

DESIGN OF RUCKSACK

SANJEEV NABAR

INDUSTRIAL DESIGN CENTRE  
INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

1974

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Design of rucksack. - Diploma in

Design of Rucksack

Diploma project

Submitted in partial fulfilment of the  
requirements for the postgraduate  
diploma in Industrial Design

by

Sanjeev Nabar

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Bombay

1974

Guide :

Prof. S. Nadkarni

Co-guide :

Shri A.G. Rao

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Diploma project entitled

"Design of Rucksack"

by Sanjeev Nabar is approved for the  
postgraduate diploma in Industrial Design.

Guide:

*W. S. D. 20.5.74*

Chairman:

*N. S. D. 20.5.74*

Examiners:

• *S. M. P. D. M. S.*  
• *A. R. Chatterjee*  
•  
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My friends.

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1.0 PROBLEM STATEMENT

To design a ruck-sack

- i) useful for long duration hikes or mountaineering expeditions
- ii) to suit the requirements and structure of maximum range of Indian population.

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## 2.0 INTRODUCTION

Climbing in Himalayas is a challenge for a mountaineer. Visit to Indian mountains is the ultimate aim in his mountaineering career. Every year hundreds of foreigners visit India for mountaineering. Even in India hiking and mountaineering are very popular sports. There are three mountaineering institutes and a number of registered mountaineering clubs. In colleges there are hiking clubs. Even then India is still the least developed of all gear used in the mountains.

Why this anomaly? First, mountaineering equipment manufacturers tend to be rather small firms with few or no research facilities. Second, there is a lack of feedback from research organisations to these firms. Third, there is little or no research with respect to Indian environment, to suit Indian climate, structure and capacity of an Indian mountaineer. There is some research done by the Indian army, but the outcome of the research is not made available to common people.

Carrying the load on back or 'Back-packing' is the most important phase for a hiker or a mountaineer. The comfort, safety and the convenience of equipment is his main concern.

Walking up steep ground involves lifting the body through distances of vertical height. This entails the expenditure of energy. It is a self-evident truth, therefore, that energy when properly controlled, is valuable in mountaineering and it must be conserved for endurance in order to supply the necessary power to overcome natural difficulties.

Economy of effort is achieved mainly by keeping the body in balance. A good ruck-sack obeys the principles of good dynamic posture. It gives perfect balance and comfort. A faulty posture results in muscular fatigue and pain.

Correcting of a momentary loss of balance when walking is not a difficult thing to do, but it is extremely difficult and often impossible to correct such a loss of balance when climbing on rock or ice which is approaching the vertical.

Load carrying, by its very nature implies some amount of static work due to static or isometric contraction of muscles. Static work is more fatiguing than kinetic or dynamic work. The static work performed depends on the extent and degree of muscular contraction and varies with the load carrying.

mode, location of centre of gravity of load and location of the point where the load is born by the carrier's body.

Research done on these factors has proved that the ruck-sack is the most efficient mode of carrying load. But the ruck-sacks available in this country have not paid much attention to the convenience, comfort and safety for the user, hence need for redesigning the ruck-sack is felt.

### 3.0 INFORMATION

Information about the hikes, hikers, mountaineers, the equipments they use, the climatic conditions they have to face, was collected from the following sources.

1. Mountaineering and hiking clubs
2. Individual hikers and mountaineers
3. Research Institutes
4. Manufacturers
5. Shop-keepers

Anthropometric data for Indian persons and literature on the above subjects was also collected. The information is listed as follows.

#### 3.1

Hikes can be divided into three types according to duration.

- i) One-day hike
- ii) Three-four days' hike
- iii) An expedition of some weeks' duration

#### 3.2

Hikes consist of walking on the level and up and down-hill.

Mountaineering consists of walking on ice and snow and also on rock and soil.



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3.3

For short hikes, hikers take lunch packs, knife, spoons, chocolates, water bottles, spare clothes, towel, torch, map, note-book, pencil, compass, first-aid box, etc.

3.4

For long duration hikes, hikers carry lunch packs, tea powder, sugar, chocolates, other rations, utensils, stove, fuel, mugs, collapsible water carrier, cutlery, tin opener, towel and toilet requisites, tent, mattress, first-aid box, spare clothes, shocks, shoes, compass, map, note-book, pencils, binoculars, sometimes a camera.



3.5

For mountaineering, mountaineers need following implements :

Ice axe, pittons, pitton hammer, crampons, rope, carabiners and also the things listed above.

3.6

For long duration expeditions especially in the Himalayas, mountaineers carry toilet accessories, a change of day wear, cooked food, water, camera, film rolls, towel, sleeping bag, air mattress, etc. in a ruck-sack on their own backs and the common luggage is carried by the porters.



### 3.7

The ice axe is carried in a ruck-sack in three ways.

- i) Inside a ruck-sack: head on bottom of sack, spike outside the sack.
- ii) Between the bag and frame of a Bergan type ruck-sack.
- iii) Secured on the outside of the ruck-sack.

### 3.8

For one day hikes, hikers generally take light weight frameless ruck-sacks, also called as knap-sack. (fig. )

For long duration hikes, hikers carry heavy framed ruck-sacks. (fig. )



### 3.9

The side pockets and the front pocket are used to keep thermos-flasks, toilet articles, water bottle, first-aid kit, whistle, knife, climbing implements, torch, towel, chocolates, lunch packs.



### 3.10

Ruck-sacks have a long life. They need repairs when the strap is cut off or the sack cloth tears off. They are repaired by stitching leather patches.

3.11

Big ruck-sacks weigh about 2 - 3 kgs. when empty and upto 35 kgs. when fully loaded.

3.12

Rest period of five minutes every hour is desirable especially if the climbing is difficult or the load is heavy. If more rest is required, it is taken more frequently rather than for a longer period.

3.13

Hikers try to find a boulder or other seat at thigh level for sitting and the ruck-sack is supported at higher level for a short rest without removing it.

3.14

It is difficult to keep the existing ruck-sack in railway coach and S.T. bus because of its odd shape.

3.15

For 1965 Everest Expedition ruck-sacks were supplied by Harness and Saddlery Factory, Kanpur. These ruck-sacks had aluminium tube frames with paragon nylon 629, orange or blue, waterproofed for bags, having five additional pockets with zip fasteners.



Food :

3.16

For cooking, dry sticks are generally burnt for heating.

3.17

But in the rainy season, a kerosene stove is necessary. Kerosene is carried in an h.d.p.e. bottle with a secure top.

3.18

Aluminium pots and pans are carried for cooking. Inside space is utilised for packing fragile items such as eggs.

3.19

Plastic mugs, jerry cans and collapsible water carriers are used for water.

3.20

For long duration hikes, dried and dehydrated foods are preferred since they are light, easy to carry and store. Absence of fresh fruits for longer spells results in loss of strength. Vitamin C tablets are used when fruit is scarce.

## Accidents and Rescue :

### 3.21

Most accidents are the result of slips on snow or ice or rock or of getting lost, and are usually due to inexperience, lack of the right equipment and clothing, or underestimation of the task attempted in the prevailing conditions.

