I*), and then modified to allow for a factor of safety of 2. As a result, *Aupare* is expected to operate smoothly and reliably.

5. PRODUCT MANUFACTURING

5.1 Bill of Materials

The detailed bill of materials is as follows:

Item	Sub Assembly	Sub Item	Name	Unit	Price($)	
					Each	Total
1	Cover	1	Al Plate 3600X1200X5(mm)	2		233.3
		2	Al Plate 3600X2000X5(mm)	2		388.8
		3	Al Plate 2000X1200X5(mm)	2		129.6
2	Slide_Cover	4	Al Plate 900X600X5(mm)	1		14.58
		5	LM_Guide (1000mm)	2	224.5	449
3	Bottom_Rail	6	30mm Square Section (3600mm)	4		69.98
		7	60mm Square Section (100mm)	2		3.888
		8	Φ60 Pully	4	4.98	19.92
		9	Φ10 Steel Wire (10m)	2	14.52	29.04
		10	SGMAJ-03E*A	1	150	150
4	Bottom_Plate	11	Al Plate 800X600X10(mm)	2		51.84
		12	Al Plate 600X200X5(mm)	2		6.48
		13	30mm Square Section (100mm)	2		0.108
		14	Φ50 Wheel	4	2.2	8.8
		15	LM_Guide (400mm)	2	120	240
		16	SGMAJ-03E*A	1	150	150
5	Upper_Plate	17	Al Plate 800X600X5(mm)	2		25.92
		18	30mm Square Section (100mm)	2		0.108
		19	Al Plate 600X400X10(mm)	2		25.92
		20	Φ50 Pully	2	4.98	9.96
		21	Φ20 Circle Section (100mm)	2		0.324
		22	SGMAJ-03E*A	1	150	150
6	Carriage_Pipe	23	Φ30 Hollow_Circle_Section T5 (2000mm)	2		8.532
7	Carriage_Pillar	24	Φ30 Hollow_Circle_Section T5 (2000mm)	4		17.06
8	Folk_Lift	25	Al Plate 600X400X20(mm)	1		25.92
		26	Al Plate 400X400X10(mm)	1		8.64
		27	60mm Square Section (100mm)	1		1.944

		28	Φ30Hollow_Circle_Section T5 (400mm)	2		2.052
9	Storage_Pillar	29	140mm Hollow Square Section (1800mm)	8		210
		30	Al Plate 300X300X10(mm)	8		38.88
10	Storage_Support	31	Al Plate 2000X300X10(mm)	3		97.2
11	Storage_L_Bracket	32	Al L Section(440mm)	18		17.5
12	Inspection_Device	33	KLP-303	1	150	100
13	Plate_Parcel_400	34	Al Plate 500X500X5(mm)	6		40.5
		35	20mm Square Section (500mm)	6		6.48
14	Plate_Parcel_600	36	Al Plate 700X500X5(mm)	6		56.7
		37	20mm Square Section (500mm)	6		6.48
15	Plate_Parcel_800	38	Al Plate 900X500X5(mm)	6		58.32
		39	20mm Square Section (500mm)	6		6.48
					Total	**2860**

One reason Korea was chosen as the pilot market and as part of the primary market is that country's inexpensive, high-quality materials and competitive labor costs. As a result, material procurement and manufacturing processes for the local Korean market will both be sourced locally, enabling *Plus 1* to maintain a short supply chain and avoid logistical nightmares as it tries to break into its primary market

5.2 Production Processes

Aupare's production process will use metal cutting to create custom-sized modular components, and a CNC lathe can be used for drilling operations during early batch production of the forklift. The storage chamber, being highly modular, will be manufactured entirely of cut metal. Two other salient features of the forklift are the motor assembly and motor housings; the former is to be constructed manually, and the latter will be stamped metal.

Wiring and mounting of the optical sensors will be completed by technicians, and upon completion the system will be ready for software interfacing and calibration. Once an order is received, cabinet components will be assembled on-site according to customer specifications while a software interface is prepared for that specific system. Next, the motion elements and forklift will be installed, and upon final assembly of the mechanical system a technician will arrive on-site software interfacing, motor and sensor tests, and system calibration.

6. PROTOTYPE

6.1 Prototype as Deliverable

In its prototype, *Plus 1* wished to build a proof of concept capable of performing all of

the essential functions described above. Due to time and monetary constraints, these functions were limited to biaxial motion control, storage, and internet capabilities.

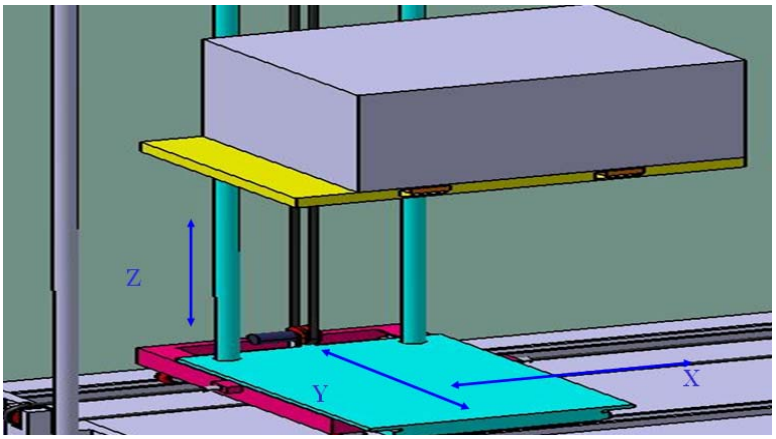


Figure 6.1 – Motion axes of Actual

Figure 6.2 – Motion axes of Prototype

Motion Control: The prototype only demonstrates motion control along the Y- and Z-axes. Demonstration of tri-axial motion was precluded by the limited number of ports in the WIT-provided internet kit, but successful biaxial motion in the system logically proves the feasibility of adding a third axis. (*See* Figure 6.2 *for motion axes in the actual prototype*) In addition, the prototype uses on-off contact switches to begin and end axial motion instead of measuring distance with revolutions because the switches make it easier to demonstrate starting and stopping points of forklift motion.

Storage: The storage cabinet in the final product will consist of at least a dozen variably-sized chambers. The prototype, however, only displays four chambers and accesses one. This limitation was due to the elimination of X-axis motion as well the need for ease of manufacturability. The ability to access one chamber, however, logically demonstrates the system's ability to access any chamber in the final product. Finally, use of off-the-shelf aluminum profiles instead of custom cabinet components has allowed *Plus 1* to keep down prototype costs.

6.2 Bill of Materials and Sourcing Strategies

Time, monetary, and transportation concerns guided component sourcing decisions for the *Aupare* prototype. As a result, after the team established general guidelines and dimensions for the prototype, storage chamber components were sourced to Korea, forklift components to the U.S.A. because of the Americans' greater machining experience, and motors, sensors, and internet components to Germany because of their responsibility for the product's internet connectivity capabilities. The prototype Bill of Materials is as follows:

Bill of Materials - Prototype				
Item No.	*Sub-Assembly*	*Purchased Items*	*Units*	*Location*
1	Forklift	Aluminum profile	4	Korea
		Steel rib	1	USA

		Polymer plastic sheets	2	USA
		Switches	6	Germany
		Steel mounts for switches	6	Germany
		Motors - 12 Volt DC, 5 kg-cm torque @ 52 rpm	2	Germany
		Steel L-section fastners		Korea
		Steel L-section II	3	Germany
		Chain for chain drive	1.5 m	Germany
		Steel Sprockets	2	Germany
		Aluminum L-section for motor mounting	2	Germany
		Steel circular section for motor mounting	2	Germany
		Spring and rod for locking mechanism to arrest vertical motion	1	Germany
		Mount for spring and rod	1	Germany
		Control plate for motion control	1	Germany
2	Cabinet	Aluminum profile	12	Korea
		Steel L-section fastners	32	Korea
		Wooden plates	4	Germany

6.3 Manufacturing and Assembly

The Korean team members purchased modular aluminum profiles to allow 3-D flexibility in cabinet construction, the Americans purchased pulleys, metal cable, music wires (for vertical motion) and model railway tracks (for horizontal motion), and the Germans purchased high-torque, low-rpm motors and physical switches for the control system. Upon arrival in Berlin, however, extensive consultation with local experts persuaded the team to change the prototype's physical design and drive system. Pulley-driven plastic bushings on steel rods were replaced by a gear-driven plate gliding along grooves in the aluminum profiles for vertical motion, and a wheel-driven track-on-track system was replaced by a similar gear-driven plate-groove system for horizontal motion. As a result of these changes, the *Aupare* prototype improved in functionality as well as aesthetic appeal.

Figure 6.3 shows the motor and sprocket assembly. *Figure 6.4* shows the horizontal and the vertical aluminum profiles that form the frame, the diagonal steel rib that was added for support, the frame-mounted motors, various connecting wires, horizontal and vertical plastic plates, and L-shaped mounting brackets for mounting various mutually-perpendicular components.

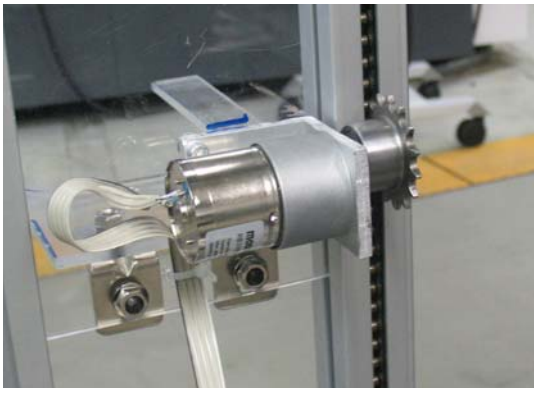


Figure 6.3 – Motor and sprocket assembly

Figure 6.4 – Forklift assembly

Figure 6.5 shows the switches used for starting and stopping the motors. Each switch has three pins, and six switches are mounted onto the prototype for positioning the forks, with two being used for horizontal motion and four for vertical motion.

The motors and the switches are connected through a software program, which also monitors the state of each chamber and decides which chamber to place a package into. For instance, in order to deposit a package into the top left chamber of the cabinet will occur:

- First, the base plate of an empty compartment will be retrieved. The program will create horizontal motion until the point where the forward switch is triggered, vertical motion until the top switch is triggered, and inward motion until the rear switch is triggered. (The forward and rear switches are illustrated in *Figure 6.5* with the forward switch being away from the reader)
- Once the package is placed on the plate and validation is complete, vertical motion will occur until the topmost switch is triggered.
- Inward motion occurs until the forward switch is triggered.
- Downward motion occurs until the switch just below the topmost is triggered. This will place the package in the storage.
- Finally, outward motion occurs until the rear switch is triggered.

All of the logic in the prototype will be of this nature. In the actual product, however, linear location will be determined through revolution counting, and only a few optical switches will be present to allow the system to zero itself.

