Gas cylinder transfer system for gas cylinder delivery person

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Under the guidance of
Dr. G. G. Ray

India has over 150 million LPG cylinders and on an average seven million cylinders are circulated in the market every year.*(Reference- The Hindu, 02/02/2008)*

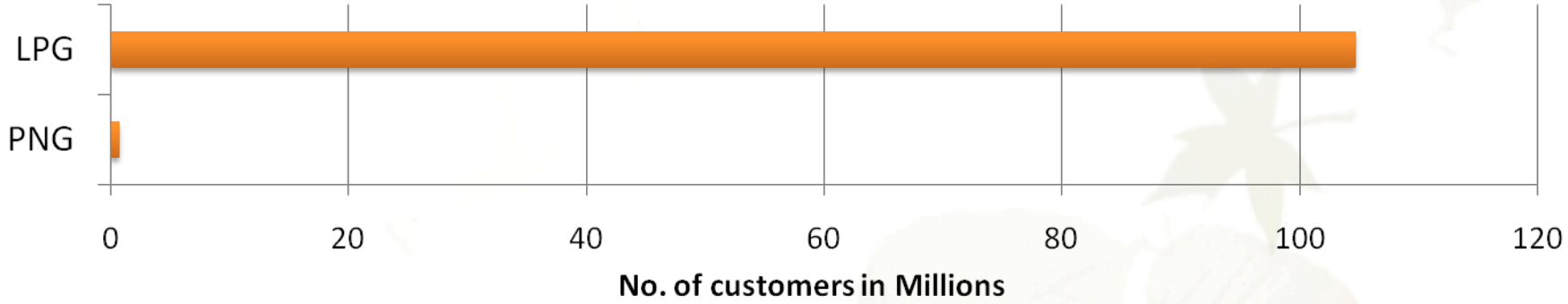
55 million new LPG connections by 2015 *(Reference- Rediff Business, 15/07/2008)*

It means…

Year	No. of cylinders in millions
2009	150
2015	(150 + 55x2) = **260***

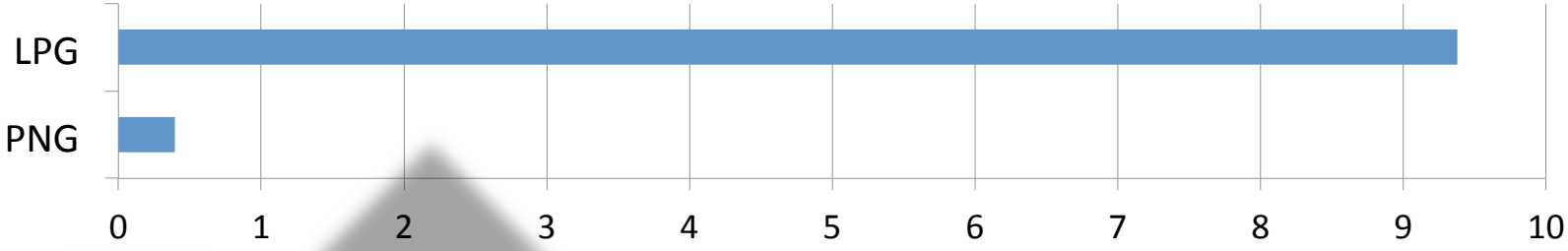
* - assuming only one gas cylinder per new LPG connection

Alternative… PNG?

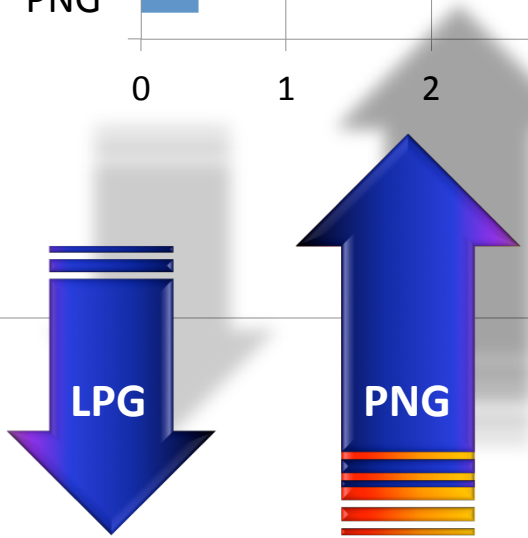


As on 1.10.2008, LPG customer population covers approximately 53% of country's total population.

Alternative… PNG?