### 3.22

Different types of rigid and rope stretchers are used to carry injured persons to the hospital.

Patient can be carried by hands. The patient sits on the crossed hands of two people, with a third to take the weight of the legs.

### 3.23

Patient can also be carried by one person pick-a-back.

### 3.24

He may be carried by the fireman's lift. (the carrier brings the patient's left arm over his right shoulder from behind, passes his left arm between the patient's legs and hoists him up on his shoulder.)

### 3.25

A coil of rope is some times used to carry pick-a-back. The coils are separated into

two and the person who carries puts his arms through the loops, as if wearing a ruck-sack; the patient is then lifted up and his legs passed through the loops.

### 3.26

A framed ruck-sack can be turned into an effective carrier by cutting slits in the bag for the patient's legs.

### 3.27

Some times a pair of skis is used to make a stretcher, with the aid of two or three wooden battens and screws carried ready for the purpose. ]

Information from the Research Institutes:

### 3.28

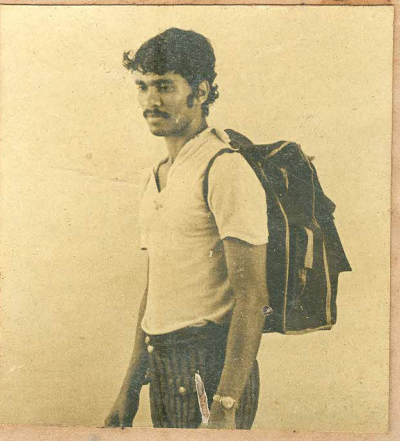
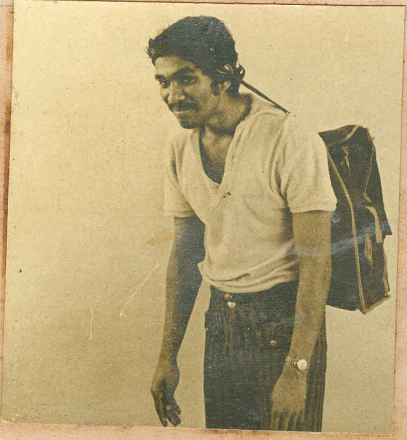
Average load carrying capacity is considered as one third of an individual's body weight according to Cathcart, a British scientist. However, this will depend upon one's training in the particular job.

### 3.29

There is no marked or significant change in the load carrying capacity as such of an individual under different climatic set ups, as encountered in mountaineering, but in extremely cold conditions, heavy snow-clothing assembly causes a reduction in efficiency.

3.30

Eight modes of carrying the load are generally used. Of these head mode is universally practised in India. Hands are used in the case of smaller loads. Rice bag mode is used by coolies transporting heavy bags of cereal, sugar, coal, etc. Nepali porter method is exclusive to Himalayan people. The bamboo yoke is a mode peculiar to India, especially in the villages. Ruck-sack carrying is mostly resorted to by armed forces personnel, hikers, mountaineers and some school children. School children generally carry their bags across the shoulders or in low back position.



## 3.31

Indian scientists, N.L. Ramanathan, S.R. Datta, and M.N. Gupta carried out experiments on seven healthy subjects from different age groups and different body structures. The modes they compared could be arranged serially according to energy expenditure (increasing).

1. Double pack
2. Head
3. Ruck-sack
4. Nepali porter
5. Rice bag
6. Yoke
7. Hands

## 3.32

Scientists, M.S. Malhotra and J. Sen Gupta conducted studies to determine the most economical way of carrying school bags by children. They compared four modes i.e. ruck-sack, low back, across shoulder and in hand. They found that energy expenditure was minimal when the back was carried in ruck-sack fashion, and maximum when it was carried in the hands; low back and the side position being intermediate.

## 3.33

Collective weight of the head, neck and trunk is 56.5% and the weight of the arms 9.7% of the total body weight. The centre of gravity of these segments is calculated to be located in the median plane about 2.6 cms in front of a line 1 connecting the mid points of the ilio-sacral joint and the shoulder line and at 60% of 1 from the ilio-sacral joint (Ref. Dempster 1955).

#### 4.0 ANALYSIS

#### 4.1 Structural analysis

A framed ruck-sack consists of following parts:

- i) Frame
- ii) Sack
- iii) Shoulder straps
- iv) Waist belt

##### 4.1.1

Frame is made by welding aluminium or mild steel pipes together.

##### 4.1.2

Sack is tied to the frame strongly with leather or canvas straps.

##### 4.1.3

Sack is made from canvas, nylon or P.V.C. coated fabrics.

- i) Canvas treated with waterproofing coats is waterproof. It is not very stiff and can be stitched on a sewing machine. It is strong and sturdy. Some times leather or rexin is used for reinforcement.
- ii) Nylons are light weight and come in attractive colours. But they are very expensive and quality of the nylons available in India is not satisfactory.

- iii) Proofed nylons have nylon fabric outside with a layer of proofing inside. The nylon is often siliconed and the proofing cannot be welded. The seam has to be cleared and then either coated with a layer of proofing or have strip of waterproof material stuck inside. The process is time consuming and, therefore, expensive to manufacture.
- iv) P.V.C. fabrics have P.V.C. outside and fabric inside. These have waterproof seams because the sewn seams can be welded. P.V.C. fabrics are stiff and heavy. Some times they are sticky to handle.

#### 4.1.4

Welding makes the frame weak near the joints because of thermal stresses.

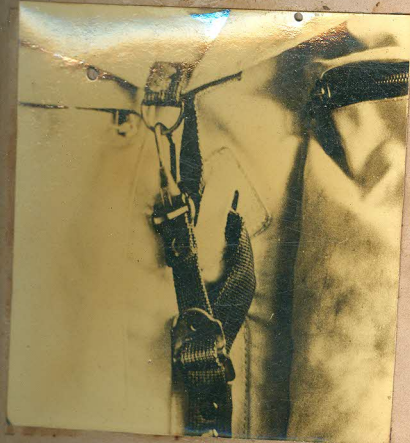
#### 4.1.5

Production rate of the frames is low because gas welding of pipes is done manually and it needs grinding and filing afterwards.

#### 4.1.6

Two shoulder straps of canvas or nylon are attached to the sack or frame permanently with rivets or temporarily with pins.

Straps have buckles for length adjustment.



## 4.1.7

Flap has leather straps and buckles or strings to close the sack. Some times a draw-ring is provided to close the sack.

## 4.1.8

Leather straps and the buckles is a weak point in the ruck-sack. The straps are cut off after a use for some time and need repairs. Repaired straps generally do not work smoothly as before.



## 4.1.9

The waist strap is attached to the frame. It has buckles for tightening up. The material of the waist straps is canvas or nylon.

## 4.1.10

Light weight knap-sack does not have frame or reinforcement. This usually has two or three outside pockets, and is small and cheap. It is used mainly for light loads.