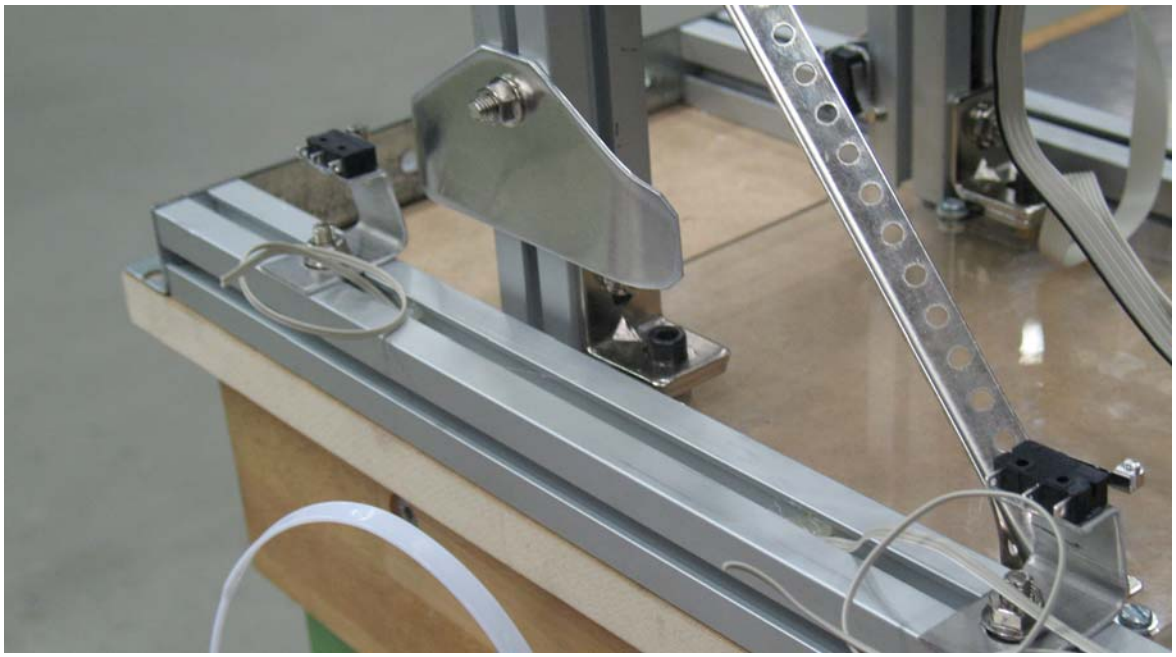


Figure 6.5 – Switches mounted on the horizontal profiles and control plate mounted on the vertical profile

7. BUSINESS PLAN

Target Sales Volume and Price

Ideal Characteristics of a Fully-Operational Aupare *Network:*

- *Aupare* network to partner with delivery companies and an eclectic mix of retailers
- Delivery to *Aupare* available as an option during checkout (online or in-store) from a store in the retailer network. Upon selection of an *Aupare* delivery, the customer has the following choices:
  - -Delivery with inspection & validation.
  - -Delivery with notification.
  - -Delivery without notification.
- The network checks for compartment availability of the customer-specific *Aupare* system
- Upon confirmation of compartment availability, a specific compartment of appropriate size is assigned to that delivery for an estimated delivery date, and a unique, one-time-use code is generated for accessing the specific *Aupare* system
- The package is delivered to the specific *Aupare* system
- Apart from the above use of *Aupare,* it can also be used, depending on compartmentn availability, for day to day deliveries in the absence of the recipient.
- The consumer has a 48-hr time slot to retrieve the package once it is delivered

Primary Market – S. Korea:

Data Source for primary and secondary market data: "The world fact book"

https://www.cia.gov/library/publications/the-world-factbook/print/ee.html

Population of Korea	400	Million
Average family size	4	
Average number of families	100	Million
Approximate percentage people living in apartments	80	%
Approximate number of families living in apartments	80	Million
Average number of apartments per building	50	
Approximate number of buildings	1.6	Million
Factor for families owning more than one apartment	1.2	
Normalized number of buildings	1.92	Million
Approximate percentage of apartments equipped with internet	98	%
Average Internet speed	80	Mbps
Market for Aupare	**1.8816**	**Million**

Figure 7.1 – Market sizing for primary market

The primary market size for Aupare is 1.88 million.

Secondary Market – Germany

The market sizing for the secondary market has been done in a similar manner and is attached in *Appendix G*. The secondary market size is 8.7 million.

In order to estimate the target sales volume, the next step is to establish the number of units that can be sold in the market size as described previously. *Plus 1* plans on starting with the primary market for two reasons: First, broadband speeds are much higher in S. Korea than in Western Europe (data given for EU for sake of convenience). Moreover, higher population densities in East Asian cities and higher percentages of people living in apartments will allow for easier market penetration. Keeping all factors in mind, *Plus 1* has set *Aupare* a nominal target of 0.25% in the primary market for the first year. This yields a volumetric sale of approximately 4600 units. The rationale for setting this target is the limited marketing resources that *Plus 1* has at its disposal and the nature of the market. Although *Aupare* differs from the past products in terms of internet readiness and functional design, few customers would actually take the initiative to acquire one for their own building. Hence, a target of 1 in 400 buildings is reasonable.

Pricing (Primary and secondary markets)

The price based costing method will be used to establish a price that *Aupare* would be sold for. As a background, the price based costing method establishes how much a customer would be willing to pay for such a service and uses this to mark the price of the product rather than pricing the product based on how much it costs to manufacture it and then marking it up by margins.

Addressing the recipient as a customer, their advantage along with psychological relief, is saving time and costs (by avoiding the drive to the package delivery center in case of missed deliveries in all attempts). The customer could pay a surcharge on normal delivery price and higher rent for the apartment, justified by providing the possibility of using Aupare. The additional fee, which will be about 2000 won per normal use and more for advanced use, benefits *Plus1*.

The first aim is market entry, but the long-term pricing strategy is to raise the price when a strong position is reached because worth grows when people get used to the service Aupare offers. *Plus 1* will attempt to have several companies subsidizing Aupare:
The company/landlord that runs the apartment building: The device will be installed and then added to the rent - to the price of the apartment as an additional service like it is done with elevators, central heating systems, etc. The amount depends on what the renter is willing to pay for the option to use Aupare. This could be about 5000 won per month. If the costs should be recovered in one years, that gives 5000*12months*50apartments= 300,000 won per Aupare[1]. This of course could be more for an advanced version of Aupare.
The delivery company: Fuel savings through elimination of redeliveries and reduction of delivery to multiple locations, convenient package pickup option and potential for greater delivery volume due to partnership in a system providing convenient delivery options and services will encourage them to subsidize Aupare. The amount a company might be willing to pay can easily be calculated. The delivery company will be willing to pay as much as it looses by doing multiple delivery attempts. Consider Germany as an example[2]: the average price of sending a parcel is for instance 3.90€[3], final distribution is 15% of the cost. 50% of the parcels need multiple attempts, the 2nd one is free but the total costs are approximately double as high as for the first attempt, because the parcel needs to be taken back to the companys' storage and then out again. So 10% of the fee is wasted for multiple attempts. Lets say the company´s interest is 12%, then the total saving per package is 3.90€ * 0,10/1,12 = 0.35€ (500 won for Korea). In Germany about 0.7 Mrd[4] parcels are delivered in one year (to private households). The average person receives 0.7Mrd/82Mio=8.5 packages a year. 45Mio people live in circa 0,9Mio apartment buildings and can be served by Aupare. So the total saving per year is: 8.5*45Mio*0.35€=134Mio€ and according to this, the delivery company will pay 8.5*45Mio*0.35/0.9Mio€≈1.60€ (2000 won)
The retailers: Additional customer loyalty and potential for greater order volume due to part-

[1] Calculation is done with the average size of Aupere, which provides an average apartment building with 50 apartments Product manufacturing costs described in the next section.

[2] Calculations with Germany as an example are done here to signify cost calculations for this country as well. However, when deciding price for the product in the secondary market, a premium might be charged

[3] This is the price for the most frequently delivered package size.

[4] Number of parcels delivered to private households per year is not published by German delivery companies.

nership in a system providing convenient delivery options and services as well as significant reduction of delivery costs for retailers who provide their own delivery services by eliminating the constraint of delivery time slots, the expense of dealing with peak deliveries, the need for redeliveries will encourage the retailers supporting Aupare. Retailers who cooperate with delivery companies will support *Aupare* in marketing; retailers will be charged the same amount i.e. 1.60€ or 2000 won per *Aupare* per year.

The above subsidizations show that retailers, delivery companies and apartment landlords must be approached and a balance must be attained. Although it is difficult to summarize the cost of an *Aupare,* the initial price of the product will be about 300,000 won charged to the apartment complexes. Delivery companies that chose to be linked with the *Aupare* network will be charged a one time fee of 200,000 won and 2000 won per *Aupare* year. In addition, retailers who chose to be linked with the *Aupare* network will be charged the same price of one time fee of 200,000 won and 2000 won per *Aupare* year. However, negotiations will be permitted whereby delivery companies and retailers might get the option of paying one time amount upfront for 10 year contracts on all *Aupares.*

The sales volume and the pricing for the secondary will largely depend on the success of the strategies in the primary market. Reactions to different marketing campaigns will be taken into account along with the difference in the market behaviour itself. Initially, the target will remain at 0.25% of market yielding approximately 21000 units in sales in the first one year of launch.

Marketing campaigns will focus mainly on the benefits of the product and also its retrofitting abilities. *Aupares* being highly modular will be able to sustain this marketing feature as it would be having the provision to fit into any kind of space available on the premises of the building.

Product Manufacturing Costs

See Section 5 for details

Marketing and Distribution Strategies

Since this product would enter a market where somewhat similar products exist, Plus 1 would have to market using the following strategies:

Product: The first and foremost, the marketing strategy would target the benefits that *Aupare* has compared to its competitors. Infact, if all of its features were marketed, then the competitors would be irrelevant as currently, there is no product that has all of the features as *Aupare.* The internet ready features would and the resulting economical benefits yielded to all segments, the delivery companies, the end customers (residents) and to the retailers will be marketed. It would be more of an awareness of the product rather than a gimmick.

Promotion: The promotion channels that would initially be used include articles in magazines. Other channels of outreach would be mail-ins sent out to retailers which would make them

aware of the benefits *Aupare* would have on their sales and growth. For mass retailers that have net sales of over 10 million dollars per year and for large delivery companies such as DHL, personalized sales staff would be sent out and presentations would be made. These presentations would include metrics and quantitative data on the net savings *Aupare* could potentially create for them. They would also be given the option to purchase *Aupares* if they chose to install them at their own convenient locations, perhaps somewhere in the central region of downtown to serve as a distribution center for their redeliveries.

Recipients as targets: As our product is a service for the customer, there is no need to worry about distribution to them. The customer just has to be canvassed. This will be eased because our main customer is clearly defined as an office worker. They will be reached through publicity, which will be placed in order to avoid wastage. For example posters can be put next to post-offices, inside office-buildings or shops, which provide the service. Also flyers can be offered on seminars and courses our customers take part in. Effective are also pop-ups or banners on specific websites (retailers and online-shops). In cooperation with delivery and retailer companies it is also possible to get in touch with customers directly via email.

Aupares will be sold solely through the company's network because of the flexibility of the product's demand. Moreover, the modularity of the product would require *Plus 1* to manufacture to requirements. These factors would also account a great deal when negotiating and deciding a price that might be charged for an *Aupare.*

Product Changes for the Secondary Market

For launch in the secondary market, a few changes have to be made. Dimensions will change because average parcel-sizes are bigger and number of boxes in an average *Aupare* will be smaller. Arrangement of numbers on the pin-pad needs to be changed as well as the look of control elements because market research identified Western European people's wish for simpler and less technical looking control elements.

These changes are mostly aesthetic or concerning dimensions and easy to achieve. Furthermore we expect a stronger need of oversized boxes and lower need of fridge/frozen-boxes. But these differences do not need to be considered as *Aupares* with advanced functions are manufactured for individual wishes, anyway.