No. of distributor/Pumping stations in Thousands

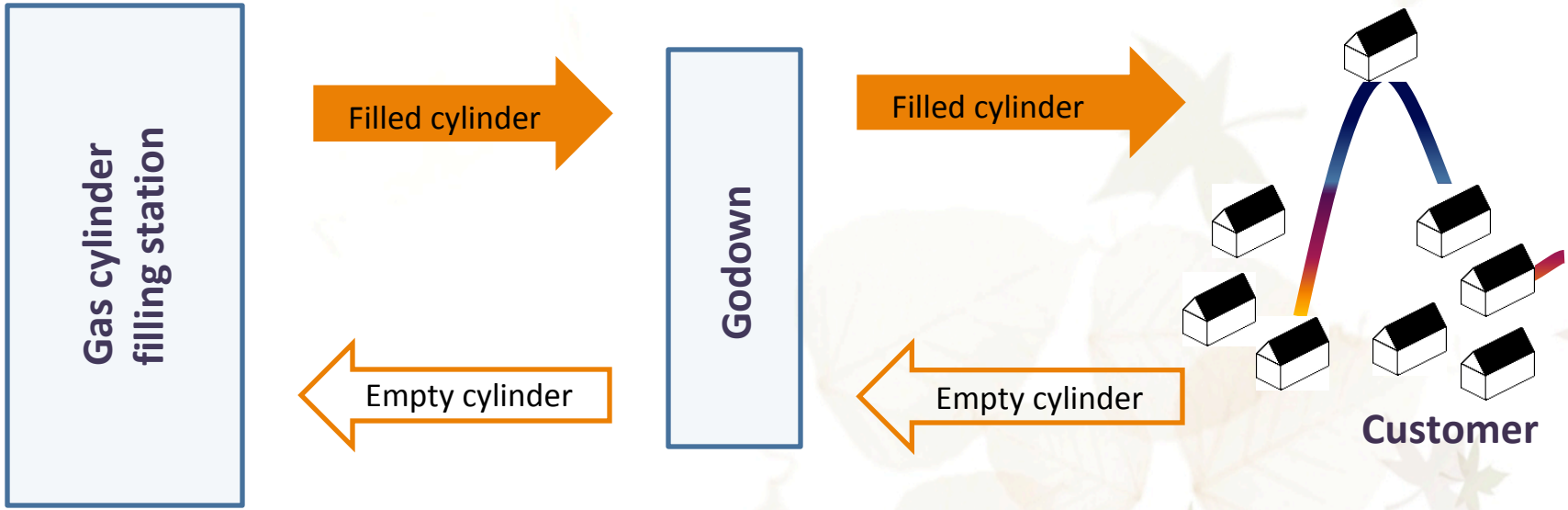


IMPORTS

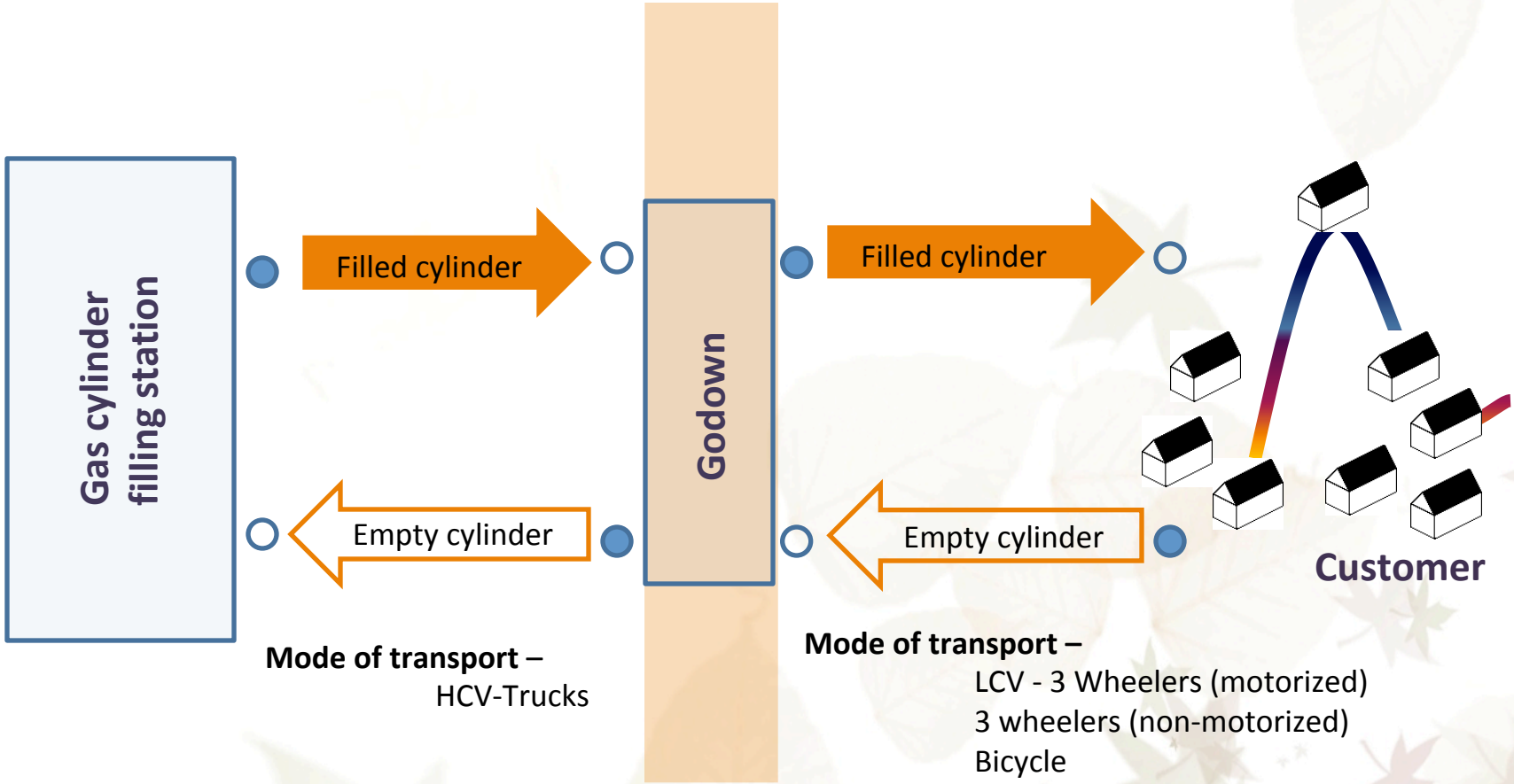
PNG **LPG**

BTU Comparison between LPG & PNG

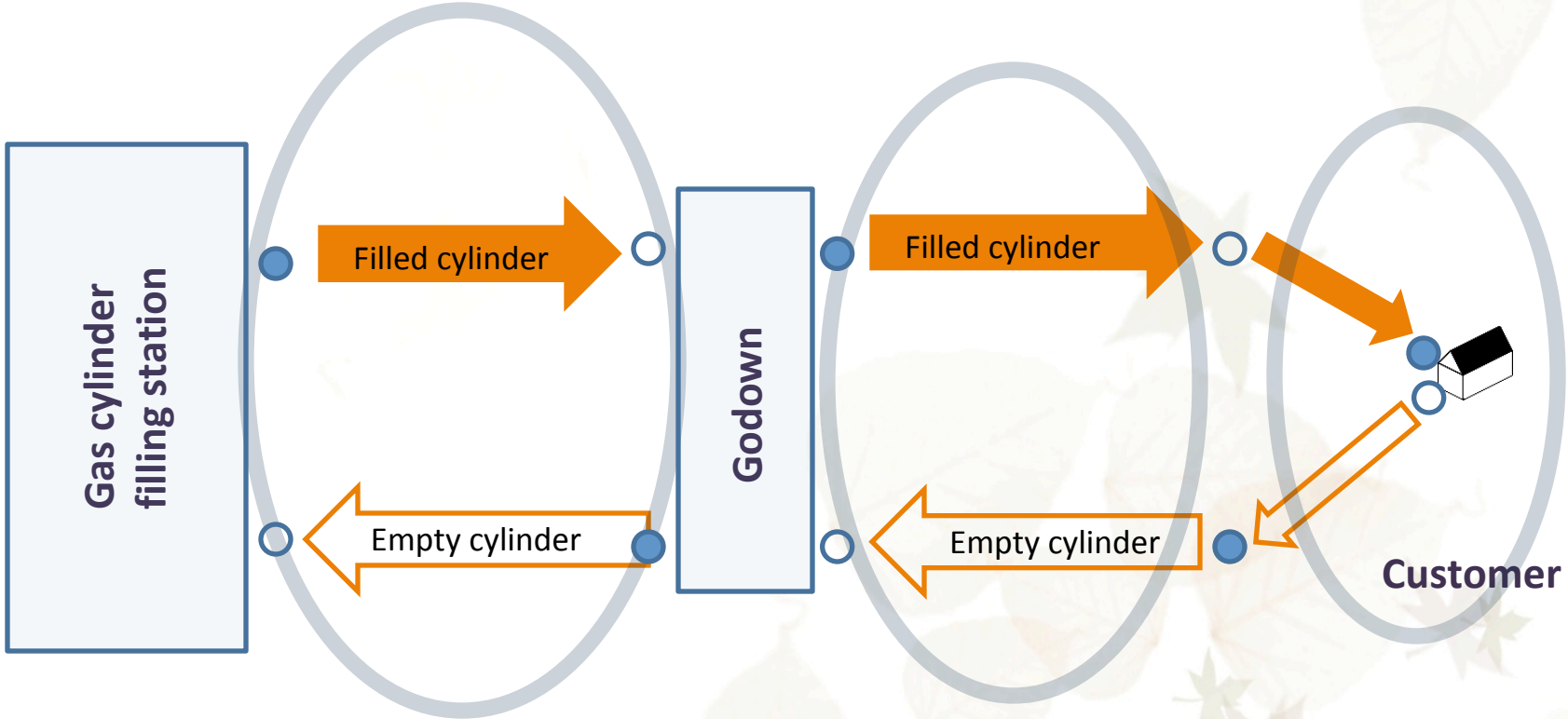
Where do they come from and Where do they go?



How do they travel?



How do they travel?



