COMPUTER WORKSTATION DESIGN FOR CEREBRAL PALSY CHILDREN

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Final presentation: November 24, 2006

we can and we will.....

WHY THIS PROJECT ?

This project was brought up by NJDC team (National Job Development Center,Chembur) because it was felt that there is a need to solve a lot of issues concerned with their spastic students working on the computer workstation.

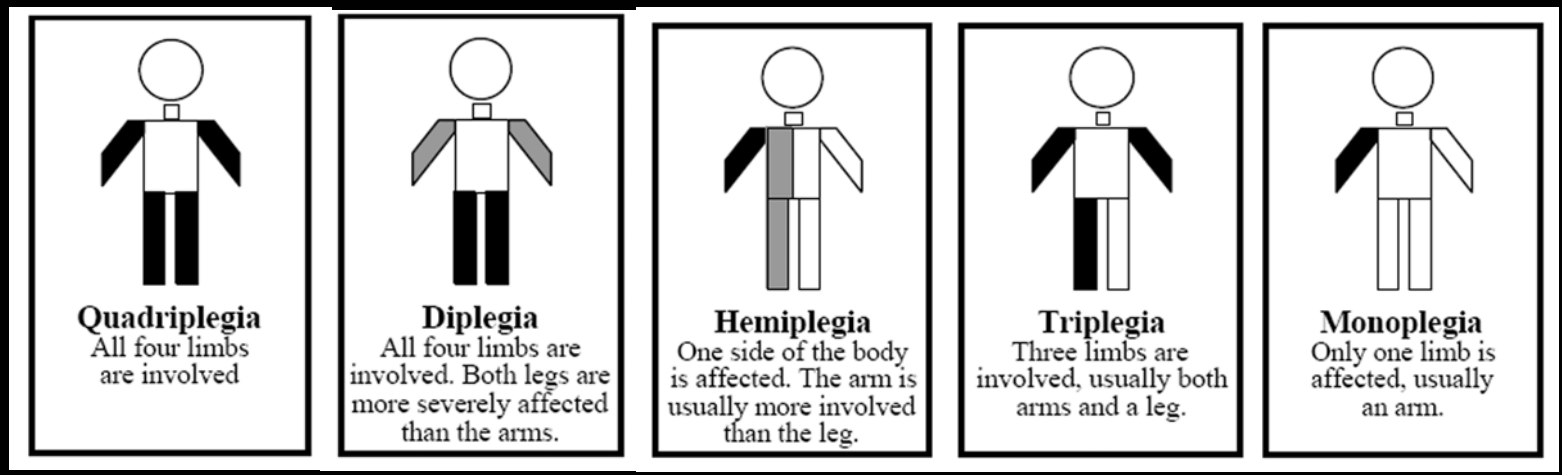
BRIEF INTRODUCTION:

What is CEREBRAL PALSY?

CEREBRAL PALSY (CP) is a term used to describe a group of chronic conditions affecting body movements and muscle coordination.

The four main categories include:

1. *Spastic CP*
2. *Athetoid or Dyskinetic CP*
3. *Ataxic CP and,*
4. *Mixed CP.*



PROBLEM DEFINITION:

The spastic subjects working on the computer can not sit in the prescribed postures as followed by the normal people based on ergonomics principle. This unintentional awkward posture in turn can cause a lot of other musculo-skeletal problems to them, which may further attenuate their muscle tone.

PRESENT SCENARIO:

Although the monitor table and the keyboard table are being provided with adjustments they are placed in such remote locations that it becomes extremely difficult for the spastic person to access it as well as use it.

The chair that is provided is an ordinary tubular structure chair, which does not have any scope for adjustments. Also the chair itself is so heavy that it becomes really cumbersome for the ingress and egress of the subject as shown.

TYPE OF USERS:

The type of subjects considered here are the persons who are in the age group of 18 to 25 years. They are not that severe in their particular kind of spasticity and can work on the computer satisfactorily.

PROJECT AIM:

To design an ergonomically efficient workstation, which the spastic person can adjust by himself to sit comfortably while working on computer.

DESIGN APPROACH:

A user study was conducted and analyzed based on the following methods:

1. *Video documentation*
2. *Time motion analysis*
3. *Questionnaire and experimentation*

1. Video documentation:

Conclusions:

- Switches placed at the extreme position, making it difficult for the subject to operate.