Secondary Market Launch

Secondary market launch is planned not more than a year after the primary launch. The problem to get seed capital is not grave because sources of providing subsidization are existing. Market research shows that the mood for saving fuel because of raising oil-prices and protection of the environment as well as rising rates of online shopping support fast market launch also in Western Europe. The timing of the secondary market launch is also dependant on the available labor resources and the time required to support the demand. The performance in the primary market might also influence the timing and the marketing strategies.

8. PROJECT SUMMARY

Concluding the project, it may be rightfully said that the team realized the objectives it set out to attain. The product design satisfies all of the conditions necessary to perform. The skills that the team possessed were put to good use in the design and prototyping phase. Structural analysis, material selection, prototype definition and configuration, its manufacture in a dispersed environment were completed successfully.

Aupare satisfies the requirements of enabling closed-loop economy by being internet ready. A few of the market needs and their satisfaction by being internet ready are described below:

- Communication between the recipient and the delivery person in order to enable remote inspection of a package before accepting it
- The closed loop economy formed by savings in fuel wasted in redelivering packages
- Other economies include savings in package handling, inventory and labor involved associated with re-deliveries
- Packages received by recipients early combined with the previous benefits would lead to growth of the package delivery industry.

9. LESSONS LEARNED

9.1 Objectives Achieved

Objectives that were identified at the start of the project both in terms of the group as a whole, and the project itself in particular and the completion of the same are as follows:

- *Identifying a realistic need in the market, one that might have even been experienced by one or more of the team members:* This objective, as perceived by the team was achieved in totality. The requirement of a system that would accept packages in the absence of residents was definitely needed and had been experienced by all of the team members. Although, not all of them believed that they would invest in a product like this, there were none that were averse to the idea of having one in their apartment complex.
- *Establishing a rationale for the requirement and marketability of the product in a global market:* Analysis of global markets revealed that the product could be marketed in several countries. However, *Aupare* would have to be greatly modified to be compatible with single owned houses. Moreover, the economics would not permit the installation of the system in these houses with the exception of the elite segment of the market. Nevertheless, the team believed that this objective was achieved around 75%. This is because apartment complexes equipped with internet are common in the metropolitans of all developed countries and also some developing countries. Market sizing as described in an earlier segment also supports this hypothesis.
- *Internet readiness enabling a closed loop economy:* This objective is believed to be

achieved 100%. The reason being that all of the savings that this product generates for both, the residents and for the delivery cos. is owed to the internet readiness of the product. An initial study had revealed that although similar products were launched in the past, they failed because validation on delivery was a key aspect delivery cos. required which was difficult to dynamically implement in the absence of internet.

- *Understanding the global nature of markets:* An understanding of the global nature of markets was attained by all members of the team. This objective may be quantified as 80% achieved as a lot of the understanding was limited to developed countries only.

9.2 Lessons Learned and Communication modes used

Salient points of the project, apart from the engineering aspects, also included a learning experience. This was from two perspectives, learning from others' expertise, and learning how to interact in a dispersed environment. We learned that to make the best of the team, and to bring out the best in others, camaraderie is foremost important. It is only when each member knows the other at an informal level that they can function effectively. Some of our recommendations for future teams include: making friends with all teammates early, identifying strengths and weakness, making sure each member knows at the beginning, the time commitments everyone can make during the course of the project, prioritizing correctly and most importantly to have a positive outlook and having fun.

The communication modes used in our team included emails, voice conferencing and video conferencing. Files that were completed were stored on the course website from where other members could download or view.

10. ACKNOWLEDGEMENTS

The team members of *Plus 1, Inc.* would like to thank Prof. Dr. Suk Won Cha, Prof. Dr. Jongwon Kim, Dr. Kazihuro Saitou, Dipl. Wi-ing. Semih Severengiz, Dr. Lalit Patil, Prof. Dr. Debasis Dutta and Prof. Dr. Seliger for organizing lectures and bringing the team together. We additionally thank Prof. Cha, Dr Saitou and Dipl. Wi-ing. Semih for providing valuable insights and assistance in idea finalization at the team's conference in Seoul.

The team would also like to specially thank Andreas, the technician at TUB, without whose help, the manufacture and assembly of the prototype would not have been possible.

11. REFERENCES

- The Roundtable on International Parcel Delivery held in Paris on October 6th, 1996 by the Committee on Consumer Policy. Organization for Economic Cooperation and Develop-

ment (OECD)
http://www.oecd.org/LongAbstract/0,3425,en_2649_33703_2385269_1_1_1_1,00.html

- Existent idea search and results http://www.strategy-business.com/press/16635507/19877
- Data search for households and turnover for German postal services that have a co-operation with DHL
    - http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Publikationen/Querschnittsveroeffentlichungen/StatistischesJahrbuch/Downloads/Bauen,property=file.pdf
    - http://finanzberichte.dpwn.de/2001/gb/dp2001de/storage/dpreport/express_de2.pdf
    - http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Publikationen/Querschnittsveroeffentlichungen/Datenreport/Downloads/1Wohnen,property=file.pdf
- Website used for searching for patents http://search.wips.co.kr/
- http://www.strategy-business.com/press/16635507/19877
- http://www.businessweek.com/2000/00_50/b3711085.htm
- http://www.freepatentsonline.com/20010034665.html
- http://www.ideo.com/portfolio/re.asp?x=50078
- http://www.allbusiness.com/retail-trade/home-furniture-furnishings-equipment-stores/4268533-1.html
- http://www.propertyweek.com/story.asp?storyCode=3002594
- http://findarticles.com/p/articles/mi_qn4158/is_20001002/ai_n14348763
- http://en.wikipedia.org/wiki/United_Parcel_Service

12. APPENDICES

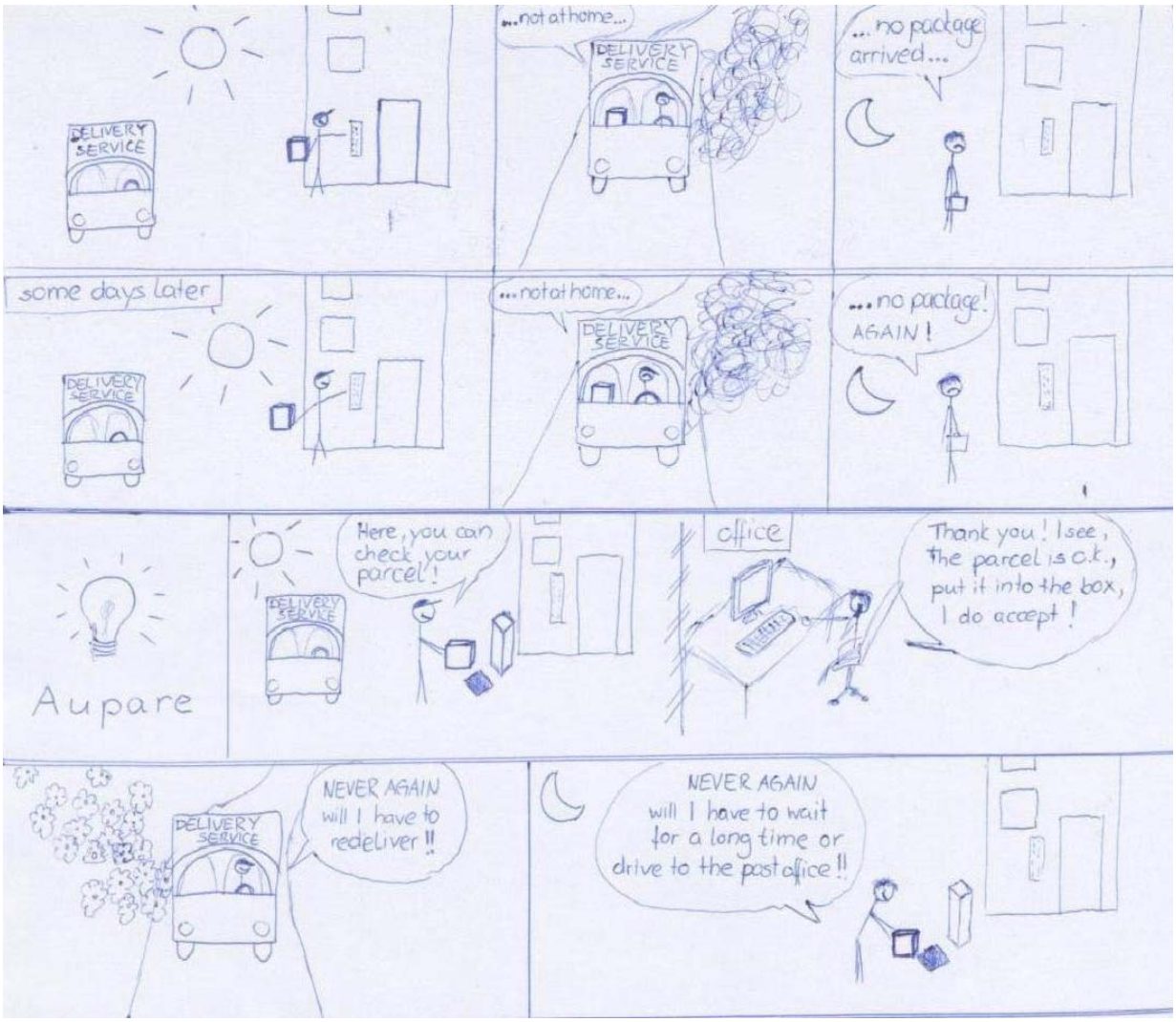
Appendix A – Details of Needs Identification Consensus

	Ease of Manufactu-rability	Marketable	Time Saving	closed loop econo-my	Internet Ready Benefits	Is it a global issue?	Total
Weight	*3*	*4*	*3*	*5*	*5*	*4*	
Smart Parking	11	20	23	18	22	21	466
Crib for Babies	26	16	15	14	20	18	429
Package Delivery	20	22	27	27	25	21	573
Alarm Clock	10	20	23	17	15	18	411
Pet Feeder	19	16	19	11	20	11	377