1 300 cylinders in HCV

2 35 cylinders in LCV
3 Cylinders on cycle

3 1 cylinder on shoulder

- Loading - Unloading

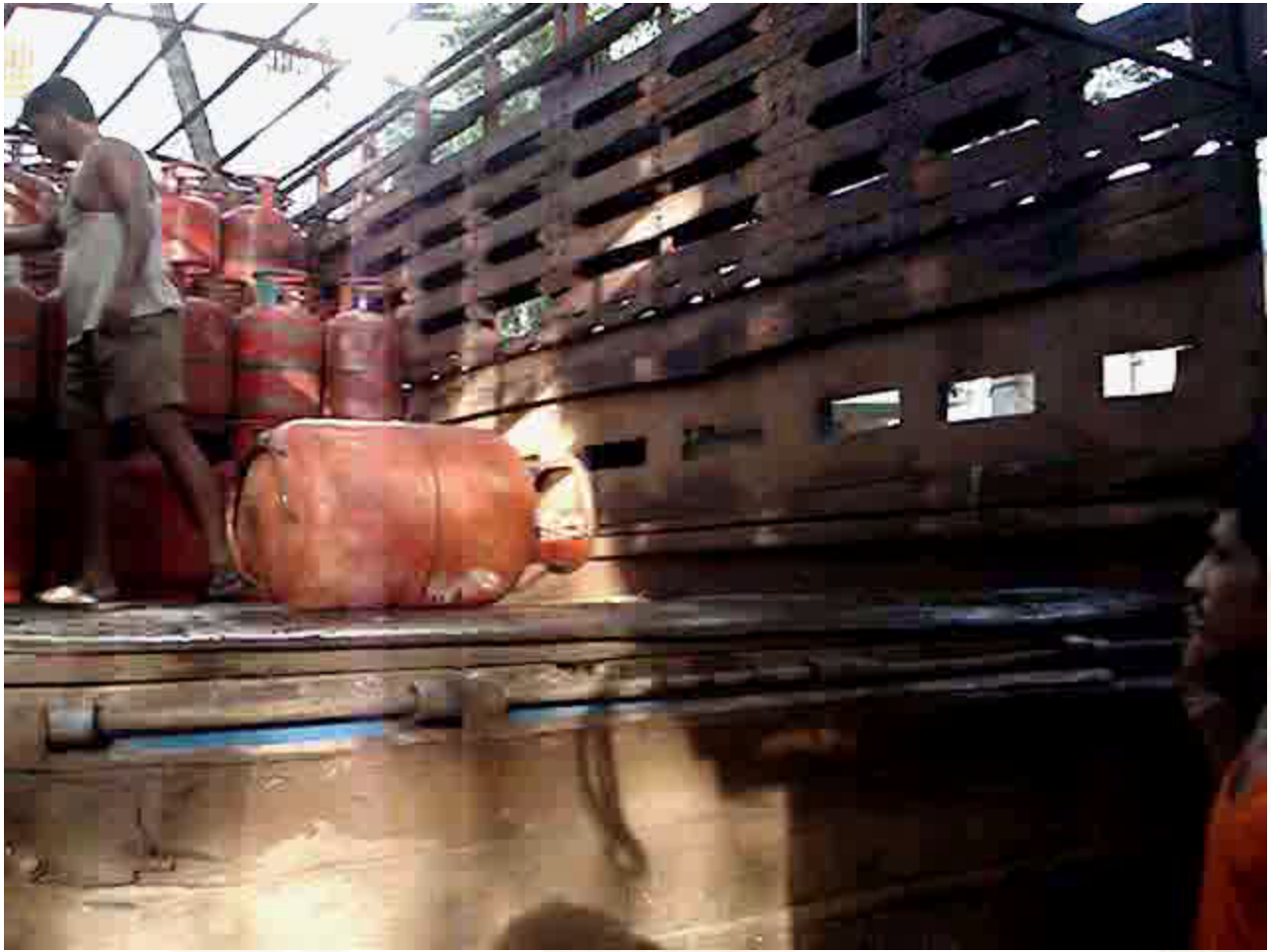
A glimpse…

Physiological measuring technique …

User's heart rate was monitored while doing the activity.

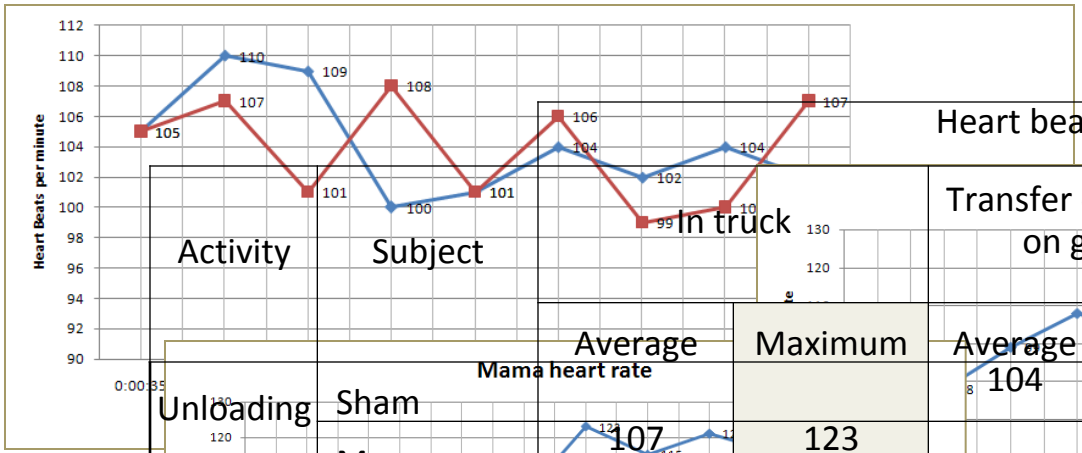
Instrument used: Polar heart rate monitor
Survey location Maharashtra gas agency – Depot, Powai

Unloading from HCV



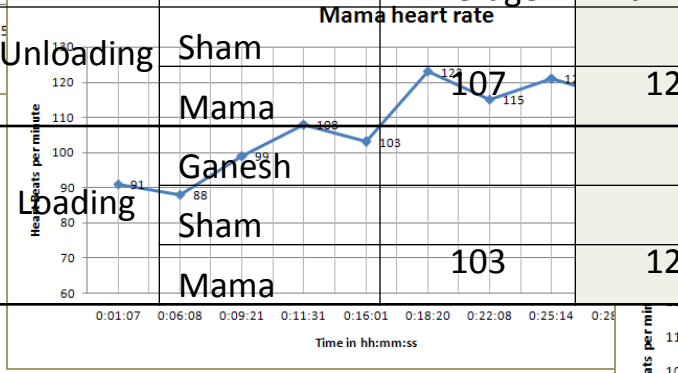
Loading from HCV

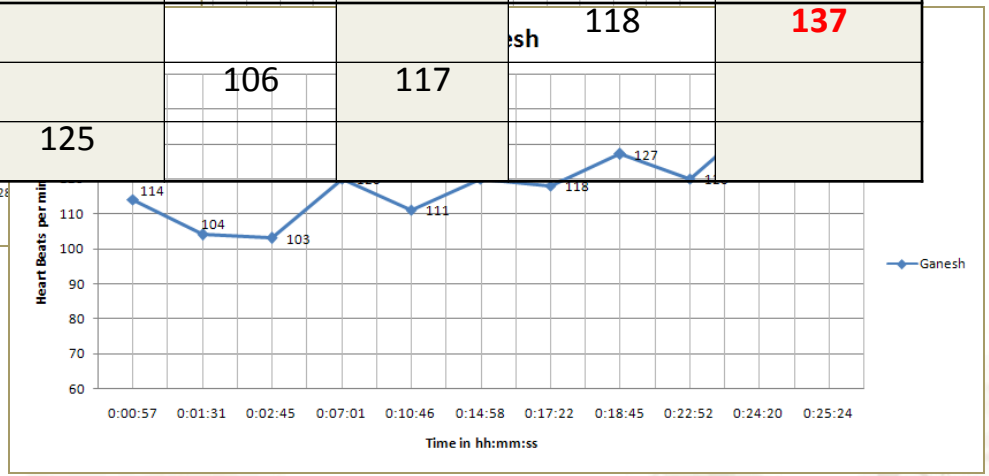
Summary



Heart beats per minute

Activity	Subject	In truck		Transfer of cylinders on ground		Lifting of cylinder (from ground into truck)	
		Average	Maximum	Average	Maximum	Average	Maximum
Unloading	Sham			104	110		
	Mama	107	123				
	Ganesh					118	**137**
Loading	Sham			106	117		
	Mama	103	125				





Gas cylinder delivery person…

- Delivering Minimum 40+ Gas cylinders in a day.
  Note: each gas cylinder weighs approximately 30 Kgs
- Work time from 9:30 am till the allotted cylinder quota is delivered

Transportation methods

Gas cylinder transfer system for gas delivery person

- Cycle
- LCV, 3 wheeler

Ups and downs

Finding the right house…

Climbing……

Climbing…

Climbing ‘stairs’

What goes up comes down…

Powerhouse… !?

Gas cylinder transfer system for gas delivery person

3 Wheeler loading

Gas cylinder transfer system for gas delivery person

3 Wheeler loading_2 persons

Facts…

- 40 + Cylinders are to be delivered in a day by a single person
- The areas where cylinders are to be delivered always do not have good accessibility with stairs or lifts.
- They get is a cycle as a vehicle from agency

Summary

Activity	Subject	Average heart beat rate per minute	Maximum Heart beat rate per minute
Cycling - with filled cylinder	Michal	126	130
	Sarvan	132	146
Pushing cycle uphill	Michal		
	Sarvan	145	**164**
While delivering cylinder	Michal	115	129
	Sarvan	106	121
While delivering cylinder uphill	Michal	142	160
	Sarvan		161
Cycling - with empty cylinder	Michal	120	122
	Sarvan	111	115

Note: Three number of cylinders handled while cycling.
One cylinder handled while delivering.

To reduce stress

Two options...

1) Reduce the weight which is handled

2) Introduce mechanization at various levels, keeping the weight of the cylinder same

Option 1 means:

Redesigning of Gas cylinder and also re-engineering it.

Gas Cylinder Design?

RAGASCO

Year 2000
Norway based company enters
into gas cylinder manufacturing

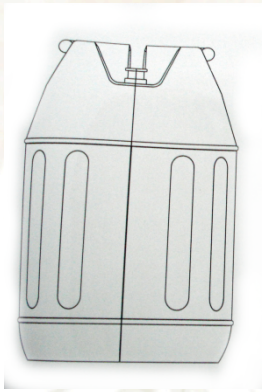
DAN JAPAN

DAN Japan

'06 INDUSTRIAL DESIGN EXCELLENCE AWARDS

Year 2006
IDEA Awards
in Packaging segment

IDC
Year 2008



For LPG in fiberglass cylinders

- **Ragasco,** has obtained the approval of the Chief Controller of Explosives to set up business in the country.

- State based oil marketing companies plan to procure 100,000 composite translucent fiberglass cylinders, expected test marketing April-June 2010

Gas Cylinder Design?