2. The currently used chairs are quite heavy with no adjustability making it difficult for ingress and egress as shown.This also leads to inappropriate table height and dangling legs.

DESIGN APPROACH:

Conclusions:

3. Possibility of the subject getting his legs entangled in the wires hanging from the table.

4. During work, the person is not able to locate the sentence on the document after a visual switchover from the document to the screen.

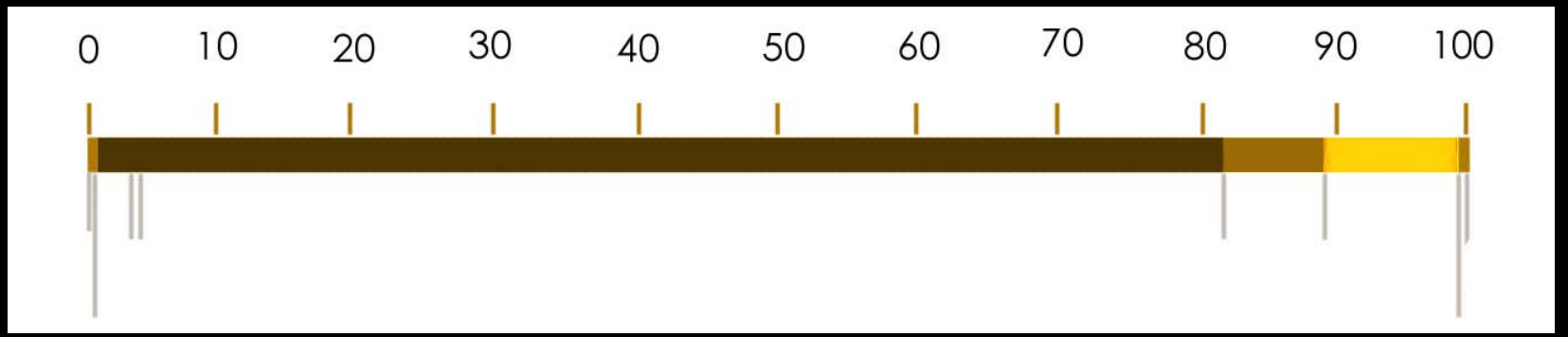
5. Hand arresting mechanisms should be incorporated as shown.

DESIGN APPROACH:

2. Time motion Analysis:

Conclusions:

Most of the time is taken by the subject to type down the sentence from the document to the monitor screen.



Entry	: 0.2 %	Idle	: 3.5 %	Egress	: 0.12 %
Switching on	: 0.24 %	Interaction (supervisor)	: 1.45 %	Switching off	: 0.62 %
Ingress	: 0.3 %	Setting document	: 0.08 %	Exit	: 0.2 %
		Typing	: 67.37 %		
		Relaxing	: 8.8 %		
		Locating word in the document	: 12.17 %		

DESIGN APPROACH:

3. Questionnaire:

The subjects were asked some general questions such as:

1. Pain in the body part before and after the job.
2. Height of the table and chair respectively.
3. Scope for height adjustment.

Conclusions:

The subjects never do any adjustments on their own because of the difficulty in operating the mechanisms. Also a need for the armrest was insisted, as it would be easier for them to type the things.

PROJECT BRIEF:

1. Table design in detail with customized options for CP subjects.
2. Chair design along with the necessary accessories used by the CP subjects.
3. Methods of arresting their different body parts.
4. Concern for storage space.
5. Concern for wire harnessing along with proper location of the mains.
6. Design of monitor, keyboard and mouse and document holder adjusting mechanisms.
7. Special keyboard and mouse design.
8. Design of the dust covers for the monitor, CPU and the keyboard.

But considering the time limitations for the project, only the first six points will be dealt with in detail.

CONSTRAINTS:

1. The spastic subjects considered here are only five in number but the concept can always be extended to a larger group of people.

2. The spastic subjects using the computer are not that severely affected. Hence it can be assumed that adjustments such as chair height, table height, monitor level, keyboard and mouse table and document holder can be performed by them.

3. If the person has to be strapped then there can be an assistant who can do these things for the subjects as it becomes difficult for the subject himself to do so.