Appendix B – Patent Search

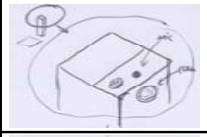
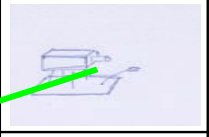
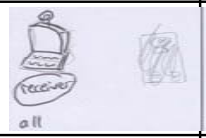
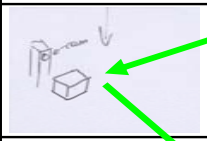
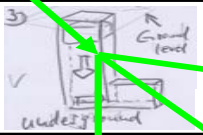
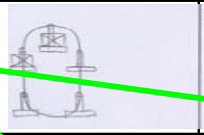
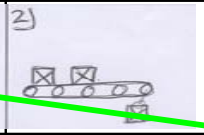
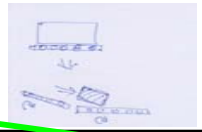
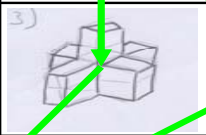
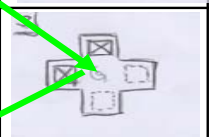
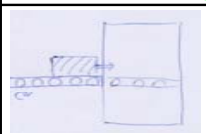
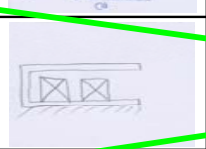
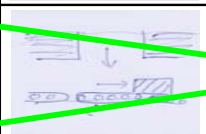
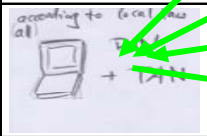
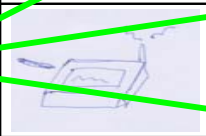
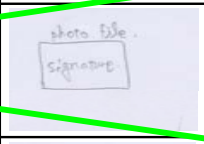
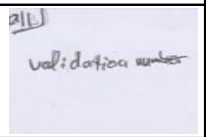
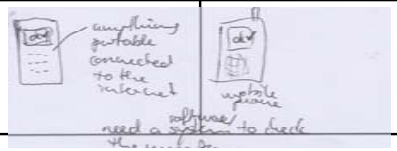
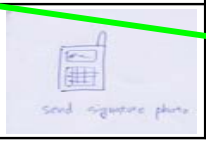
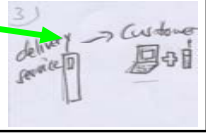
Application Number	Appl. No	Filing Date
PCT/US06/48878	2006-12-21	PROCESS OF MAKING ELECTROLESSLY PLATED AUTO-CALIBRATION CIRCUITS FOR TEST SENSORS
PCT/US06/48878	2006-12-21	PROCESS OF MAKING ELECTROLESSLY PLATED AUTO-CALIBRATION CIRCUITS FOR TEST SENSORS
PCT/US06/37259	2006-09-26	ESTRIOL THERAPY FOR AUTOIMMUNE AND NEURODEGENERATIVE DISEASES AND DISORDERS
PCT/US06/37259	2006-09-26	ESTRIOL THERAPY FOR AUTOIMMUNE AND NEURODEGENERATIVE DISEASES AND DISORDERS
PCT/US06/19796	2006-05-22	SENSOR PACKAGE WITH AN INTERIM AUTO-CALIBRATION CIRCUIT
PCT/US06/17297	2006-05-04	METHODS AND APPARATUS FOR AUTO-SUBSCRIPTION IN A NETWORK ENVIRONMENT
PCT/ES05/00658	2005-12-01	SCALABLE, FLEXIBLE, TEMPORARY SIGNPOSTING METHOD AND KIT
PCT/ES05/00658	2005-12-01	SCALABLE, FLEXIBLE, TEMPORARY SIGNPOSTING METHOD AND KIT
PCT/US05/28882	2005-08-15	A FRAME FOR BUILDING A VEHICULAR BODY WITH A LOAD BEARING SUPPORT SYSTEM
PCT/IB05/51801	2005-06-02	AUTO-DETECTION OF THE REAL END-OF-PROGRAM FOR THE CHANNEL
PCT/US04/19751	2004-06-21	POROUS GLASS SUBSTRATES WITH REDUCED AUTO-FLUORESCENCE
PCT/EP05/03290	2005-03-30	AUTO-SPLICING SYSTEM
PCT/US04/35782	2004-10-28	METHOD OF PROTECTING COPYRIGHTED DIGITAL FILES IN A DISTRIBUTED FILE SHARING NETWORK
PCT/US04/35782	2004-10-28	METHOD OF PROTECTING COPYRIGHTED DIGITAL FILES IN A DISTRIBUTED FILE SHARING NETWORK
PCT/US03/14639	2003-05-09	APPARATUS FOR RAPID AUTO-INJECTION OF MEDICATION
PCT/CN03/01027	2003-12-01	AUDIT PLATFORM SYSTEM FOR APPLICATION PROCESS BASED ON COMPONENTS
PCT/US01/42373	2001-09-28	AUTO-CALIBRATION CIRCUIT TO MINIMIZE INPUT OFFSET VOLTAGE IN AN INTEGRATED CIRCUIT ANALOG INPUT DEVICE
PCT/JP04/05414	2004-04-15	PEPTIDE HAVING HTLV-1-SPECIFIC CTL-INDUCING ACTIVITY
PCT/IN03/00047	2003-03-07	DEVICE FOR MEASUREMENT OF TISSUE HARDNESS
PCT/US03/14639	2003-05-09	APPARATUS AND METHOD FOR RAPID AUTO-INJECTION OF MEDICATION
PCT/CN01/00305	2001-02-28	A FOLDING COLLAPSIBLE STEERING LOCK
PCT/US01/15667	2001-05-16	PRE-AND POST-PROCESSING OF SPECTRAL DATA FOR CALIBRATION USING MULTIVARIATE ANALYSIS TECHNIQUES
PCT/FR02/00266	2002-01-23	CONNECTING DEVICE AND A PIECE OF FURNITURE FITTED WITH ONE SUCH DEVICE
PCT/GB01/04488	2001-10-08	AUTO ADJUSTING WELL CONTROL SYSTEM
PCT/GB01/04488	2001-10-08	AUTO ADJUSTING WELL CONTROL SYSTEM
PCT/US01/42373	2001-09-28	AUTO-CALIBRATION CIRCUIT TO MINIMIZE INPUT OFFSET VOLTAGE IN AN INTEGRATED CIRCUIT ANALOG INPUT DEVICE
PCT/US01/15667	2001-05-16	PRE-AND POST-PROCESSING OF SPECTRAL DATA FOR CALIBRATION USING MULTIVARIATE ANALYSIS TECHNIQUES
PCT/US01/13440	2001-04-27	MULTI-CELLULAR ELECTRICAL BATTERY
PCT/US01/02167	2001-01-22	AUTO-ALIGNING POWER TRANSISTOR PACKAGE
PCT/US01/02266	2001-01-23	METHOD AND SYSTEM FOR DESCRIBING AND EXTRACTING APPLICATION INFORMATION
PCT/US99/10583	1999-05-13	NETWORK BASED MULTIPLE SENSOR DEVICE
PCT/US97/18372	1997-10-01	TIME-SHIFTING APPARATUS AND AUTO-EDIT SYSTEM
PCT/NL98/00034	1998-01-20	USE OF FOOD PRODUCTS FOR PROTECTION AGAINST RADICALS
PCT/US97/19539	1997-10-10	MAIL NOTES INTERFACE WITH AN AUTO-HIDEABLE TRAY FUNCTIONING WITH VARIOUS E-MAIL SYSTEMS
PCT/US97/06371	1997-04-23	MOLDED FLEX CIRCUIT BALL GRID ARRAY AND METHOD OF MAKING
PCT/US95/09749	1995-08-01	DENTAL HANDPIECE HYGIENIC PHARMACEUTICAL STERILIZATION LUBRICANT
PCT/GB95/01306	1995-06-06	BRAKE LINING WEAR SENSING SYSTEM
PCT/US92/05759	1992-07-09	TELEPHONY SYSTEM WITH SUPERVISORY MANAGEMENT CENTER AND PARAMETER TESTING WITH ALERTS
PCT/US82/00826	1982-06-16	APPARATUS FOR MOLDING CONCRETE ARTICLES AND THE LIKE
PCT/US79/00949	1979-11-06	ROTARY LOADER AND STORAGE SYSTEM

Appendix C – Concept - Storyboard



Appendix D – Chart showing Working Principle and Sub-Functions – Concept Design 3 – DR1 Consensus

Concept design 3

Working principle / Sub function	1	2	3	4	5	6	7
1. Communicate with receiver							
2. Inspect the parcel							
3. Secure storage							
3.1 Movement							
3.2 Storage							
4. Validation							
4.1 Signature							
4.2 Message							