## 4.2 Functional analysis

## 4.2.1

The frame keeps the load off the back, for comfort and to enable the air to circulate between the wearer's back and the sack.

## 4.2.2

Frame absorbs the shocks due to jerks of the sack while walking.

## 4.2.3

Framed ruck-sacks are generally unsuitable for rock-climbing since the frame can catch on the rock and also keeps the c.g. of the sack away from the body.

## 4.2.4

The waist strap stops swaying of the sack when moving over rough ground or in case the wearer trips.

## 4.2.5

Leather straps and buckles on the flap take time for opening the flap.

## 4.2.6

They cannot stretch the flap evenly over the opening of the sack, so some part of the opening remains uncovered. (fig. )

## 4.2.7

Opening on top a small for the existing ruck-sacks, so putting things into the sack and taking them out is difficult.

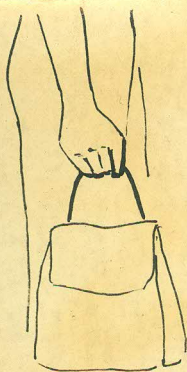


4.3 Ergonomical analysis

Nine modes of carrying load are analysed in respect of physiological economy and bio-mechanical stress. Their use in mountaineering is also analysed in the following table.

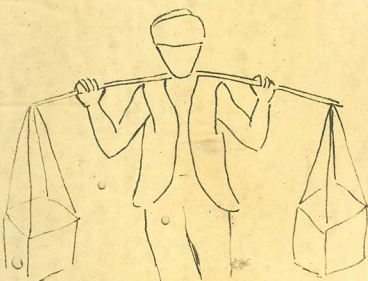
Description                      Biomechanical stress

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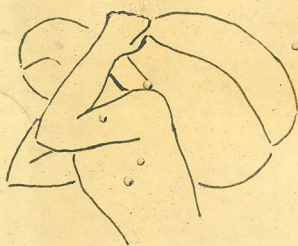
Bag carried in hands with handles, hanging at knee level

The muscles of the arms and shoulders are in static contraction causing fatigue. The hands are not free and movements of the body are restricted. Danger of the bags slipping and hurting feet is likely. Impractical for long distance walks so useless for hiking and mountaineering.



The load, equally divided, is suspended by ropes at the end of a resilient bamboo strip, which is placed across the shoulder and neck and held by one hand. A cotton pad is kept between the bamboo strip and the body, used by water carriers

There is lack of balance due to freely swinging load; hence hands have to be used to grasp the bamboo and neck is bent to one side. The muscles are in contraction. Requires practice. Regular use of this mode results in thick calluses on shoulder and neck. Useless for a common hiker.



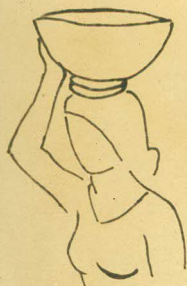
Rice bag: Load in a big sack is supported on the back with the upper two corners held by hands bent back at elbows. Resorted to by coolies loading bags in vehicles or godowns.

The back is bent forward, resulting in strain to the spinal column and adjoining muscles. Bent arms folded back are in static contraction. Grip is insecure, but area of support is large. Hands are not free and fatiguing, so useless for hiking.



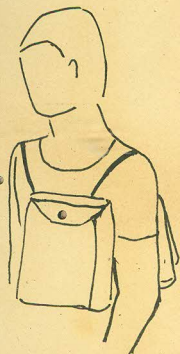
**Nepali porter:** Similar to rice bag, but the hands are freed by providing a strap around the forehead. Hands may be used to hold a stick, or bent behind the back to support load at bottom. Used by hill climbing sherpas & tea pickers.

Body is bent forward, but stress on forehead strap pulls head back. Some strain on neck muscles. Requires practice.



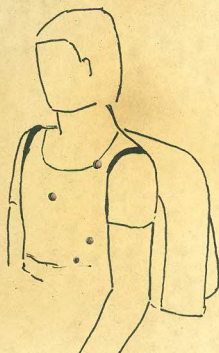
**Head:** The load is carried in a basket on the head, with a straw ring as padding. One hand is used to support and balance the weight. Most prevalent mode.

The long thin muscles of the neck are strained and in static contraction. Pressure is felt on the cranium and cervical vertebra. Hands are not free, balancing difficult, requires long practice; so useless for mountaineering.



**Double pack:** The load is divided equally in two rucksacks strapped on the front & back of the trunk at a level lower than ruck-sack. Bottom ends of sacks tied together loosely across the body.

With a proper harness, the weight is supported by a shoulder muscles and trunk, Balance readily maintained. Both hands free. Loading and unloading difficult. Cannot be used when heavy load is to be carried. Difficult to see the path close in front. So, useful especially for short duration hikes on plain terrains.



**Ruck-sack:** The load -ed rucksack is strapped across the shoulder, resulting in a high pack, resting over the shoulder blades.

Shoulders are constantly pulled back and body stoopes forward. To counter balance weight, head and neck fall forward. Straps of the rucksack cut into neck muscles. If designed to avoid above drawbacks, it is very useful for hiking and mountaineering, because both hands are free and loading/unloading easy.



Across the shoulder: Bag with a strap slung from one shoulder to the thigh level on the other side. This mode is used by school children.

The weight is borne on one shoulder and there is a slight tilt of the body on the side opposite to the load. Neck muscles and shoulder muscles are in contraction. This method is useless for heavy loads because body is in off-balance state, and the bag keeps on banging on the thigh.



Low back: The bag slung from both shoulders and hangs loosely at the buttock level. This position, though not widely used, is preferred by some children.

The strap exerts a pull on the muscles of the shoulders, which bear the weight. Both the hands are free. Body movement, however, is not as free because the bag, being loose, will strike the body during running or fast walking and hinder the movement. Not so good for hiking.



4.3.2

In a frameless ruck-sack if articles like cooking utensils, tins, etc. are kept near the bag, ruck-back becomes very uncomfortable to carry.

4.3.3

Ruck-sack wearer has to stoop to balance the weight of the ruck-sack. He has to stoop more if c.g. is lower or away from his body.

#### 4.3.4

The draw string makes the upper part of the sack comparatively smaller. This causes the centre of gravity of the sack to shift downwards.

#### 4.3.5

Bio-mechanically, any technique in which a larger group of muscles come into operation is bound to prove superior to others involving lesser muscular participation.

#### 4.3.6

When the ruck-sack wearer sits on some surface without removing the ruck-sack, the load still keeps on acting and he does not get proper rest.

### 4.4 Analysis of the rescue methods

#### 4.4.1

While carrying the patient on the back, the patient has to hold around the carrier's neck. It is very uncomfortable and awkward for the carrier. Moreover it is impossible to carry the patient this way if he is unconscious.

#### 4.4.2

Carrying the patient by hands is practicable only for short distances. It needs two or more persons to carry the patient this way. It may not be always possible to have two or more persons available at the spot.

4.4.3

If the frame ruck-sack is used for carrying the patient by cutting slits in the bag for legs, it is quite safe and comfortable but the bag can no more be used as a ruck-sack.