4. Awareness has to be created for the first time so that the subject can use the equipment easily and effectively.

5. Depending upon the subject seating posture an angle of around 100^{o} is taken as a reference.

CORRECT SEATING PROCESS:

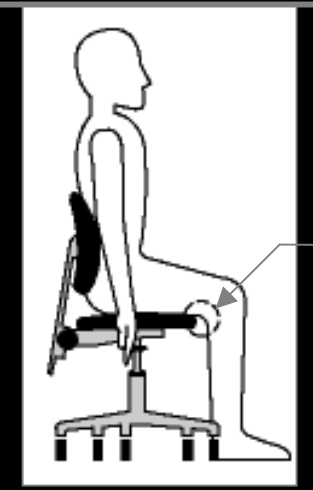
A sequential step for the proper seating is explained as follows:

1. Stand in front of the chair. Adjust the height of the chair so that the seat is approximately at knee level as shown in Fig.1.

1

2. Sit so that the space between the front edge of the chair and the lower part of the legs just fits a clenched fist as shown in Fig.2.

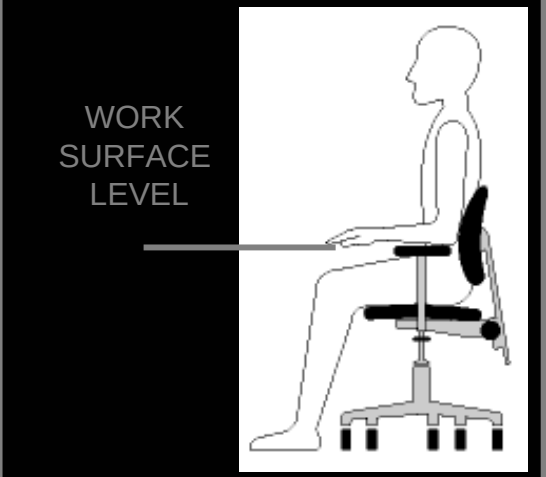
2



CORRECT SEATING PROCESS:

3. The height of the work surface should be adjusted to the level of the elbow joint as shown in Fig.3.

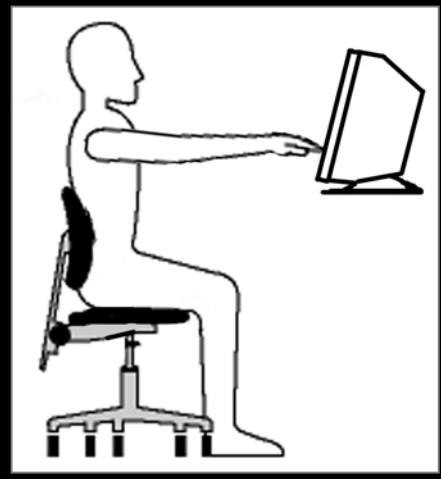
3



4. For correct monitor location,
   - Body centerline and monitor centerline should coincide
   - The center of the screen should be at 15 degrees with respect to the horizontal eye level.
   - The distance can be approximately taken as one arm length.

   The detail is as shown in Fig.4.