	Optimal Usage Condition	Worst Usage Condition
Composite	30years	30y
Steel	30y	4y
Aluminum	30y	3y

Cylinders designed by Norway company for Indian conditions…!

Trying Option - 2

Two options...

1) Reduce the weight which is handled

2) Introduce mechanization at various levels – keeping the weight of the cylinder same

Option 2:

i) Automation in loading unloading – Use of fork lifts, jacks, etc.

This will involve huge initial investment, training, maintenance, supporting devices and dealing with space constraints.

ii) Mechanization of manual transport of more than one cylinders with a vehicle from godown to location of delivery

Heart beat rate analysis also shows that this area needs attention

Even in the LPG Reticulated piping scenario this problem remains.

iii) Mechanization of manual transport from vehicle to the doorsteps

This will largely depend upon the gas cylinder design

In LPG Reticulated piping scenario this factor is not prominent.

Break up of the cycling activity

	Heart beats per minute		Time for the activity hh:mm:ss	
	Max	**Average**	**Max**	**Average**
Loading 3 cylinders	129	110	0:00:45	0:00:38
Cycling	154	146	0:03:30	0:02:01
Pushing cycle	**175**	**152**	0:03:00	0:01:40
One cylinder delivery	163	132	0:04:00	0:02:13
Cycling back to godown	133	128	0:05:00	0:03:20
Unloading	124	121	0:00:30	0:00:28

Date: 14th Sept, 09
Subject name: Mr. Sarvan
Age: 39, Height:5’ 9’’
Place: Powai Mumbai

Rules of cylinder transport

The Gazette of India
EXTRAORDINARY
PART II-Section 3-Sub-section (i)

NEW DELHI, TUESDAY, 21ST SEPTEMBER, 2004

SCHEDULE VI

(See rule 20)

TRANSPORT OF CYLINDERS

(1) Transport of cylinders by vehicles: —

(a) Cylinders filled with any compressed gas shall not be transported by a bicycle or any other two wheeled mechanically propelled vehicle.

(b) Cylinders shall be so transported as not to project in the horizontal plane beyond the sides or ends of the vehicle by which they are transported.

(c) There shall be no sharp projections on the inside of the vehicle.

(d) Cylinders shall be adequately secured to prevent their falling off the vehicle and being subjected to rough handling, excessive shocks or local stresses.

(e) Cylinders transported in vehicles shall be blished as of India, fication of Industrial objections period of e;

October,

raft Rules

Explosives e Central

(f) Cylinders filled with any compressed gas shall not be transported along with any other

Some insights –

H P GAS

1) **LCV is not owned by Gas agency.**
2) LCV is usually hired for Rs. 200 per day.
3) Gas cylinder delivery persons with LCV get Rs.5 per cylinder as commission as against normal Rs. 3 per cylinder. i.e. Rs.2 allowance per cylinder delivery.
4) With LCV daily 100 cylinder deliveries are possible. (with two persons) i.e. additional income of 100 x 2 = Rs. 200 = hiring cost per day for LCV.
5) Company pays the petrol allowance of Rs. 150 per day to persons with LCV
6) Approximately petrol of Rs. 100 required per day (case of Maharashtra Gas Agency)
7) Maintenance cost is bared by the person who uses the LCV
8) Company pays for getting the vehicle certified for LPG transport .
9) At night vehicle is parked near user's home.

Daily income of a gas cylinder delivery person amounts to approximately **Rs. 500**

Bharat Gas

Some insights –

1) **LCV is not owned by Gas agency.**

2) LCV is usually bought and owned by the user.

3) LCV cost details : Rs 20K down payment + EMI of Rs 3500 per month for next four years = **Rs 1,84,500 /-**

3) Gas cylinder delivery persons with LCV get Rs.4 per cylinder (independent of number of cylinder deliveries) as commission as against normal:

Rs. 2.50 per cylinder – if total cylinder deliveries are less than 750

Rs. 3.00 per cylinder – for cylinder deliveries above 750

4) With LCV daily approximately 20 cylinder are delivered and the LCV inaccessible areas and adjacent areas near godown are catered with cycles and tricycles (mainly to save petrol).

5) Company does not pay any additional petrol allowance.

6) Maintenance cost is bared by the person who uses the LCV

7) Company does not pay for getting the vehicle certified for LPG transport

8) At night vehicle is parked near user's home.

H P GAS
BHARAT GAS

More insights –

- In their opinion LCV is best suited for the job.
- But, they also say that for some locations cycles are more preferred than LCV because of the terrain and accessibility issues.
- Everyone do not buy LCVs because of the cost
- And not everyone hires it because of the fixed Rs. 200 per day charges as against their daily fluctuating income.
- The one who owns a LCV do not use it extensively for all scenarios mostly for saving on fuel cost.

Traffic officer

Some insights while talking with traffic police –

•Clear understanding of the rules and the reference number of the relevant rules was lacking.

•General notion exists that no vehicle qualifies for gas cylinder delivery other than that with a approval from RTO as vehicle for carrying flammable goods.

Some more information –

•Ministry of Road Transport and Highways – decides CMV rules

•ARAI – Certifying authority in India for road going vehicles according to CMV rules.

•Petroleum and Explosives Safety Organization, Department of Industrial Policy & Promotion, Ministry of commerce & Industry, Government of India – Gas Cylinder Rules, 2004

•RTO – Registering authority in India, pre-requisite ARAI approval

Inferences

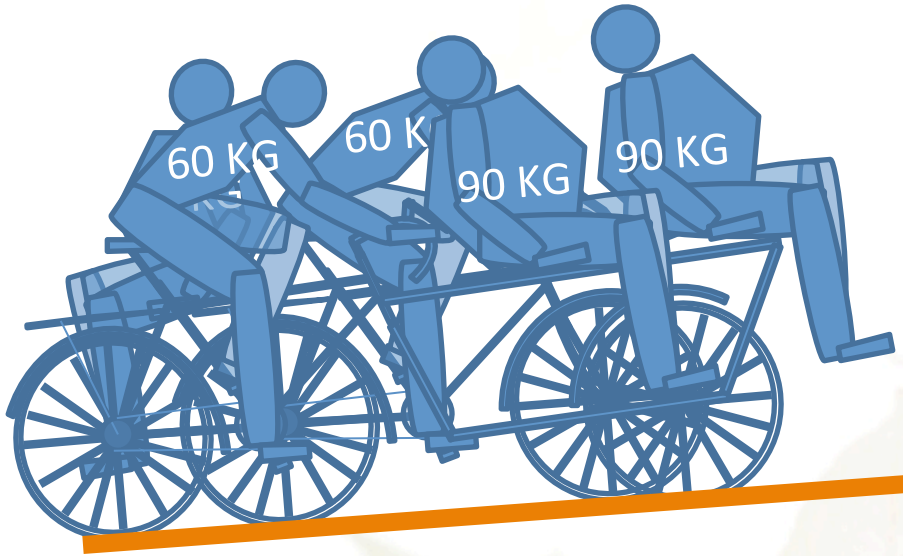
1) Cost is a major issue while making a decision of buying or hiring a vehicle as it is clear that customer; in this case who also happens to be user, has approximately income of Rs. 500 per day.

2) Though LCV serves a purpose of carrying around 20 (for Bajaj model) 32 cylinders (for Force's Minidor) the activity of loading and unloading and 'in-vehicle' arranging activity increases.

3) LCV does not solve the problem of gas cylinder delivery persons who are supposed to work in areas inaccessible to LCV and who do not deliver more than 20 gas cylinder in a day.

4) Use of TVS Excel was also attempted to deliver 6 cylinders in one journey. But, because of stringent RTO control the moped was grounded.

Manual or motorized…?



Cycle loading

3 wheeler loading

Observations

Transport:

Held in position by

Hooks in case of cycle for vertical cylinders.

Cycle tube for holding horizontal gas cylinder on cycle carriage.

Cylinder weight, when no. of cylinders does not fill the LCV completely.

Cylinder weight, stacking when LCV is filled to its capacity.

The body work of carriage also works as a limiting boundary.

Unloading cylinders:

Cylinders are taken out from vehicle one by one at the delivery location

Cycle – All three cylinders are delivered at only one delivery location

LCV – Cylinders are taken out one by one according to delivery location

Loading-unloading pattern

Cycle – to keep the balance

Side cylinders must be placed first before loading horizontal cylinder

Horizontal cylinder must be removed first to unhook the side cylinders

LCV – After every delivery to make space for new empty cylinders and to reach the filled cylinder in last row last column, the filled cylinders in vehicle from a row are unloaded at location. The empty cylinders are then loaded at the far back followed by the loading of filled gas cylinders which were unloaded earlier. And this repeats at each location.