4.4.4

Skis or other sticks are not always available for making a rigid stretcher.

4.4.5

A rigid or a rope stretcher always needs two persons to carry. Moreover if there is a thick jungle it is very difficult to carry a stretcher.

## 5.0 HYPOTHESIS

### 5.1

Ruck-sack should be made to suit the average Indian person.

### 5.2

Ruck-sack should be light, sturdy. Weight of the empty ruck-sack should not be more than 3 - 4 kgs.

### 5.3

It should be easy to mass produce.

### 5.4

Material of the sack should be waterproof. It should be sturdy but not stiff. It should be soft to handle and easy to stitch. The seams should also be waterproof.

### 5.5

Sack should be such that filling up and removing the contents should be easy.

### 5.6

The flap should be capable of covering and protecting the contents both when the sack is fully loaded and when it is partly loaded. It should be easy to open the flap.

### 5.7

The ruck-sack when worn should always allow a good dynamic posture.

5.8

Frame should be such that it doesn't obstruct movements while walking and also movements of hands in any direction.

5.9

The frame should be such that it can be used to carry odd shaped loads or injured persons safely in case of accidents.

5.10

The ruck-sack should stand on its own legs without any external support.

5.11

When the wearer of the ruck-sack sits on some surface the ruck-sack should support itself.

5.12

The sack should be easily detachable.

5.13

The straps should be comfortable, adjustable in length and easily detachable.

5.14

Conversion to the chair should be easy and should need minimum adjustment of parts.

5.15

Chair should make a good and comfortable design independently. Parts of the chair should not obstruct when it is used as a ruck-sack.

## 6.0 SYNTHESIS

### 6.1

Welded joints can be avoided by joining the elements of the frame with screws.

### 6.2

Centre of gravity of the ruck-sack can be brought close to the body by

- i) making the sack long upwards
- ii) giving the frame shape of the back.

### 6.3

Centre of gravity of the sack can be kept high by

- i) attaching it high on the frame
- ii) making the sack wedge shaped.(fig. )

### 6.4

The flap can be kept large to cover the opening and also to go over high loads.

### 6.5

Nylon strings can be used to stretch the flap on the opening and to keep it taut. Loops can be provided to tie the strings. Same method can be used for the pocket-flaps also.

### 6.6

Point of attachment of the straps can be kept higher than the shoulders so that the weight will be pressing down on the spine and shoulders,

and not pulling back from below.

6.7

Shoulder straps can be kept broad. They can be padded from inside. Buckles can be provided to adjust the length of these straps.

6.8

Separation between the straps can be varied to avoid strain on the same area.

6.9

Extra legs can be provided at the back, under the sack, on which the ruck-sack can stand by itself.

6.10

A flat platform can be provided which can be used to carry sleeping bag, oil tins under the sack. Heavy boxes or grain bags can be carried after removing the sack. This platform can be made strong enough to carry an injured person in case of accident.

### 6.11

The chair can be made foldable by using pin joints (rotational freedom for the members) and giving its elements the shape of the main pipes of the frame. The chair elements when folded can make an ordinary ruck-sack.

Rotational freedom of the chair elements can be restrained by providing stops or locks.

### 6.12

The frame can be made so that the other muscles also carry the load partly, relieving the load on the shoulders. The load can be taken up by the hips, but it should not obstruct the movements while walking.

## 7.0 DESIGN SOLUTION

### 7.1

The ruck-sack consists of two main parts

- 1) the frame of aluminium pipes
- ii) the sack of 18 oz. canvass.

### 7.2

The frame is divided into the following three units :

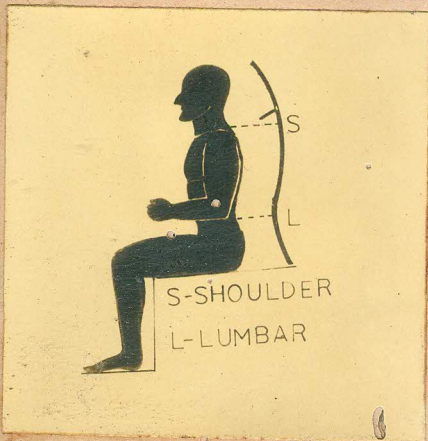
- i) Main frame consisting of two vertical pipes and cross pipes joining them.
- ii) Chair unit having two legs, two seat pipes and cross pipes.
- iii) Load carrying platform consisting of two curved pipes, two cross pipes and two supporting pipes.

### 7.3

Machine screws are used to join cross pipes with vertical pipes. P.V.C. inserts having tapped holes are press fitted at the end of the cross pipes. The ends of the cross pipes are ground or milled to the shape of the vertical pipes.

### 7.4 The main frame

The vertical pipes of the frame are bent to suit the curve of the back of an average Indian person. The curve becomes concave at the lumbar region and again goes backwards at the hip region.

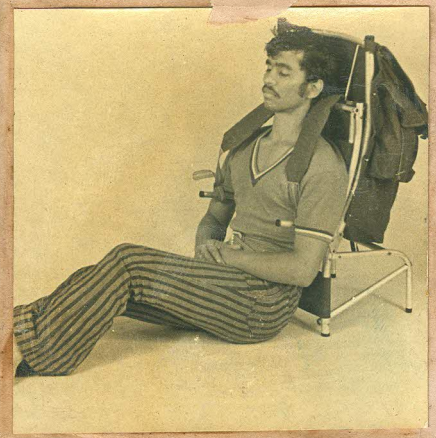




Length of the pipes from the lumbar point to the lower end is decided by the lumbar height. So when the ruck-sack wearer sits on some surface, the lower ends of the frame just touch the surface and take up the load.

7.5

The separation between the vertical pipes is optimised so that the pipes do not touch the back at any point, at the same time they do not obstruct the backward movements of the hands.



7.6

The cross pipe carrying the shoulder straps is little higher than the shoulder height so that the straps do not pull the shoulders down as in the existing models.

The cross pipe on top is curved so that it does not obstruct the head movements.



7.7

Thin aluminium rods are fitted into the cross pipes. They keep the sack away from the back of the person carrying ruck-sack.

The chair unit

7.8

The seat pipes and the legs of the chair have the same curve as the vertical pipes. The grip pipe also has the same curve as the main frame below the pivot. The grip pipe is fitted approximately at right angle to the seat pipe with rivets. The whole assembly is pivoted at the main frame vertical pipes.

The grip pipe and the seat pipe restrain the rotational freedom of each other beyond certain points.



7.9

Cross pipe at the seat pipe acts as a stop for the leg pipes.

Cross pipe at the legs is curved to avoid touching the back when the chair is folded and used as a ruck-sack.



7.10 The load carrying platform

The load carrying platform can be detached from the main frame. It can be used for carrying heavy load and also to carry injured persons.



The load carrying platform acts as a support for the chair, which is tilted backwards. It also helps the ruck-sack to stand without any external support.

#### 7.11

Eighteen oz. canvass is used as the chair cloth. It is held between the cross pipe carrying the shoulder straps and the cross pipe at the seat pipe. The chair cloth can be replaced by removing the pipes.