4

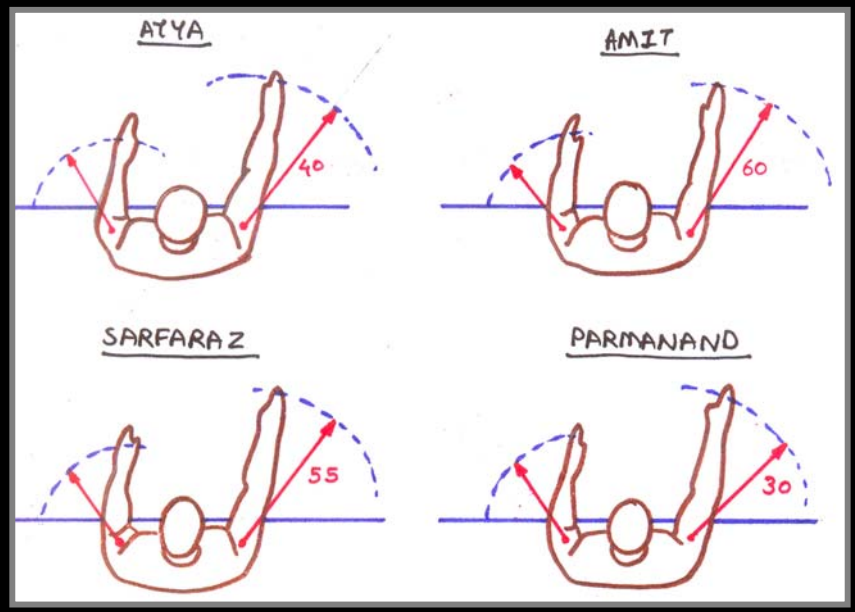


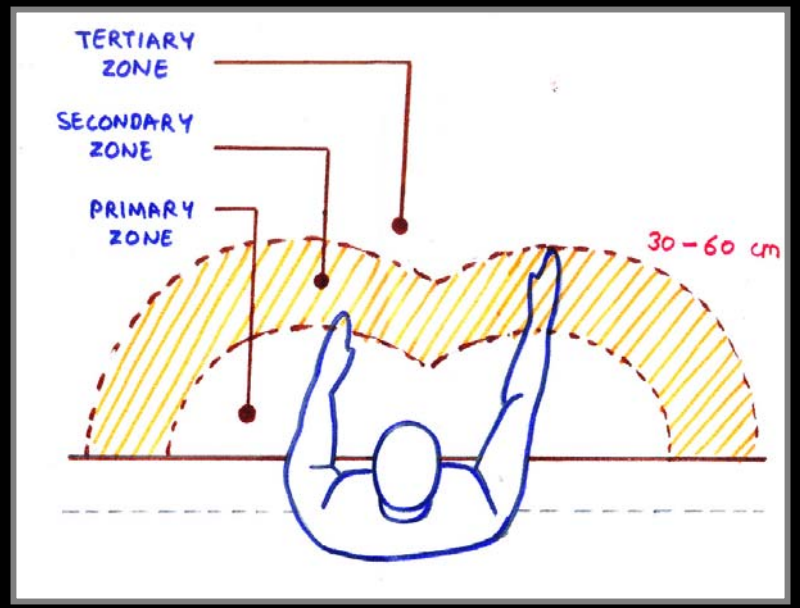
CONCEPT SKETCHES:

Defining the fundamental zones:

The zones were identified on the basis of the anthropometrics data of the five subjects. Then a common range of zone was identified as shown.

ZONES OF REACH





CONCEPT SKETCHES:

Defining the dimensions governing the adjustments:

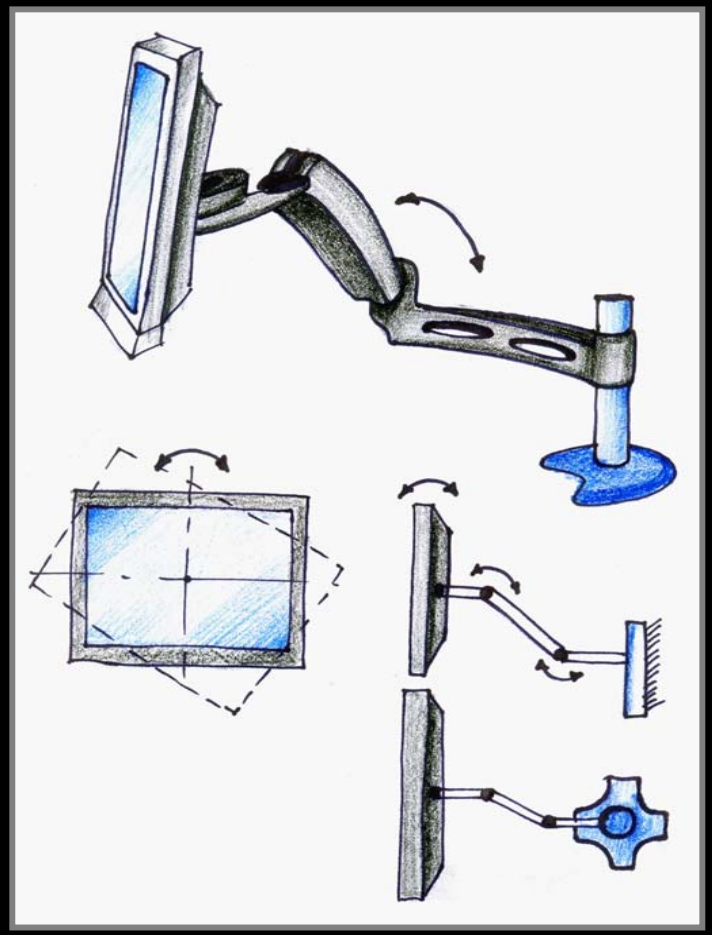
The anthropometric data acquired from these five subjects were analyzed for the chair, monitor table and keyboard table height adjustments.