Inference

- Loading and unloading of gas cylinders should be free from any bar.
- The loading height should be as low as possible. Manual mode of load transport should be reduced as much as possible or tried to be kept within physiological and bio-mechanical limits. (After comparing cycle hook height and LCV carriage height)

Findings of study:

1. A motorized vehicle is required which can replace cycle.
2. The vehicle should be small enough to access the areas which are currently served with cycle.
3. The vehicle should carry 6 cylinders to reduce the trips as against 3 cylinders carried by cycle.
4. The vehicle should also follow rules set-up by regulatory authorities for safety reasons.

Which led to Vehicle Specification:

- Single sitter
- Three wheel vehicle
- Payload - 400 Kg (Max 6 Gas cylinder + Driver)
- Minimum ground clearance – 150 mm
- Footprint of vehicle should not exceed 900 x 2000 mm
- Turning radius as small as possible (Cycle's turning radius 1.5m)
- Space on body for RTO's flammable goods transporter stamp and dealer's details as per norms
- Space on body for Company's branding

Two options:

1. Design a new chassis to suite the requirements and propose a new vehicle.
2. Search existing vehicle which suits the requirement

Comparison

					
Model name	Bajaj GC 1000	Minidor Pickup	Ape	Alfa cargo	Pick-up
OMC	Bajaj Auto	FORCE Motors ltd	Piaggio	Mahindra & Mahindra	Atul Motors
Gross vehicle weight	990 kg	1350 kg	975 kg	995 kg	990 kg
Kerb weight	425 kg	725 kg	415 kg	460 kg	437 kg
Payload	565 kg	625 kg	560 kg	535 kg	553 kg
Overall length	2960 mm	3595 mm	2930 mm	3015 mm	2960 mm
Max width	1375 mm	1490 mm	1490 mm	1460 mm	1310 mm
Max height	1810 mm		1635 mm	1700 mm	1810 mm

Comparison

					
Model name	Bajaj GC 1000	Minidor Pickup	Ape	Alfa cargo	Pick-up
OMC	Bajaj Auto	FORCE Motors ltd	Piaggio	Mahindra & Mahindra	Atul Motors
Cargo bed length	1500 mm	1960 mm	2040 mm	1590 mm	1520 mm
Cargo bed width	1325 mm	1430 mm	1470 mm	1460 mm	1300 mm
Cargo bed side wall	250 mm	330 mm	300 mm	320 mm	400 mm
Wheel base	2025 mm	2492 mm	1920 mm	2005 mm	1845 mm
Rear wheel track		1330 mm		1260 mm	1140 mm
Turning radius	2.75 m		2.75 m	3.5m	
Ground clearance	170 mm	140 mm	165 mm		130 mm

Conclusion:

Available vehicles are oversized and overpowered for the laid requirements.

Modifying carriage of existing vehicle:

Advantage: As more number of cylinders can be carried, number of trips to and from godown will decrease.

limitation: As minimum turning radius available is 2.75m (Bajaj GC 1000) these vehicles can only reach to areas where road width is 4m.

Apart from this this study also shows following areas which needs attention while carriage redesign for gas cylinder delivery application:

Focus areas

Focus area	Description
Accessibility	Loading and unloading of gas cylinders should be free from any bar.
Loading and unloading	The loading height should be as low as possible. Manual mode of load transport should be reduced as much as possible or tried to be kept within physiological and bio-mechanical limits. (After comparing cycle hook height and LCV carriage height)
Safety	There should be a provision to firmly hold the cylinders in their position whilst transporting (rope or rubber tube used now)
Security	Quick locking provision for load space to safeguard against possible theft whilst delivering one cylinder to customer.
Unrestricted use	It should be able to hold varying sizes of cylinders – Domestic and Commercial
Branding	Space on body for Company's branding

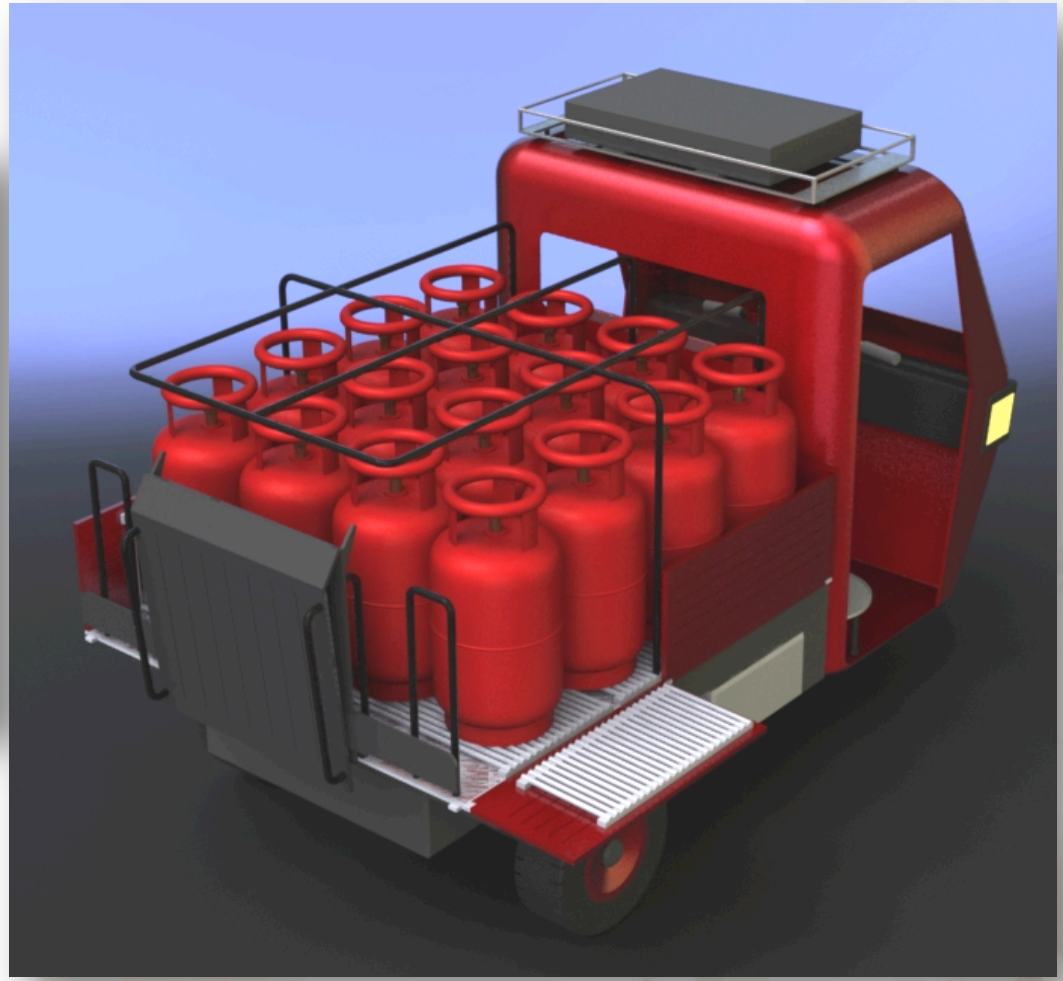
Focus area

Focus area	Description
Affordability	Low tech modifications
Maintainability	Availability of spare parts and service
Compliance with rules	Gas cylinder rules 2004
Additional weight as less as possible	As any additional weight will eat away a share from payload capacity.