#### 7.12

Two canvass straps, tied across the leg pipes with nylon strings, rest on the user's back, when the chair is folded and used as a ruck-sack.



A wide canvass strap, tied across the main frame in the hip region, rests on the upper hips.

#### 7.13

All the pipes which rest on the ground are provided with P.V.C. bushes at the end.



The sack

7.14

The sack is made from 16 oz. canvass treated with waterproofing coats. This canvass is available in three colours, olive green, khaki, and dirty white. Olive green is preferable.

7.15

The sack has a large opening. It is wedge shaped (tapering downwards).

7.16

The sack is attached to the frame with loops at the top and with aluminium pins at the sides along the vertical pipes.

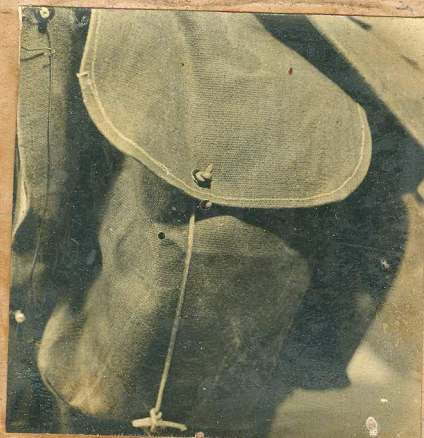
7.17

A spring steel wire passes through the holes in the pins and locks them. The sack can be detached from the frame simply by pulling out the wire out of the pins and removing the pins.



7.18

The sack has two side pockets, large enough to carry water bottles or jerry cans. The flaps of the side pockets can be tied on to the pockets with nylon strings.



7.19

The front pocket has a zip fastener and a hood to keep out the rain. The front pocket should be used for carrying first-aid box, whistle, knife, gloves, socks, napkins, chocolates etc.

7.20

A map pocket with a zip fastener and a hood is provided on the main flap. The map pocket can be used for keeping a map, a note book, pencils etc.



7.21

Nylon strings passing through the seams of the flap can be tied to the loops provided on the sack. This keeps the flap stretched over the opening of the sack. The nylon strings are replaceable.

7.22 .

A waist strap is provided at the lumbar region. It can be tightened with the buckle attached to one end of the strap.

The waist strap performs two functions:

- 1) prevents swaying of the sack to the sides
- ii) does not let the hip resting strap to slide down.



7.23

The shoulder straps are 2" wide and padded with U foam. The upper ends of the straps are attached to the frame with M.S. pins. The lower ends are attached to the grip pipe and can be detached easily.

7.24

The load is taken up by shoulders, back and partly by hips. The load distribution pattern can be changed by rearranging the location of the hip rest strap, tightening and loosening the waist strap and varying the length of the shoulder straps.

In case of heavy load, the load can be taken up by supporting the grip pipe with hands.

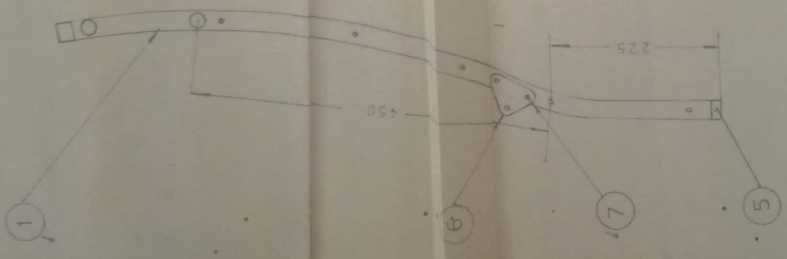
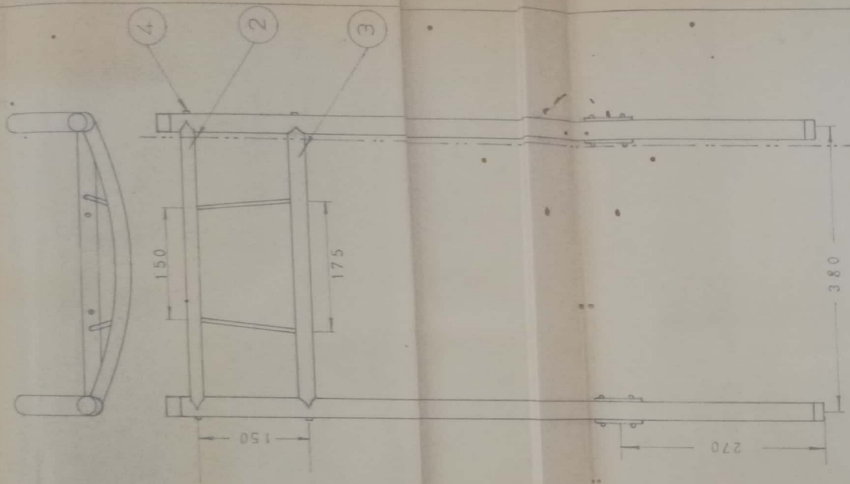
The grip pipe is also used for resting the forearms on it.

8.0 COMMUNICATION

8.1 Model

8.2 Photographs

8.3 Technical drawings

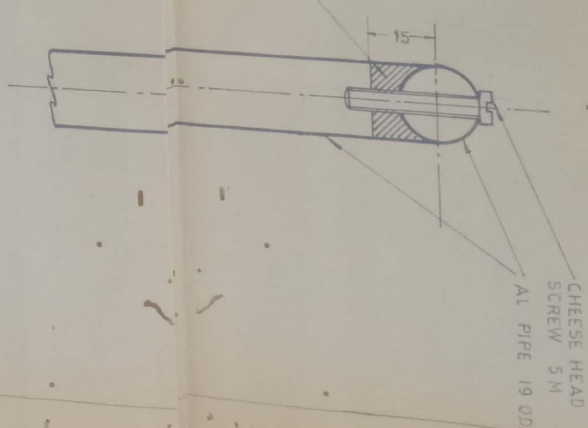
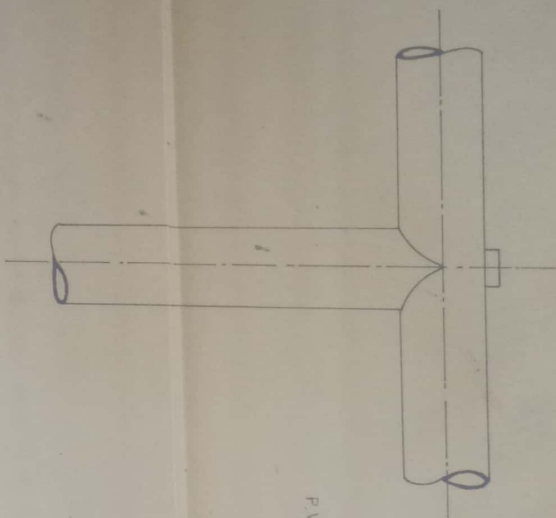


|     |               |        |               |
|-----|---------------|--------|---------------|
| 7   | RIVET         | M.S.   | 4             |
| 6   | PIVOT PLATE   | AL.    | 4             |
| 5   | BUSH          | P.V.C. | 4             |
| 4   | SCREW         | M.S.   | 4             |
| 3   | CROSS PIPE 2  | AL.    | 1             |
| 2   | CROSS PIPE -1 | AL.    | 1             |
| 1   | VERTICAL PIPE | AL.    | 2             |
| NO. | NAME          | MATL.  | No OFF FINISH |