Appendix E – Design Alternatives

Figure 4 - Design Alternative 1

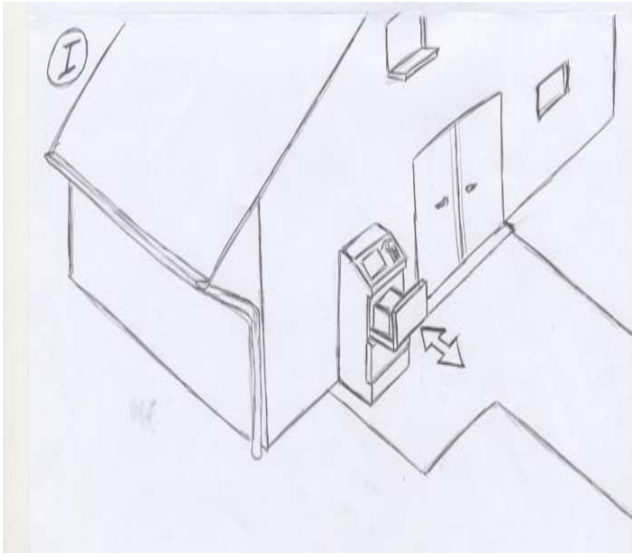


Figure 5 - Design Alternative 2

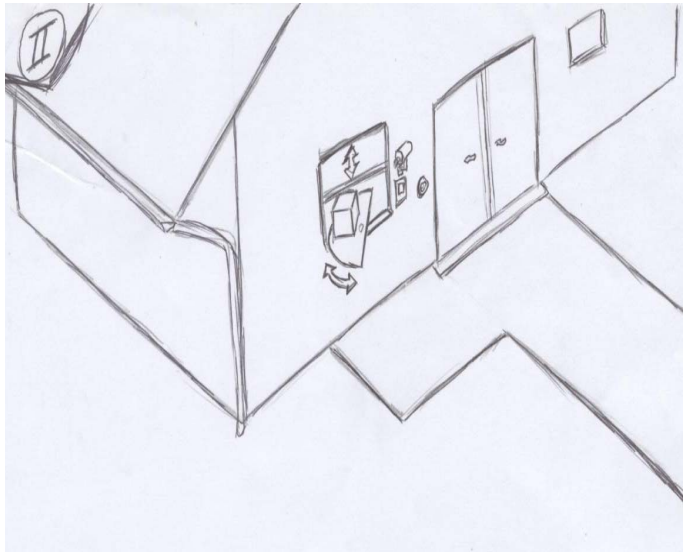
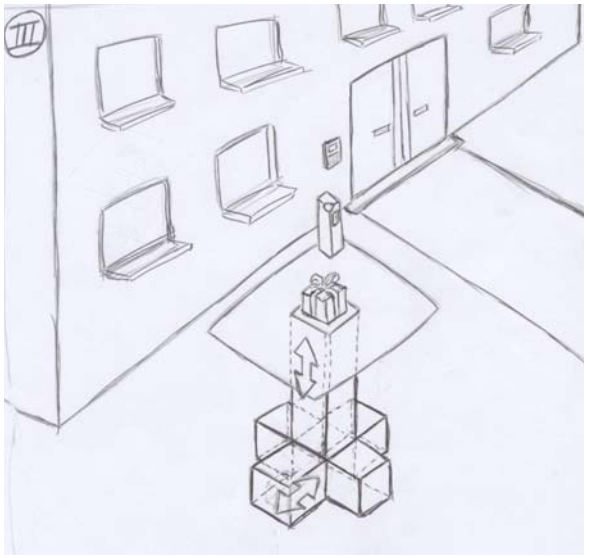
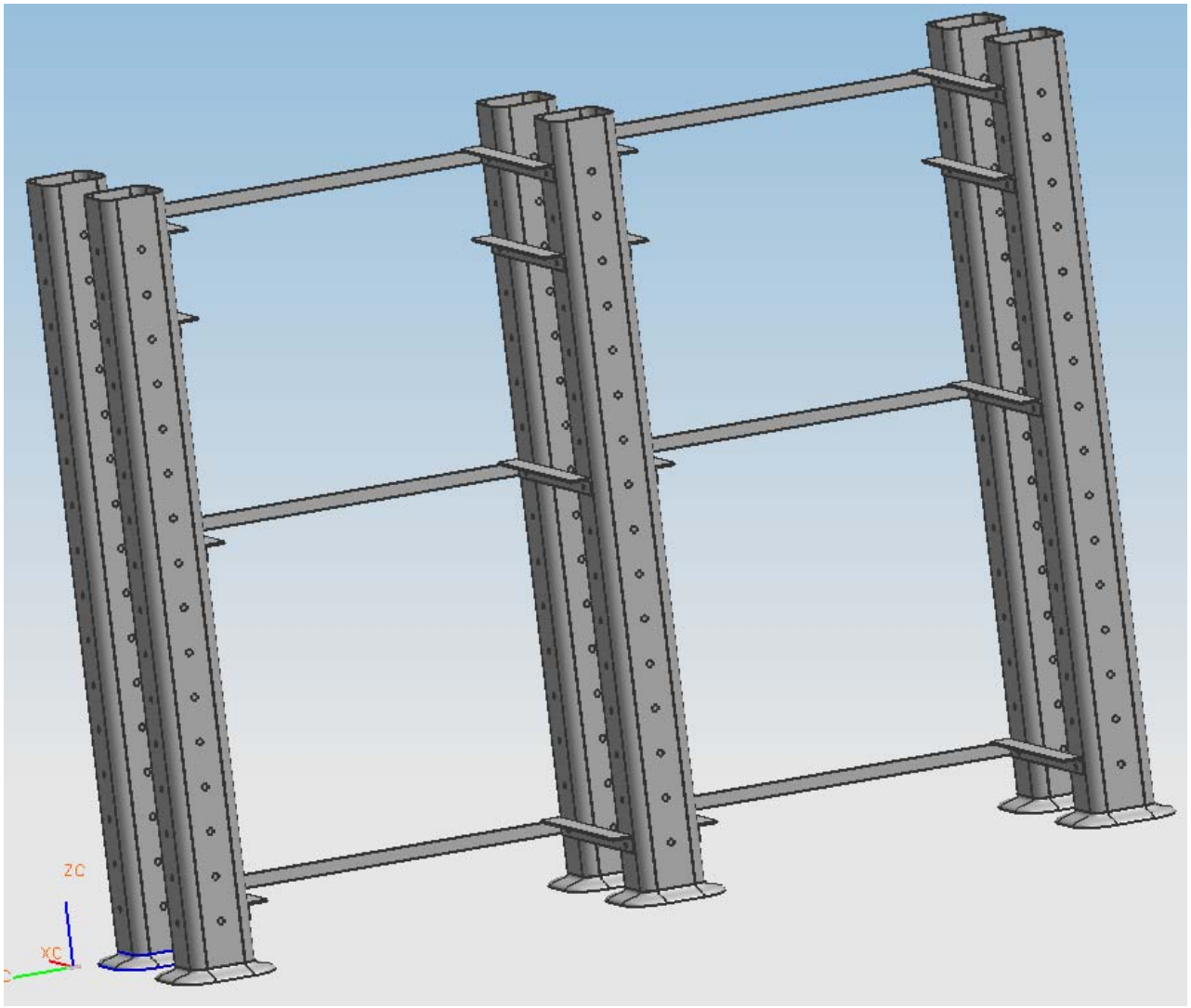


Figure 6 - Design Alternative 3



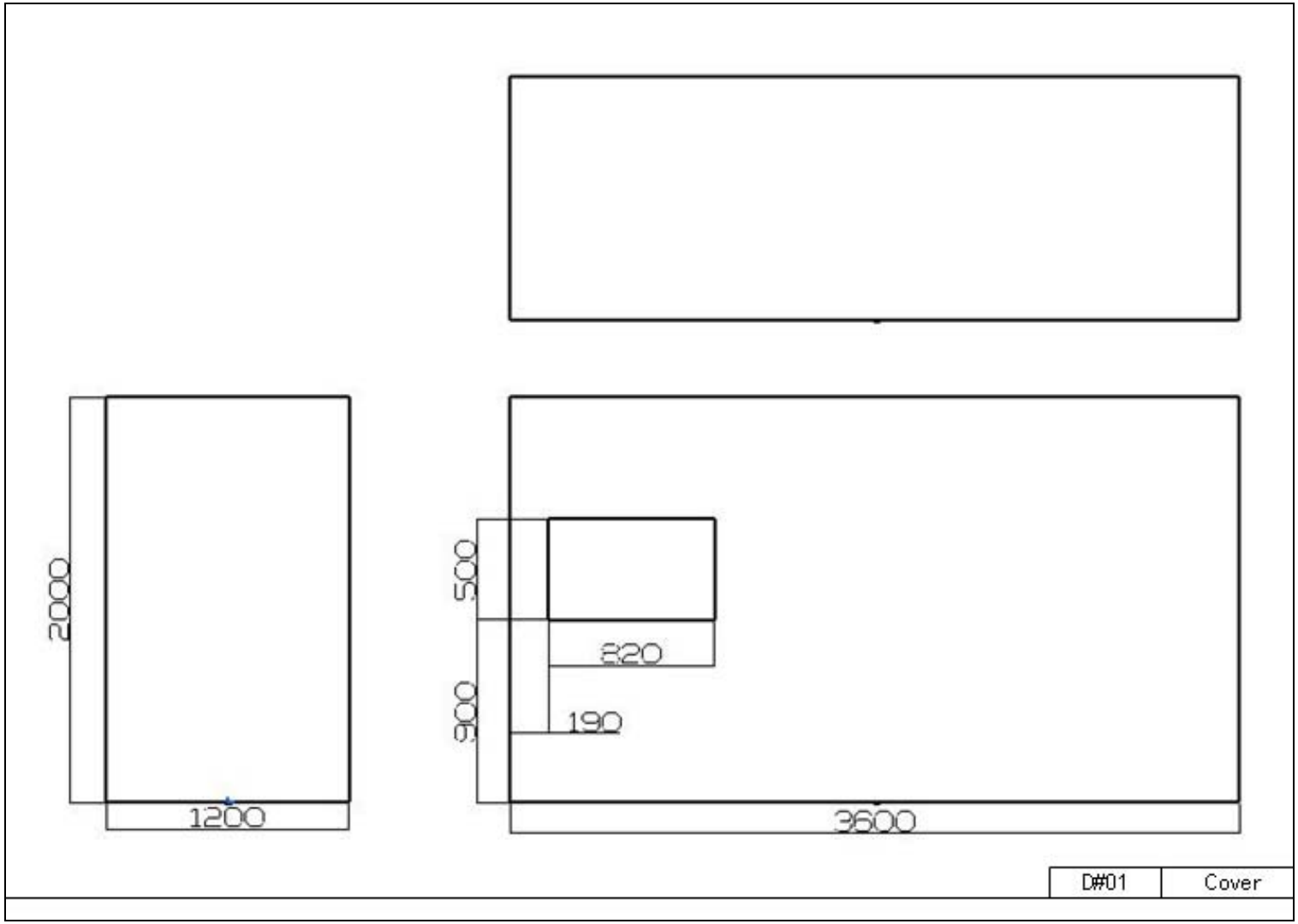
Appendix F – Model of Frame forming the chambers of storage