Idea highlight	Major drawback
Power take off (PTO) shaft from engine	• Requires modification in standard engine • Cost will increase • It will involve additional gear box and linkages • High running cost
Pneumatics	• High cost of actuators • Additional requirement of compressor driven by engine and air tank • Maintenance issues • High running cost
Hydraulics	• High initial cost • High maintenance cost • Requires additional compressor and regulating system • High running cost
Mechanical leverage	• Fatigue • Time factor • Complexity of linkages

Concept 1

Gas cylinder transfer system for gas delivery person



Concept 1

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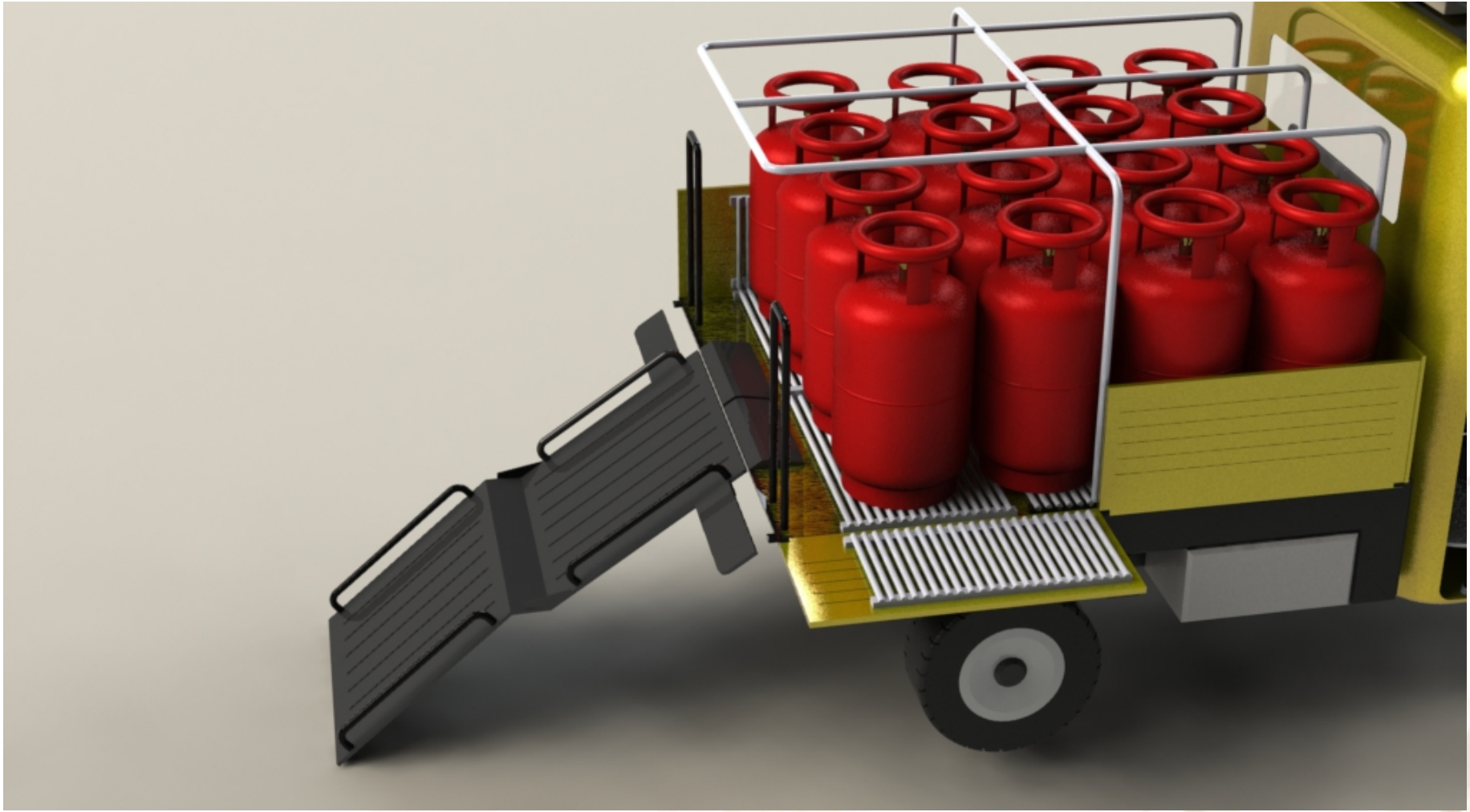


The great ‘Concept-1’ fails…

Observations/experience :

- Efforts required increases as cylinder needs to be stopped and held in that position while repositioning arms.
- Time required to load one cylinder (upto height 0.75 m) is around 14 sec

Conclusion:

- Loading cylinder with ramp is a stressful activity as time taken to handle the load in considerable as compared to the existing *free swinging* method.

Trying an alternative

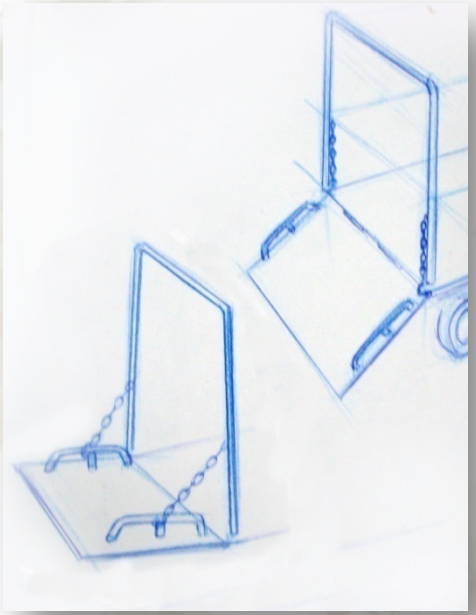
Another attempt to make ramp work
- pulling cylinder in vertical position

Results –
Arm gets twisted towards the end of lift

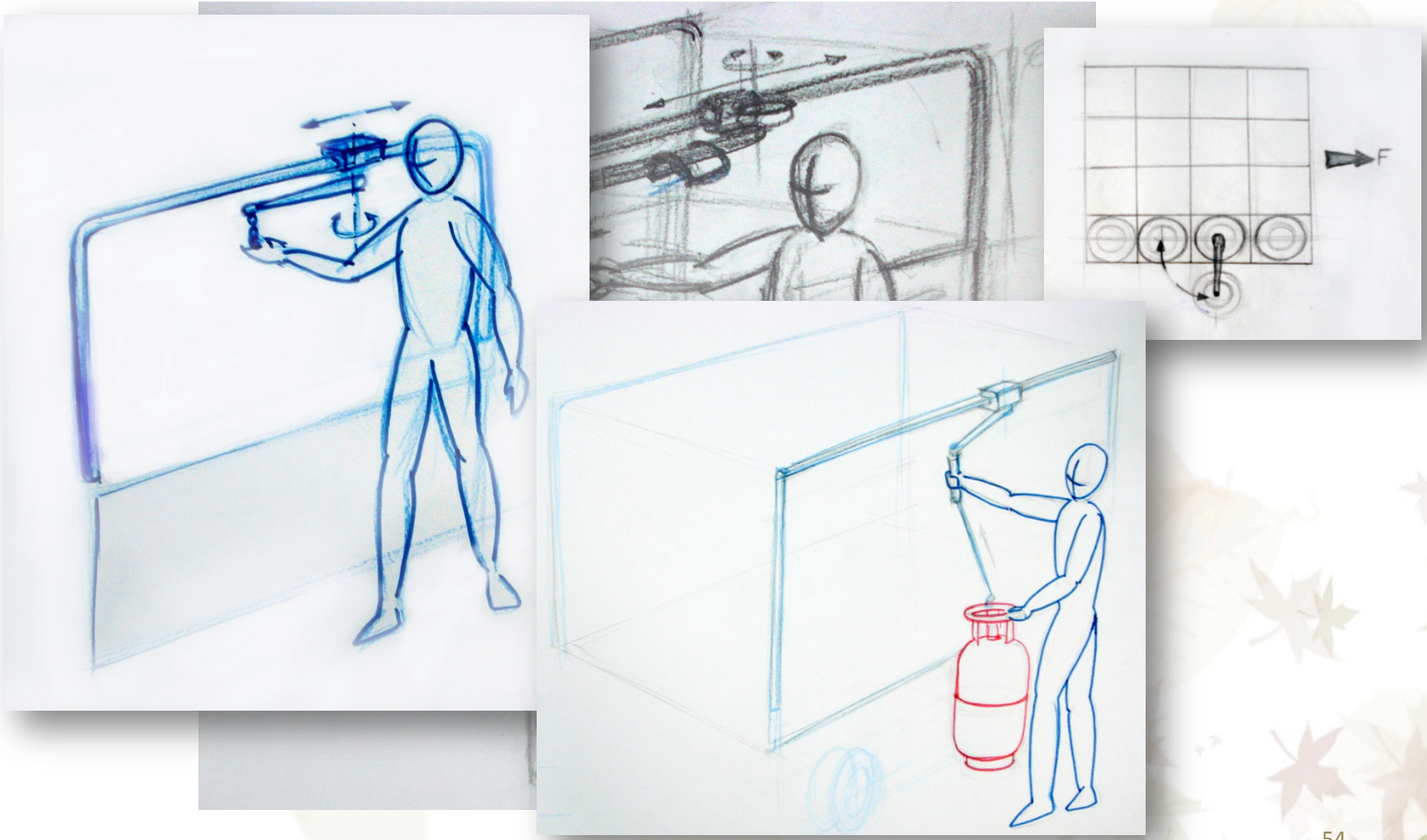
The spider – (handle)

The spider – (handle)