RUCK SACK - MAIN FRAME

|         |           |                                  |
|---------|-----------|----------------------------------|
| NAME    | S J NABAR | 3 <sup>rd</sup> ANGLE PROJECTION |
| ROLL NO | S 921     | SCALE 1 : 5                      |
| BATCH   | IV        | DIMENSIONS IN M.M                |

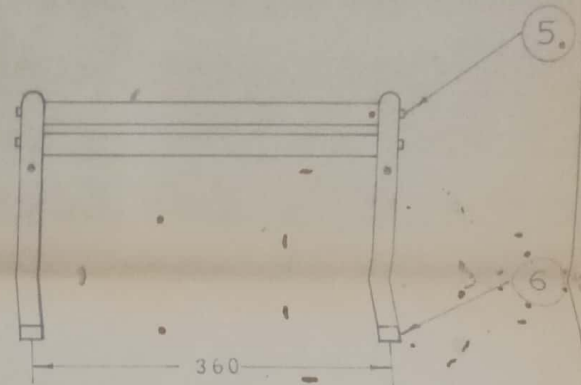
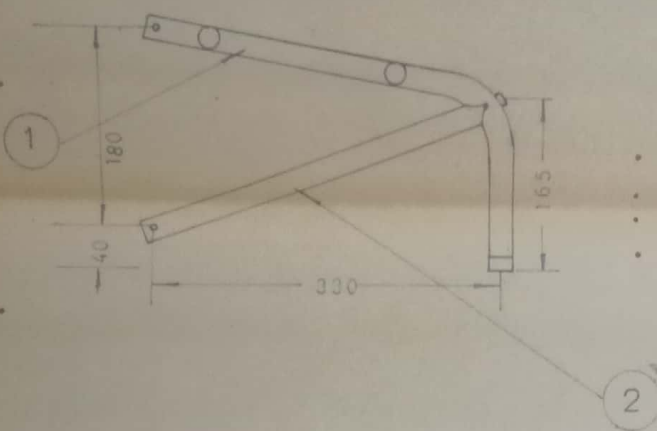
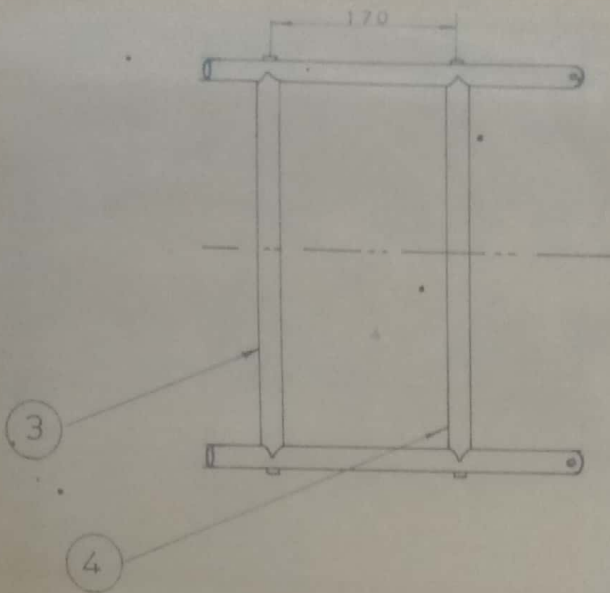
INDUSTRIAL DESIGN CENTRE



RUCK SACK - PIPE JOINT

|          |             |                                  |
|----------|-------------|----------------------------------|
| NAME     | S. J. NABAR | 3 <sup>rd</sup> ANGLE PROJECTION |
| ROLL NO. | S 921       | FULL SCALE                       |
| BATCH    | IV          | DIMENSIONS IN M.M.               |