	POPLITEAL HEIGHT	ELBOW HEIGHT	EYE LEVEL HEIGHT	FOREARM LENGTH
SUBJECT				
ATYA	46	55	108	41
AMIT	45	61	115	46
SARFARAZ	45	56.5	108	40
PARMANAND	45.5	55.5	118	43
GARGI	36.8	47.3	92.3	38

All dimensions are in cm

CONCEPT SKETCHES:

Design of the monitor stand:

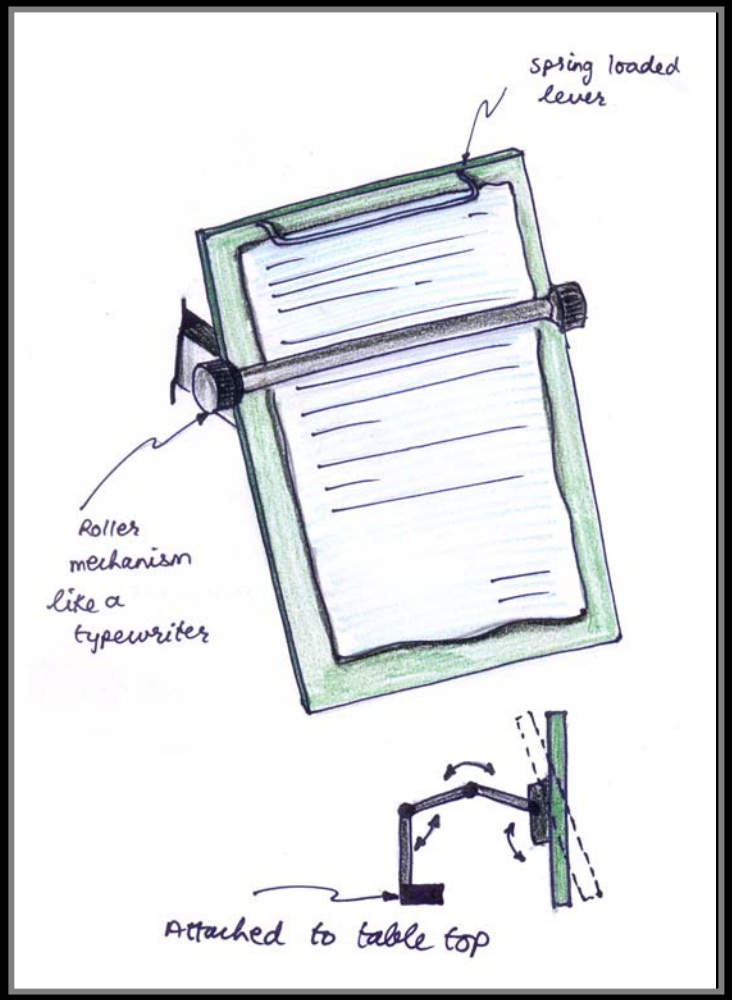


This design consists of two arms which has a spring inside to counteract the weight of the computer screen which will be fixed to it.Also it has three degrees of freedom which makes it easier to get adjusted.

The best part of this stand is that it requires only the touch of the fingertip to adjust the screen in the vertical as well as in the horizontal direction.

CONCEPT SKETCHES:

Design of the document holder:



CONCEPT 1:

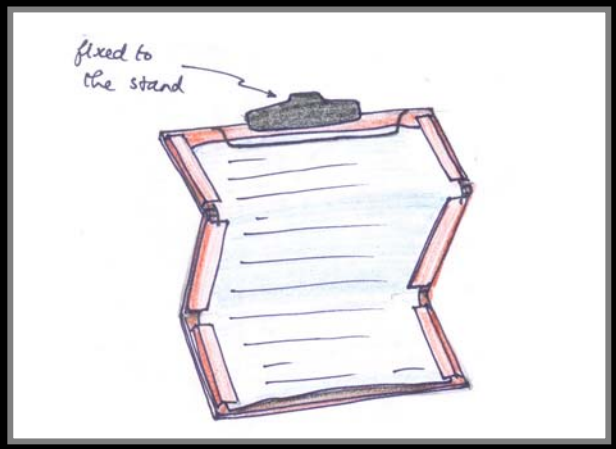
This concept shown involves the use of a typewriter like mechanism which uses a rubber roller to scroll the paper up and down just as it is done in a typewriter.