Roll it in… with Handle

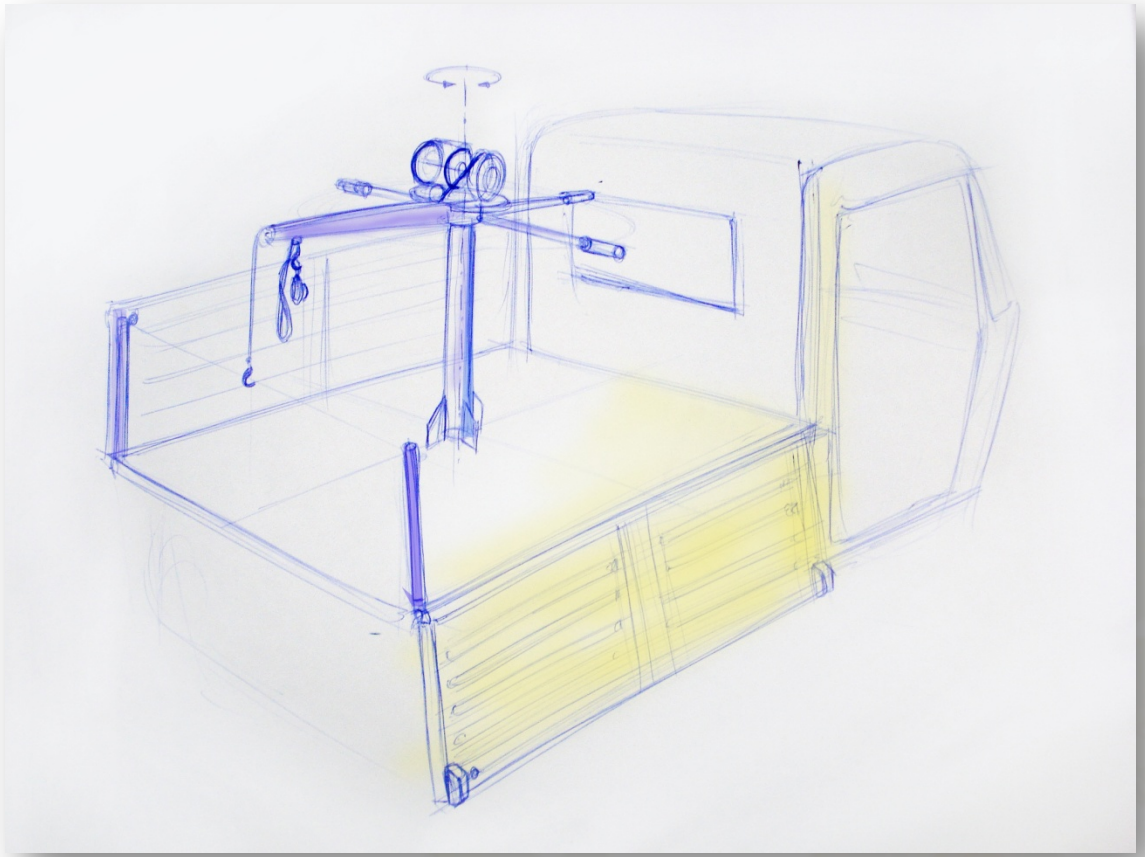


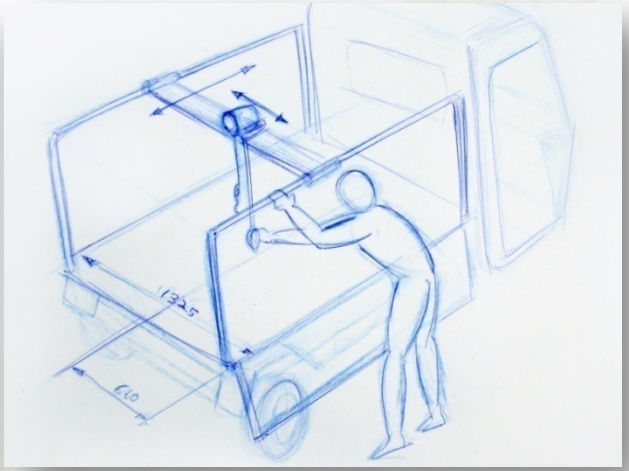
Swiveling arm

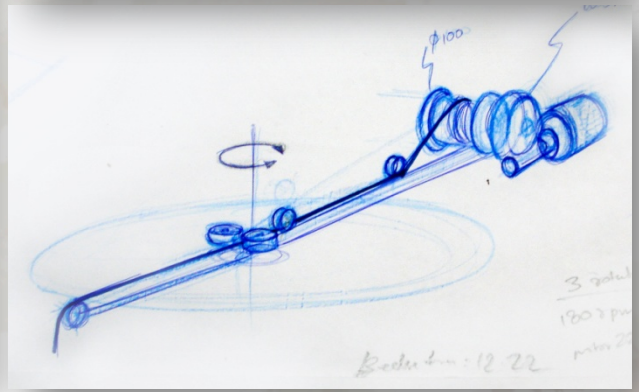


Electric assistance

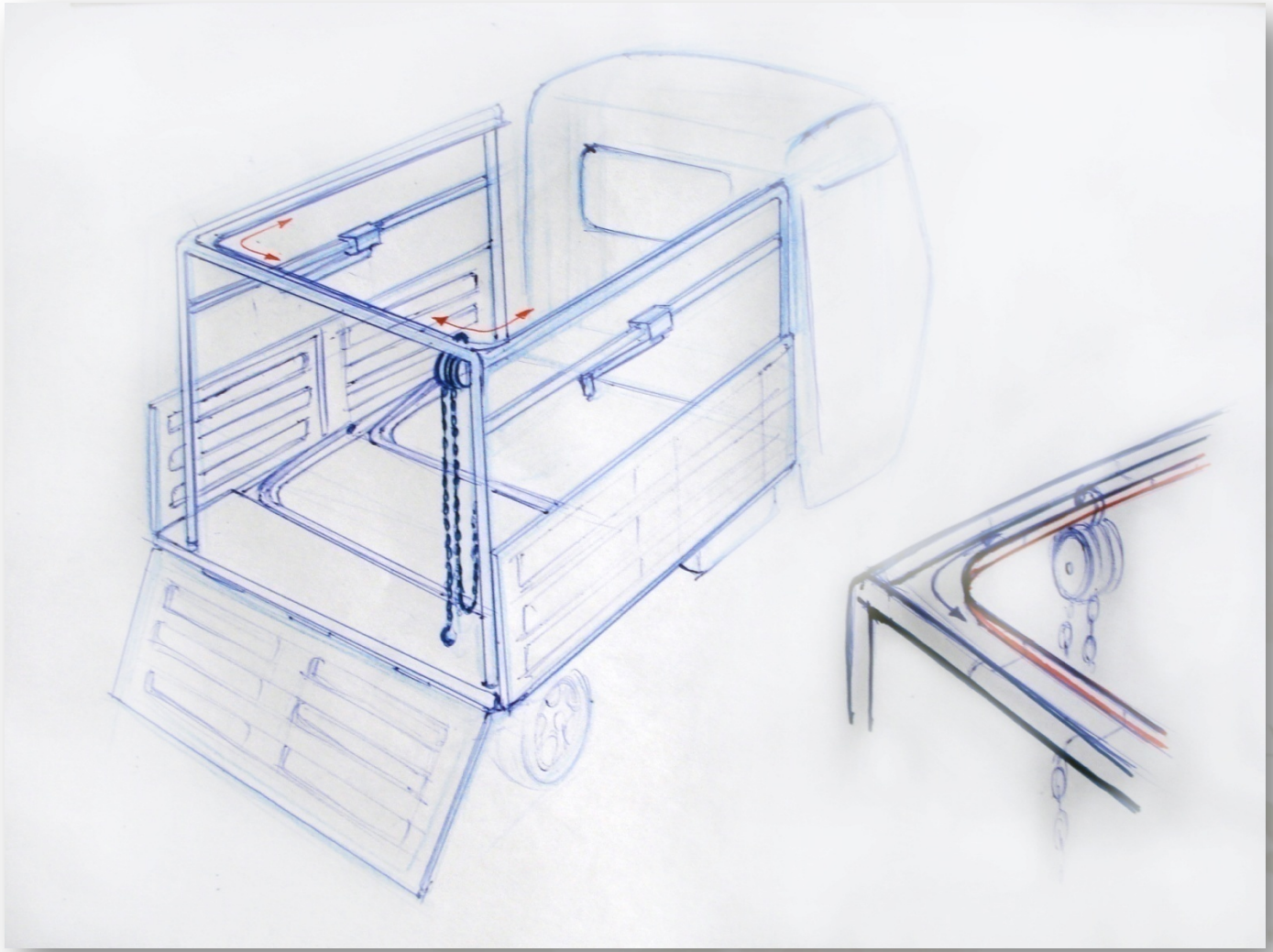
Gas cylinder transfer system for gas delivery person