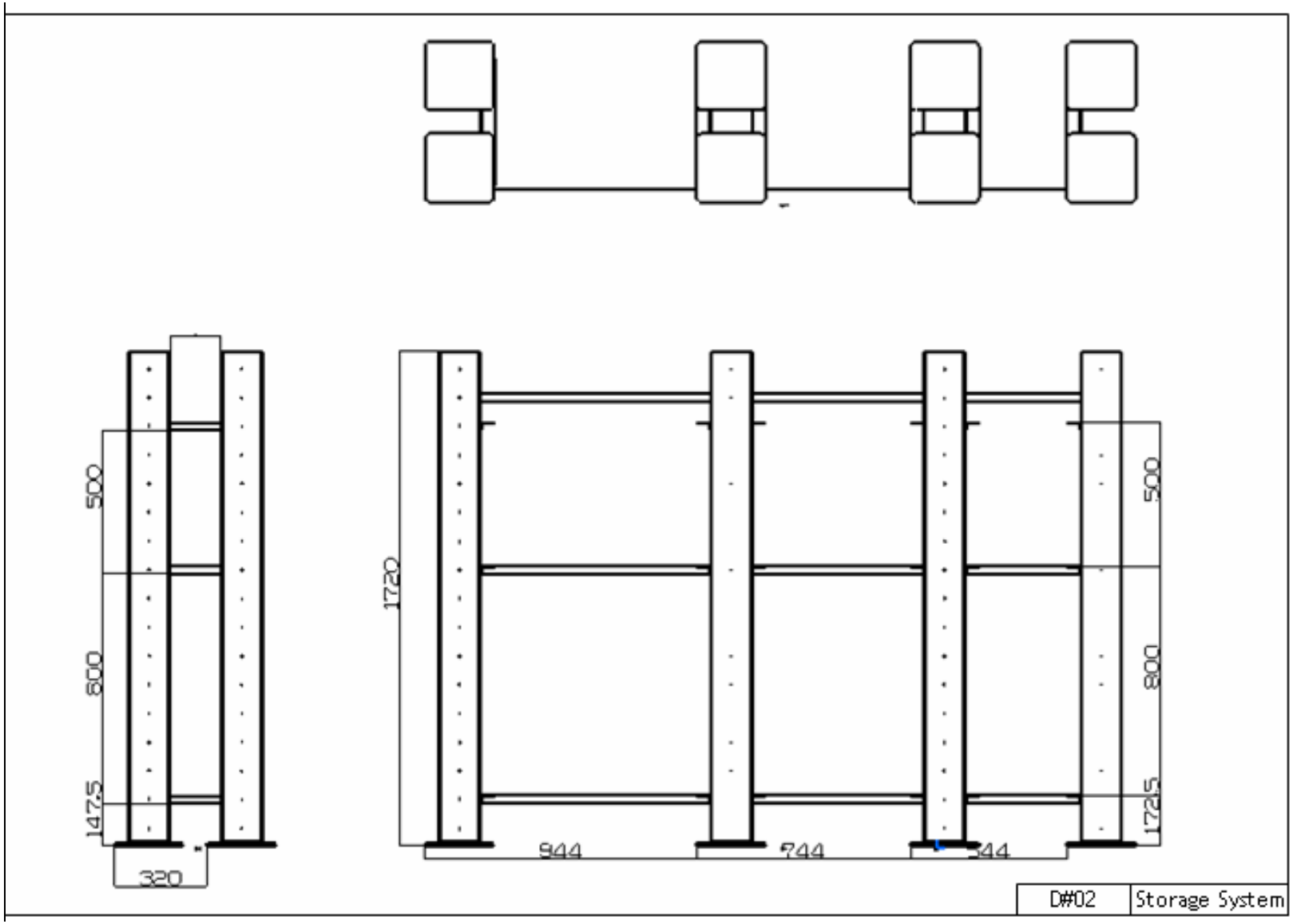


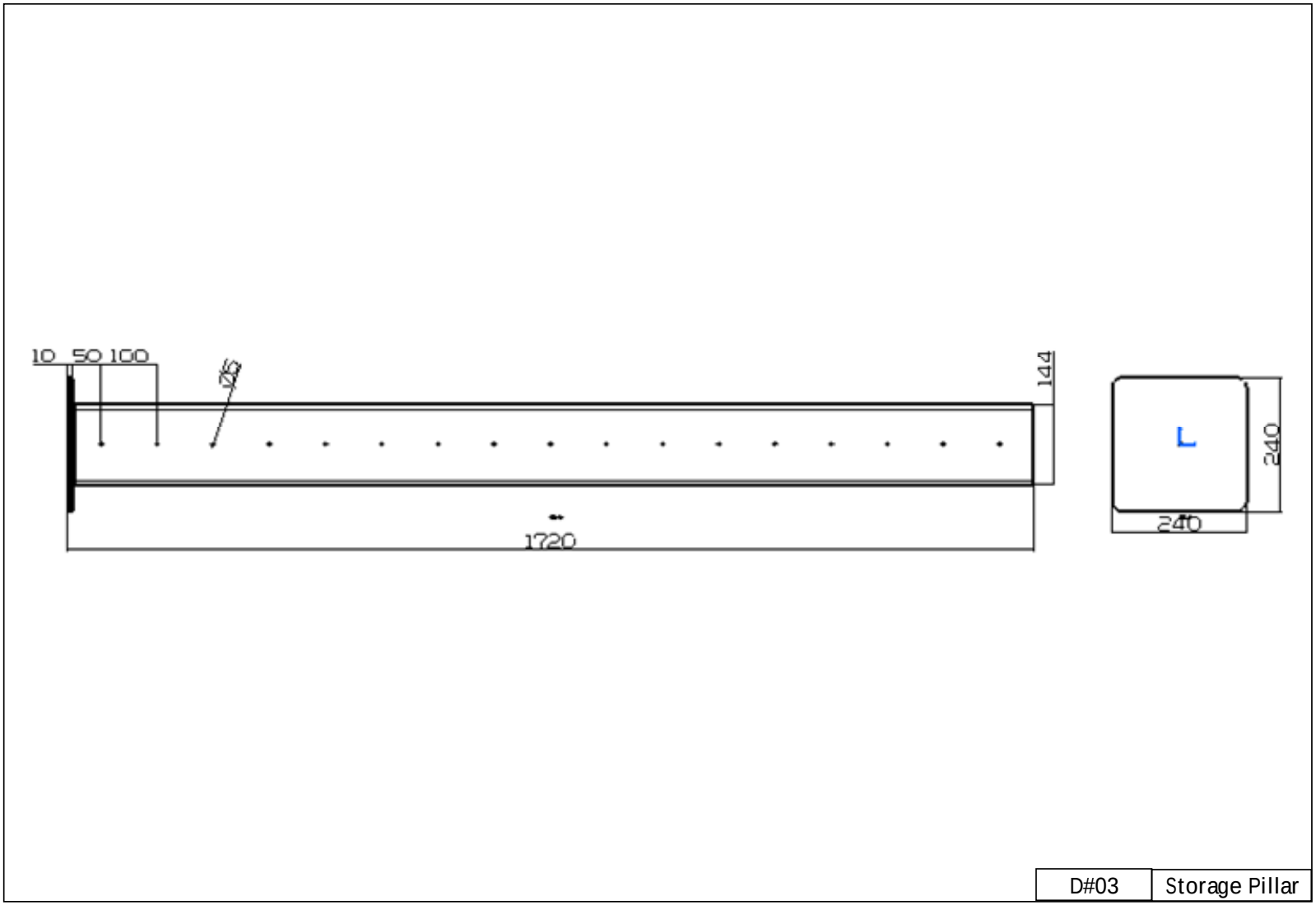
Appendix G – Secondary Market Sizing

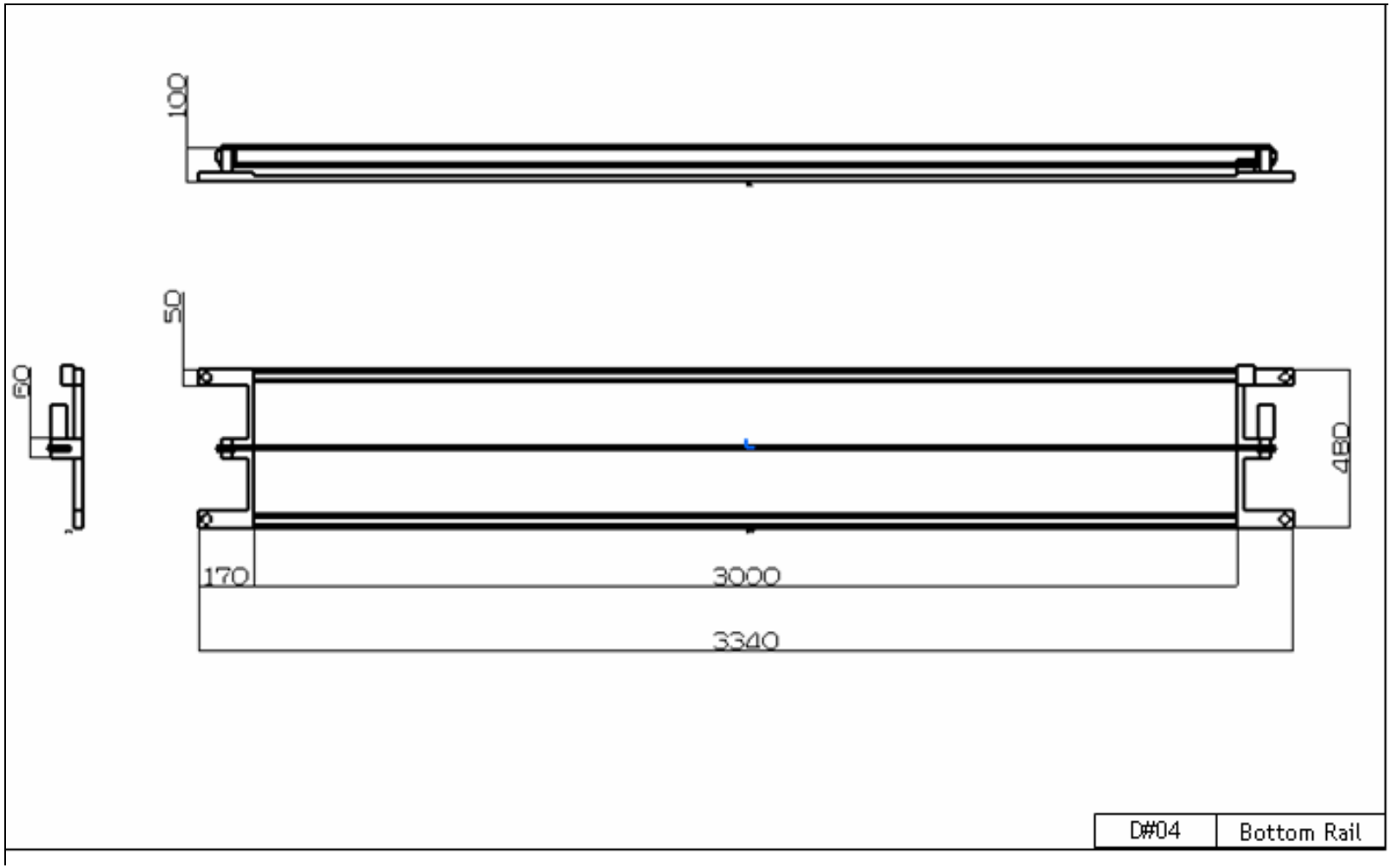
Population of Germany	82.4	million
Average family size	2.5	
Average number of families	32.96	million
Approximate percentage people living in apartments	74	%
Approximate number of families living in apartments	24.39	million
Average number of apartments per building	20	
Approximate number of apartment buildings	1.2195	million
Approximate percentage people living in row houses	8.5	%
Approximate number of families living in row houses	2.8016	million
Average number of houses in a row houses (combining neighboring row houses)	10	
Approximate number of row houses' units	0.2802	million
Total of apartment buildings and row house units	1.4997	million
Factor for families owning more than one apartment/row house	1.3	
Normalized Total based on above factor	1.9496	million
Approximate percentage of apartments and row houses equipped with internet *(Aug 2006)*	75	%
Total considering above internet	1.4622	million
Average Internet speed = 6 Mbps	6	Mbps
Population of European Union (27 states of the EU) = 490.5 million *(July 2007)*	490.5	million
Assuming direct relation between Germany and rest of EU, Market for Aupare	**8.7039**	**million**