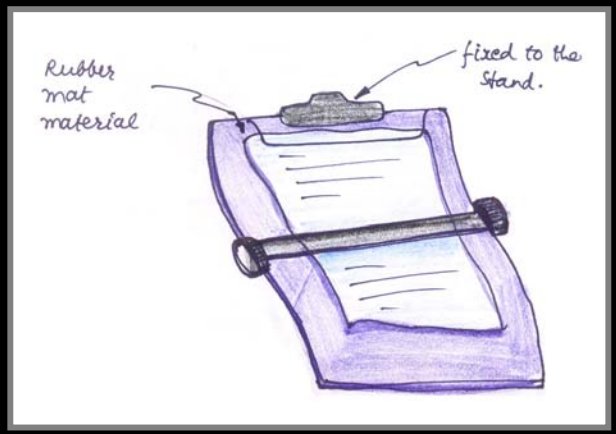
For loading the document in the holder the roller opens from one end, the other end being hinged. The paper is then loaded in that holder and the roller is then closed.

The advantage of this mechanism is that the roller itself acts as a guide to locate the sentence.

CONCEPT SKETCHES:

Design of the document holder:





CONCEPT 2:

This concept shown uses the collapsible technique so that the same document holder can be used when placed at the side or at the center in front of the monitor.

The main disadvantage with this is that the angle of viewing is not proper.

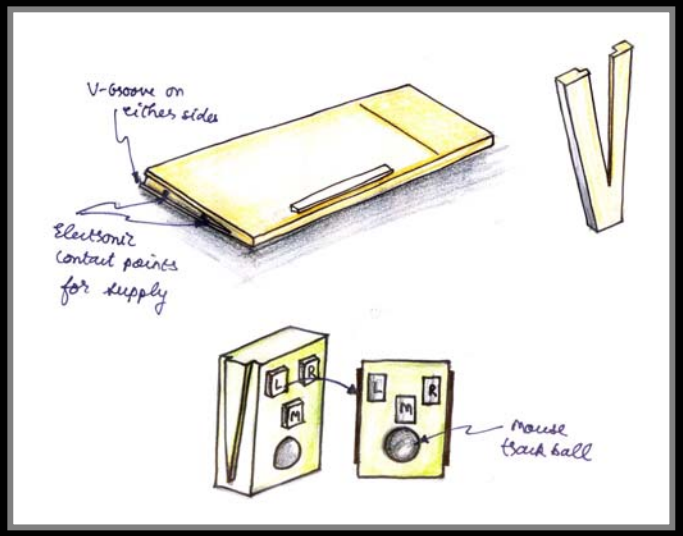
CONCEPT 3:

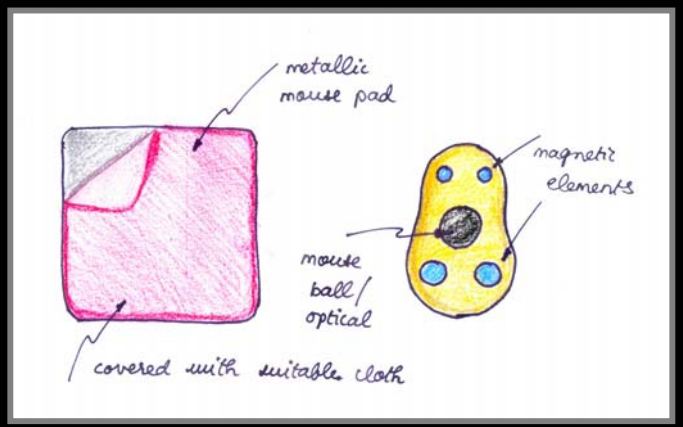
In the concept shown the document holder is made of a flex type material, which can be very well placed at the sides as well as in the center in front of the screen.

The disadvantage is that this when placed at the center flexes in such a manner that it becomes difficult to read the matter.

CONCEPT SKETCHES:

Design of keyboard and mouse:





CONCEPT 1: Keyboard integrated mouse:

This concept shown involves the use of a special mouse which can be slided on either sides of the keyboard.