INDUSTRIAL DESIGN CENTRE

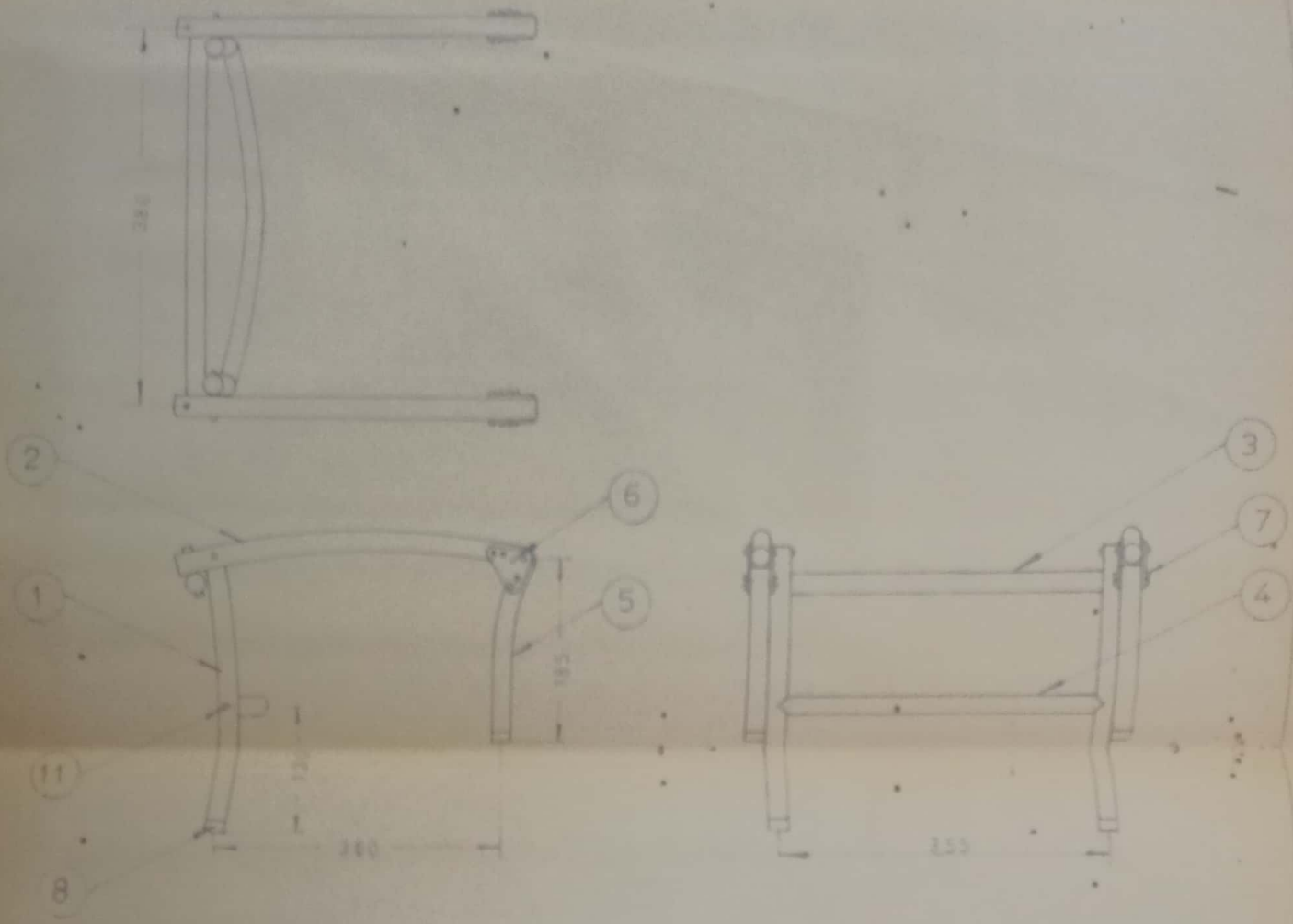


| 7   | NUT BUSH     | P.V.C. | 6      |        |
|-----|--------------|--------|--------|--------|
| 6   | BUSH         | P.V.C. | 2      |        |
| 5   | SCREW        | M.S.   | 6      |        |
| 4   | CROSS PIPE 2 | AL.    | 1      | BUFFED |
| 3   | CROSS PIPE 1 | AL.    | 1      | BUFFED |
| 2   | SUPPORT PIPE | AL.    | 2      | BUFFED |
| 1   | CURVED PIPE  | AL.    | 2      | BUFFED |
| NO. | NAME         | MATL.  | No-OFF | FINISH |

### RUCK SACK - LOAD CARRYING PLATFORM

|          |             |                                  |
|----------|-------------|----------------------------------|
| NAME     | S. J. NABAR | 3 <sup>rd</sup> ANGLE PROJECTION |
| ROLL NO. | S 921       | SCALE 1:5                        |
| BATCH    | IV          | DIMENSIONS IN M.M.               |

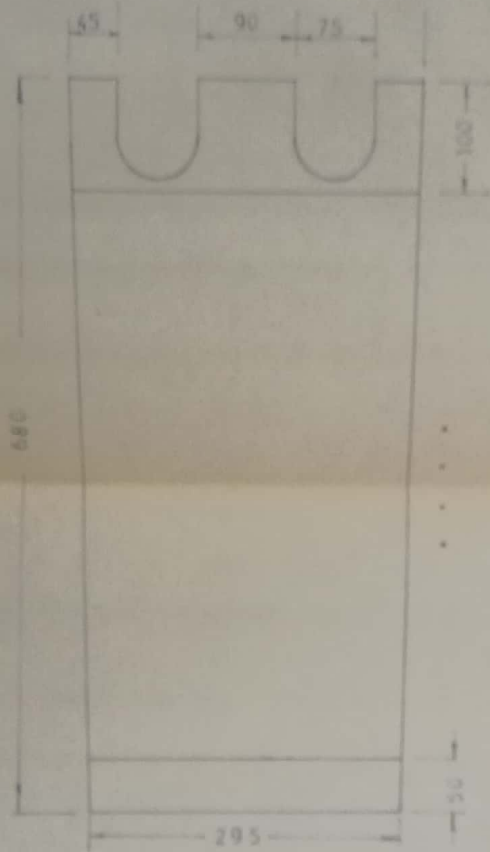
INDUSTRIAL DESIGN CENTRE



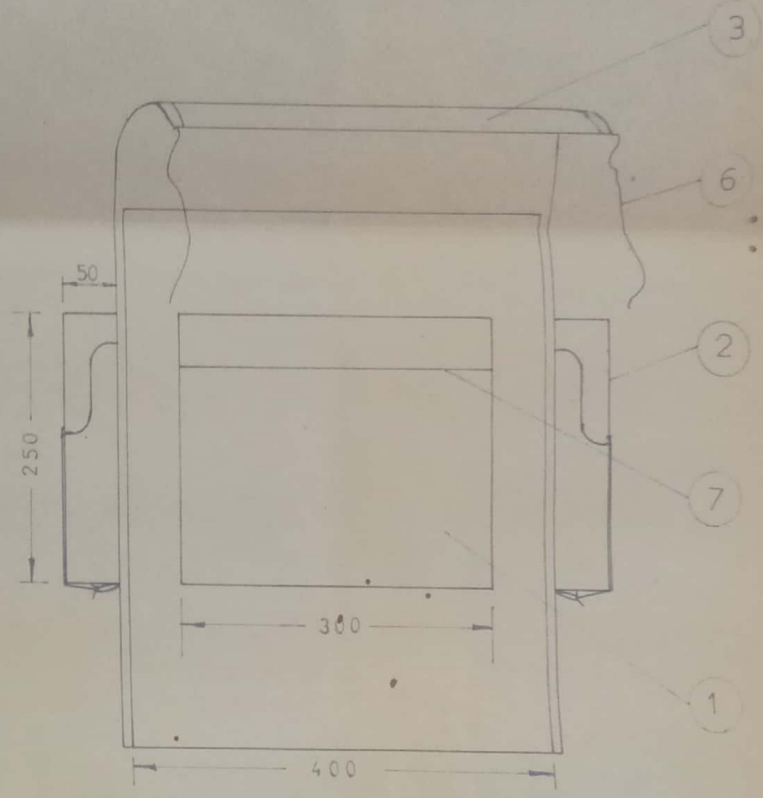
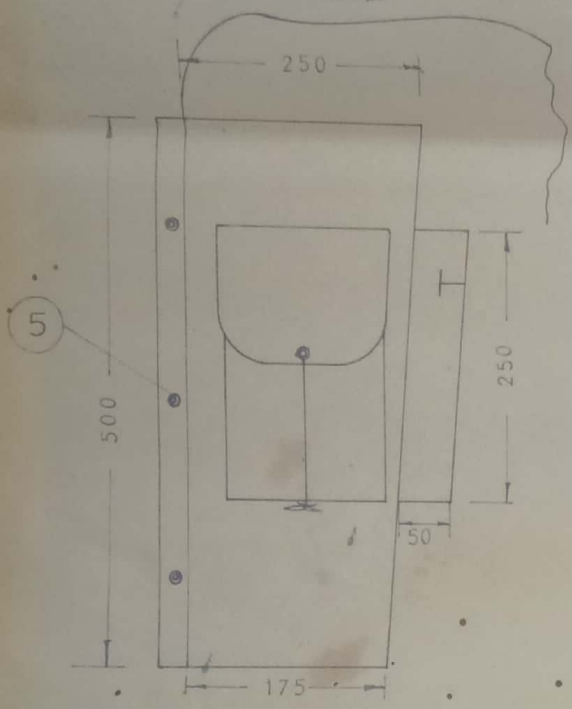
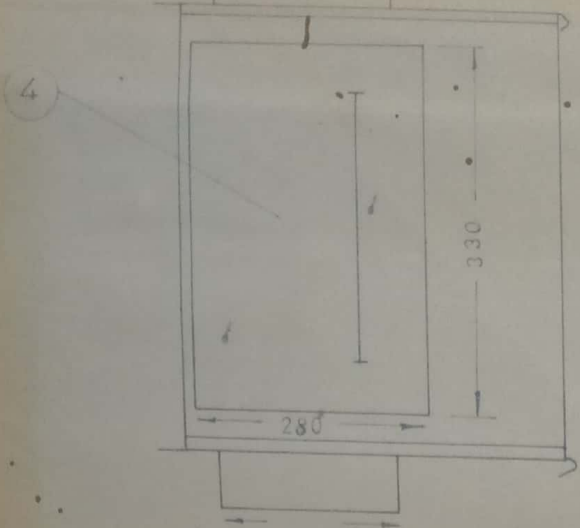
| 11  | SCREW        | MS.   | 4      |        |
|-----|--------------|-------|--------|--------|
| 10  | END BUSH     | PVC   | 10     |        |
| 9   | NUT BUSH     | PVC   | 2      |        |
| 8   | BUSH         | PVC   | 4      |        |
| 7   | RIVET        | MS    | 8      |        |
| 6   | CORNER       | AL    | 4      |        |
| 5   | GRIP PIPE    | AL    | 2      |        |
| 4   | CROSS PIPE 2 | AL.   | 1      |        |
| 3   | CROSS PIPE 1 | AL.   | 1      |        |
| 2   | SEAT PIPE    | AL.   | 2      |        |
| 1   | LEG PIPE     | AL.   | 2      |        |
| NO. | NAME         | MATL. | No OFF | FINISH |