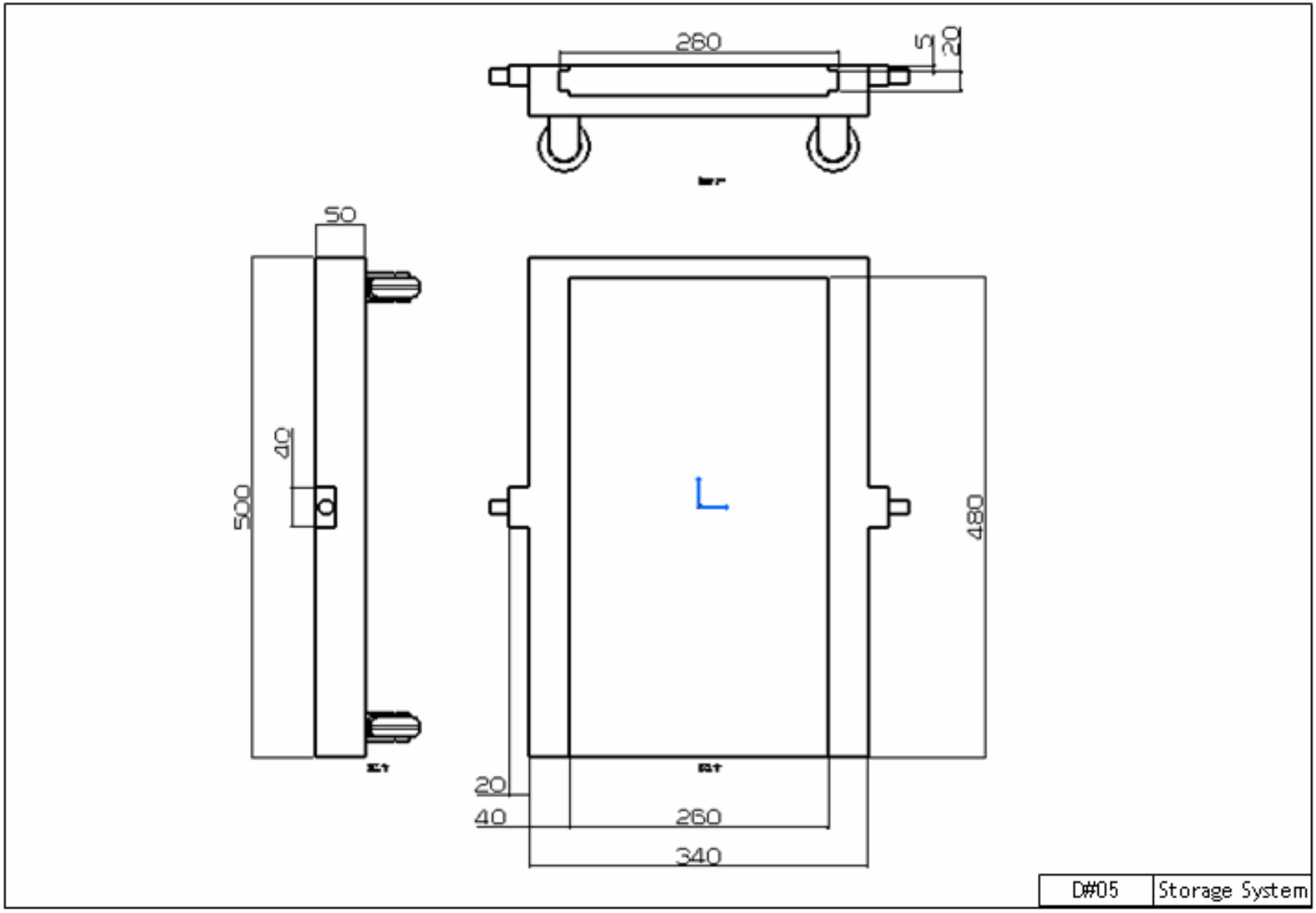
Appendix H – Aupare Production Drawings

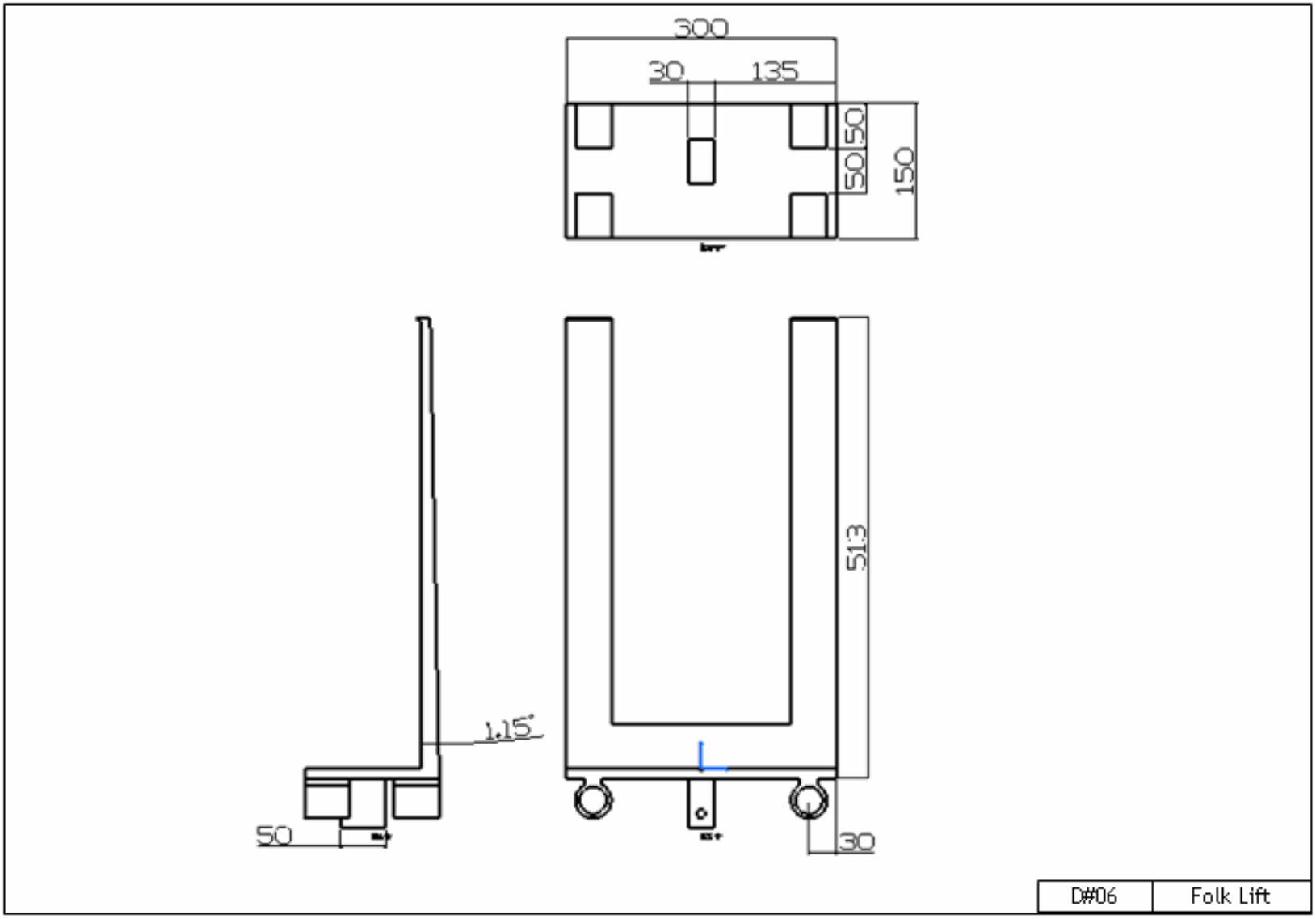


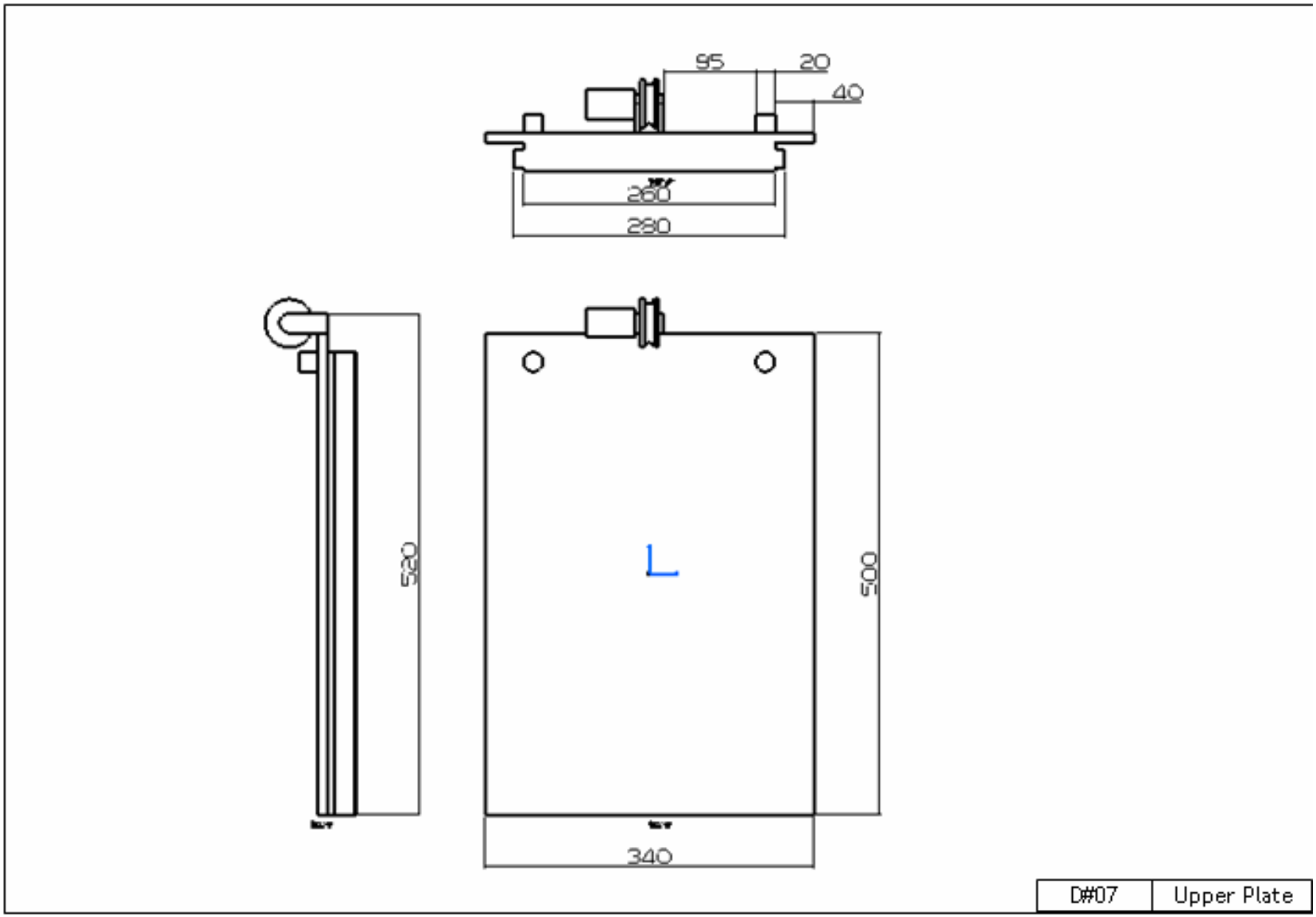

500
800
147.5
320
1720
944
744
344
500
800
172.5
D#02
Storage System


10
50
100
Ø6
144
1720
240
240
D#03
Storage Pillar

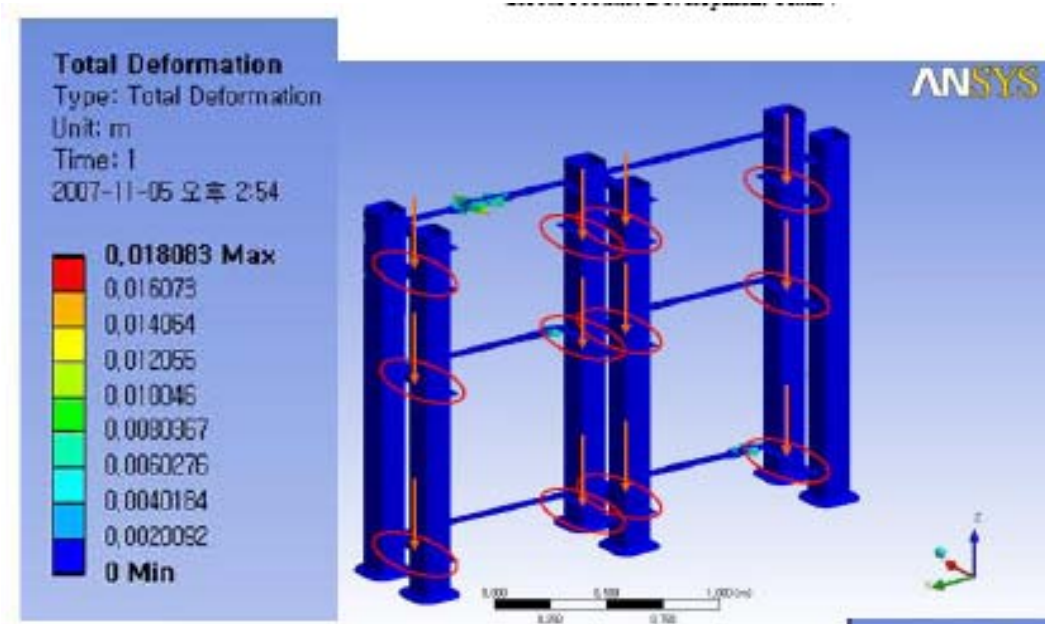

100
50
60
480
170
3000
3340
D#04
Bottom Rail

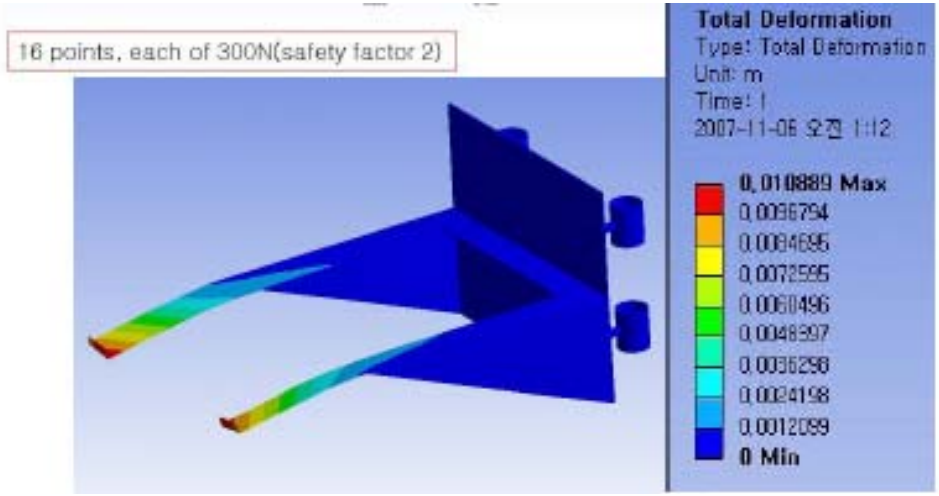