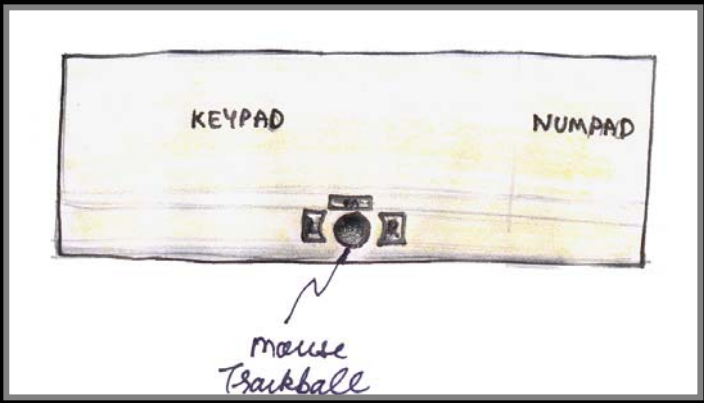
CONCEPT 2: Magnetic mouse:

A steel plate is placed inside the mouse pad with an optical mouse incorporated with small magnets.The magnetic force will be just sufficient enough for the mouse to stay onto the table, and will not affect the muscle force of the CP person.

The main advantage of using this kind of a mechanism is that the mouse will not fall even if the keyboard table is inclined at a certain position.

CONCEPT SKETCHES:

Design of keyboard and mouse:



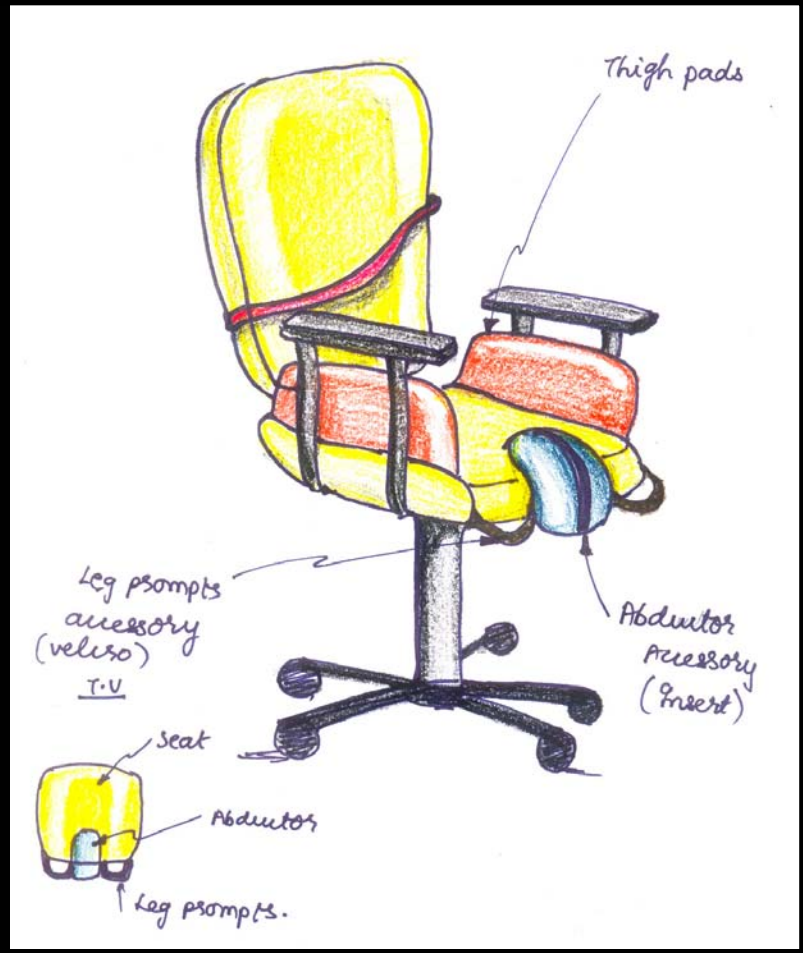
CONCEPT 3: Keyboard with mouse at the center:

This concept has a mouse ball or a track ball at the lower central portion of the keyboard as shown in Fig.6.6.3.

The main disadvantage in this concept was the accidental motion of the trackball while typing hence making it very difficult to operate.