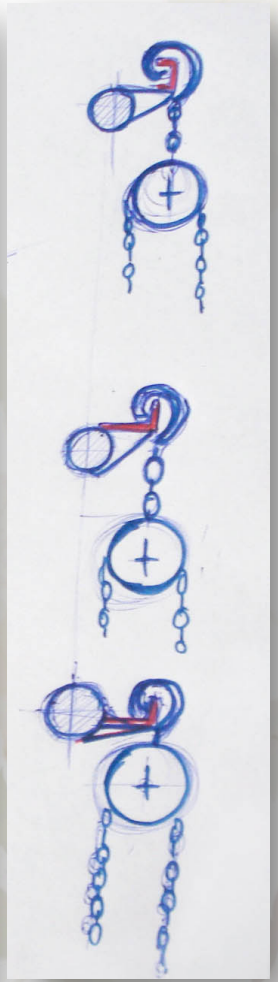


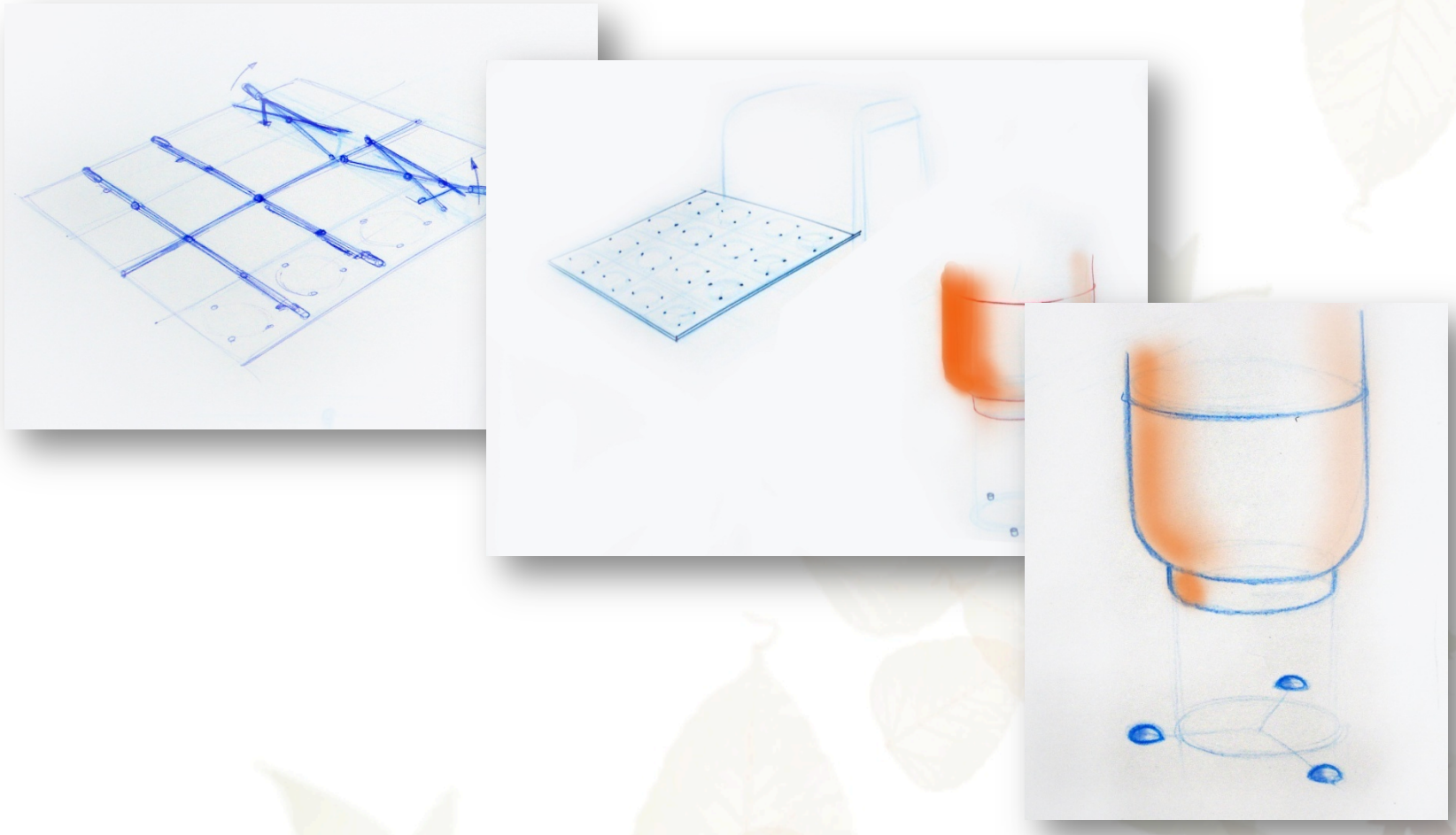




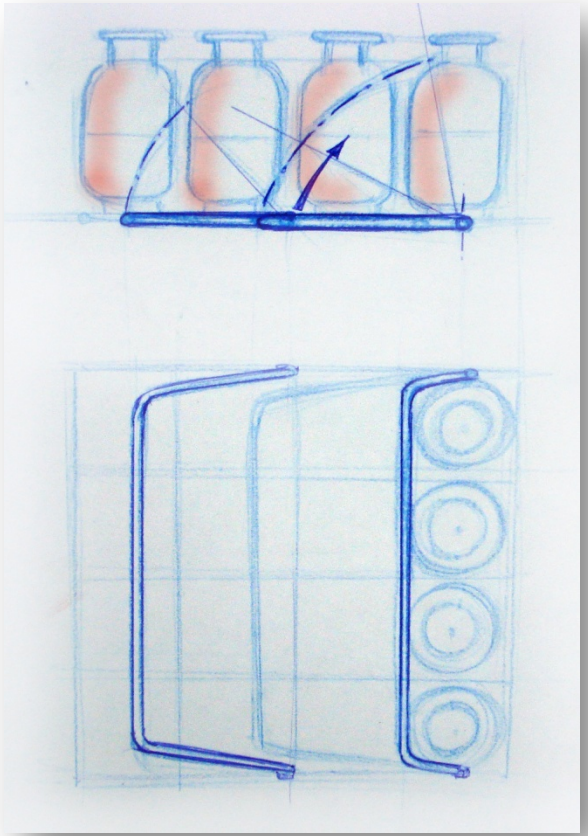
Chain pulley

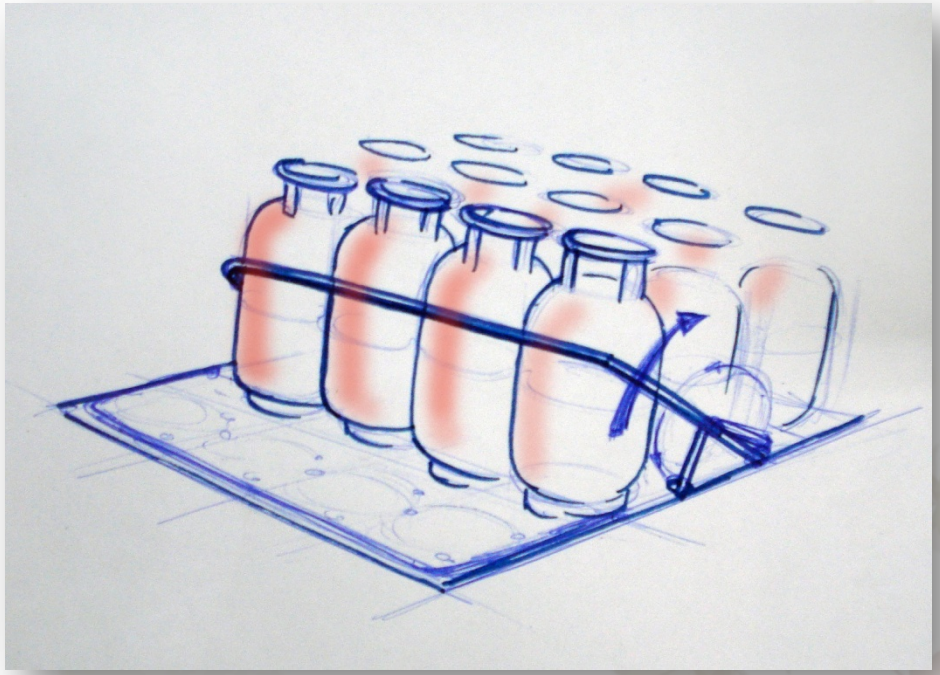






Safety_ keeping cylinders in position





Further development of Handle

1st Study model

2nd Study model

Further development of Handle

3nd Study model

User feedback

Further development of Carriage