RUCK SACK CHAIR UNIT

|                          |             |                                  |
|--------------------------|-------------|----------------------------------|
| NAME                     | S. J. NABAR | 3 <sup>rd</sup> ANGLE PROJECTION |
| ROLL NO.                 | S 921       | SCALE 1:5                        |
| BATCH                    | IV          | DIMENSIONS IN M.M.               |
| INDUSTRIAL DESIGN CENTRE |             |                                  |



|                          |             |                                  |
|--------------------------|-------------|----------------------------------|
| RUCK SACK - CHAIR CLOTH  |             |                                  |
| NAME                     | S. J. NABAR | 3 <sup>rd</sup> ANGLE PROJECTION |
| ROLL NO.                 | S 921       | SCALE 1:5                        |
| BATCH                    | IV          | DIMENSIONS IN M.M.               |
| INDUSTRIAL DESIGN CENTRE |             |                                  |

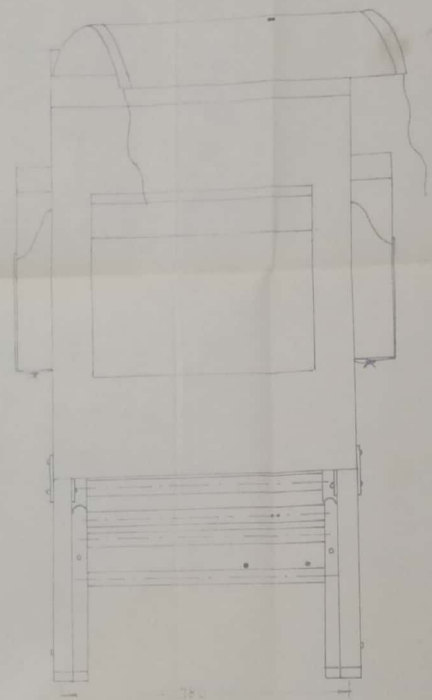
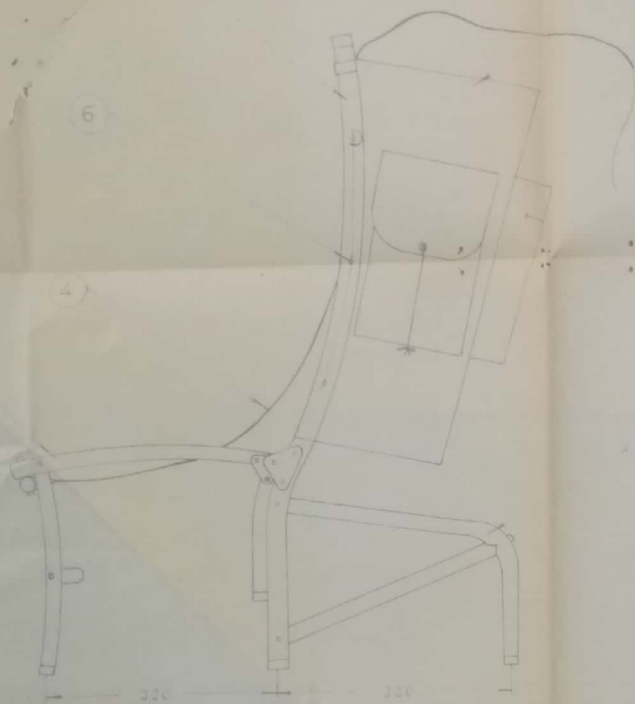


| 7   | ZIP          | NYLON  | 2      |        |
|-----|--------------|--------|--------|--------|
| 6   | ST.RING      | NYLON  | 2      |        |
| 5   | EYELET       | BRASS  | 8      |        |
| 4   | MAP POCKET   | CANVAS | 1      |        |
| 3   | FLAP         | CANVAS | 1      |        |
| 2   | SIDE POCKET  | CANVAS | 2      |        |
| 1   | FRONT POCKET | CANVAS | 1      |        |
| NO. | NAME         | MATL.  | No.OFF | FINISH |

RUCK SACK - SACK

|          |             |                    |     |                  |
|----------|-------------|--------------------|-----|------------------|
| NAME     | S. J. NABAR | rd                 | 3   | ANGLE PROJECTION |
| ROLL NO. | S 921       | SCALE              | 1:5 |                  |
| BATCH    | IV          | DIMENSIONS IN M.M. |     |                  |

INDUSTRIAL DESIGN CENTRE



|    |                        |    |            |
|----|------------------------|----|------------|
| 8  | ALUMINIUM PINS         | 6  |            |
| 7  | WAIST BELT             | 1  |            |
| 6  | SHOULDER STRAPS        | 2  |            |
| 5  | SACK                   | 1  |            |
| 4  | CHAIR CLOTH            | 1  |            |
| 3  | CHAIR UNIT             | 1  |            |
| 2  | LOAD CARRYING PLATFORM | 1  |            |
| 1  | MAIN FRAME             | 1  |            |
| NO | NAME                   | No | OFF FINISH |

RUCK SACK - ASSEMBLY ..

|                          |           |    |                    |
|--------------------------|-----------|----|--------------------|
| NAME                     | S J NABAR | rd | 3 ANGLE PROJECTION |
| ROLL NO                  | S 921     |    | SCALE 1:5          |
| BATCH                    | IV        |    | DIMENSIONS IN M.M. |
| INDUSTRIAL DESIGN CENTRE |           |    |                    |

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