260
5
20
50
40
500
480
20
40
260
340
D#05
Storage System

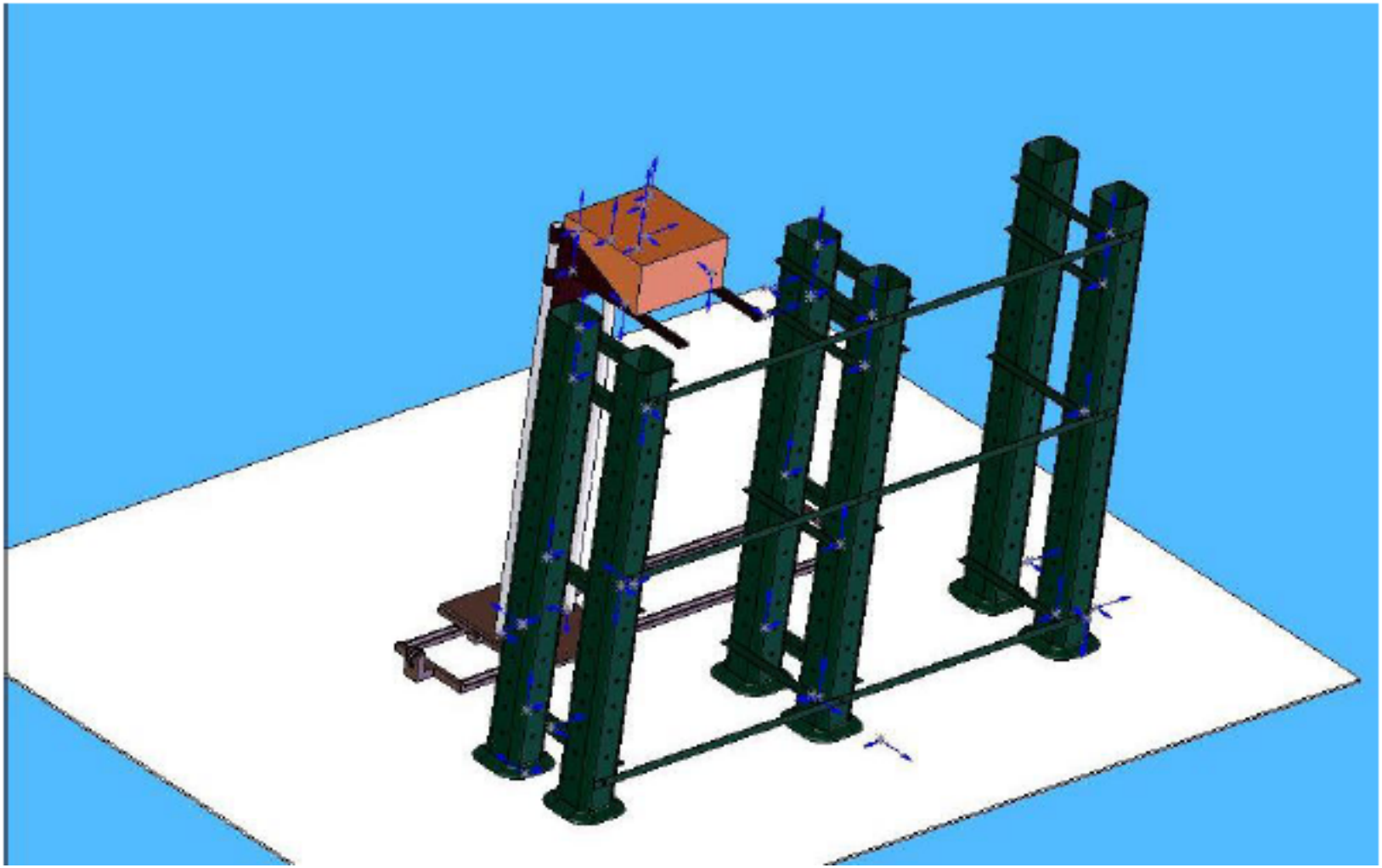

300
30
135
50
50
150
513
1.15"
50
30
D#06
Folk Lift


95
20
40
260
280
520
500
340
D#07
Upper Plate

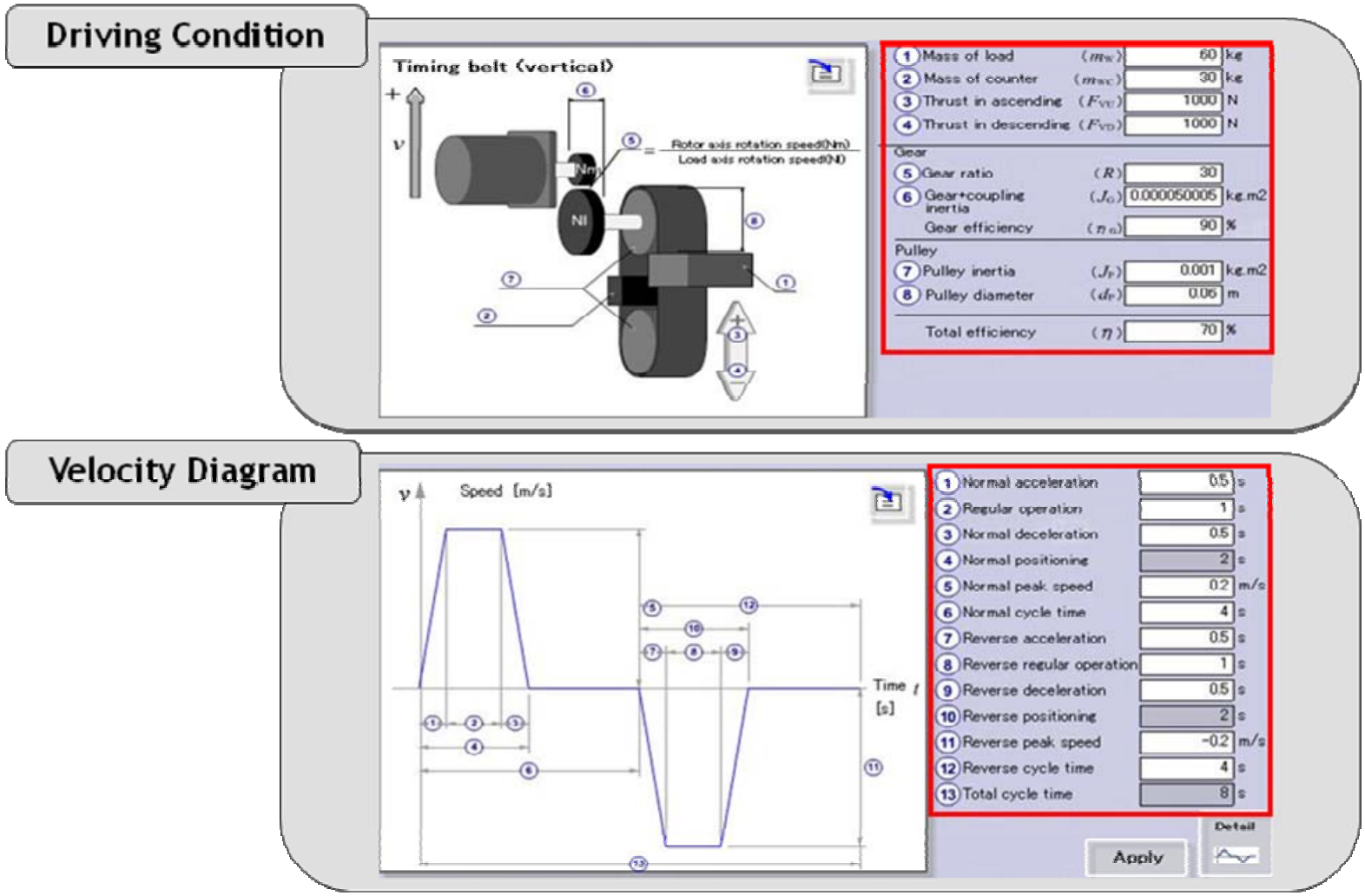
Appendix I – Structural Analysis



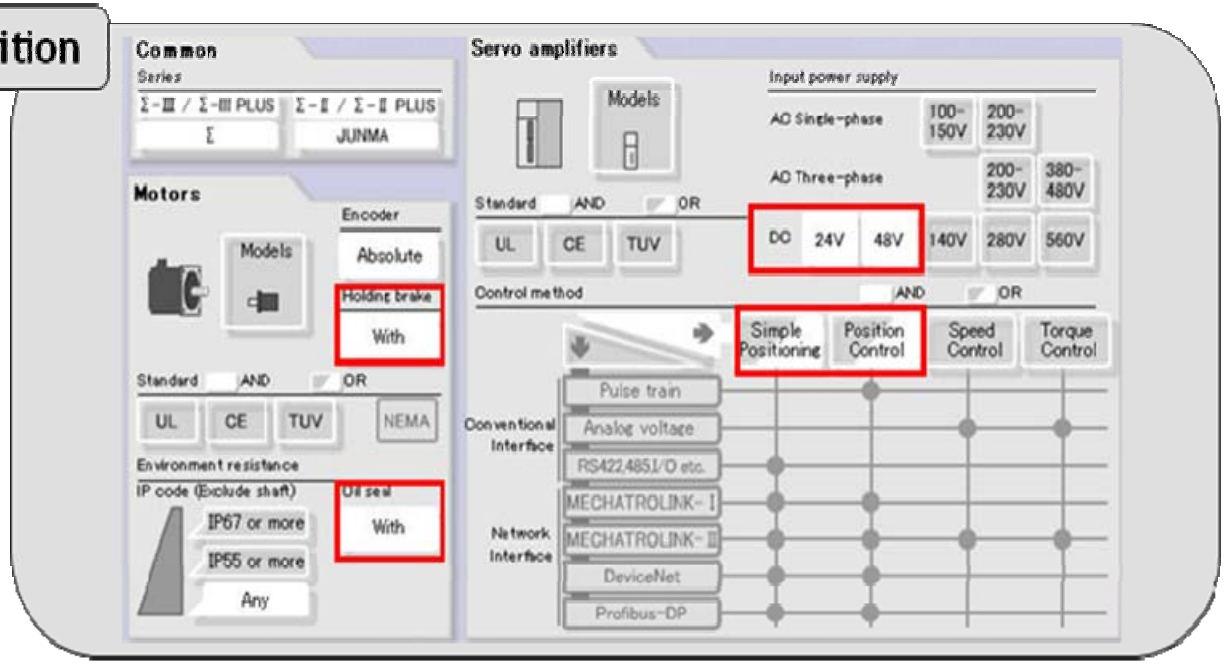




Appendix J – Motor Selection



Operation Condition



Motor Selction