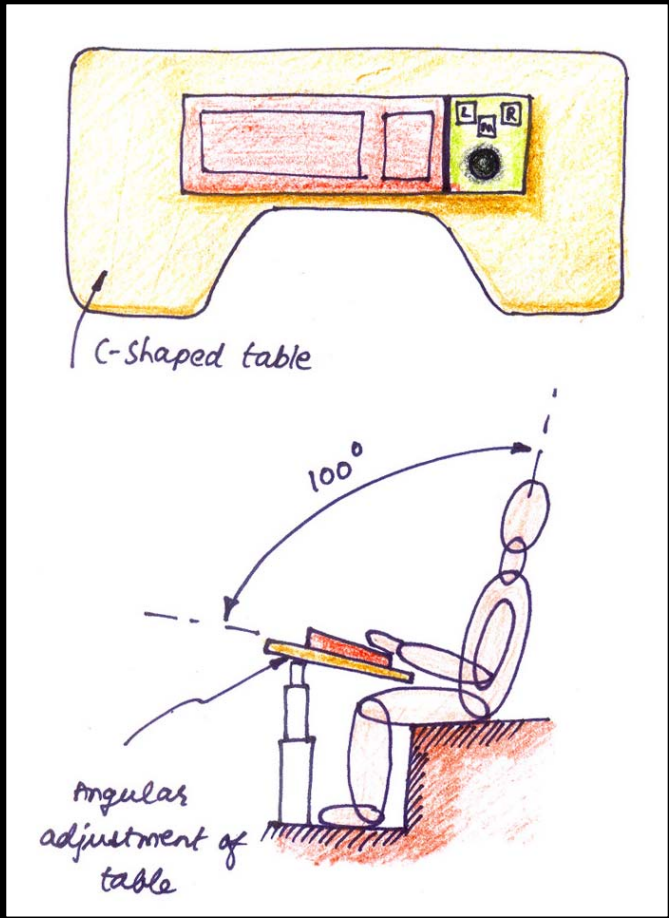
CONCEPT SKETCHES:

Arresting body parts of the subjects:



CONCEPT SKETCHES:

Design of table:



CONCEPT 1:

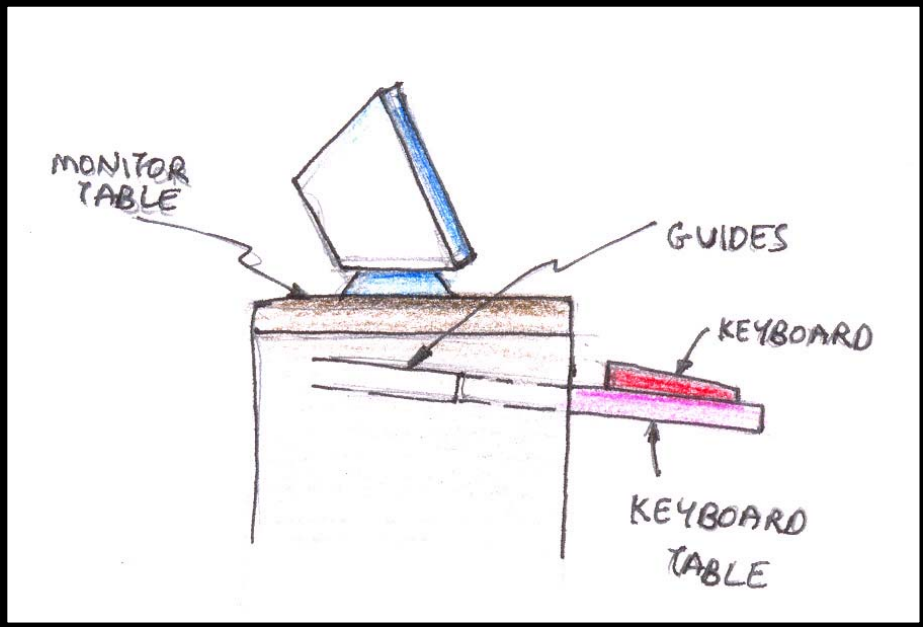
This design involved a ‘C’ type contour which helped the subject to automatically sit in a proper way.Also a provision should be made for the subject to arrest their hands if they require to.

CONCEPT SKETCHES:

Design of table:

CONCEPT 2:

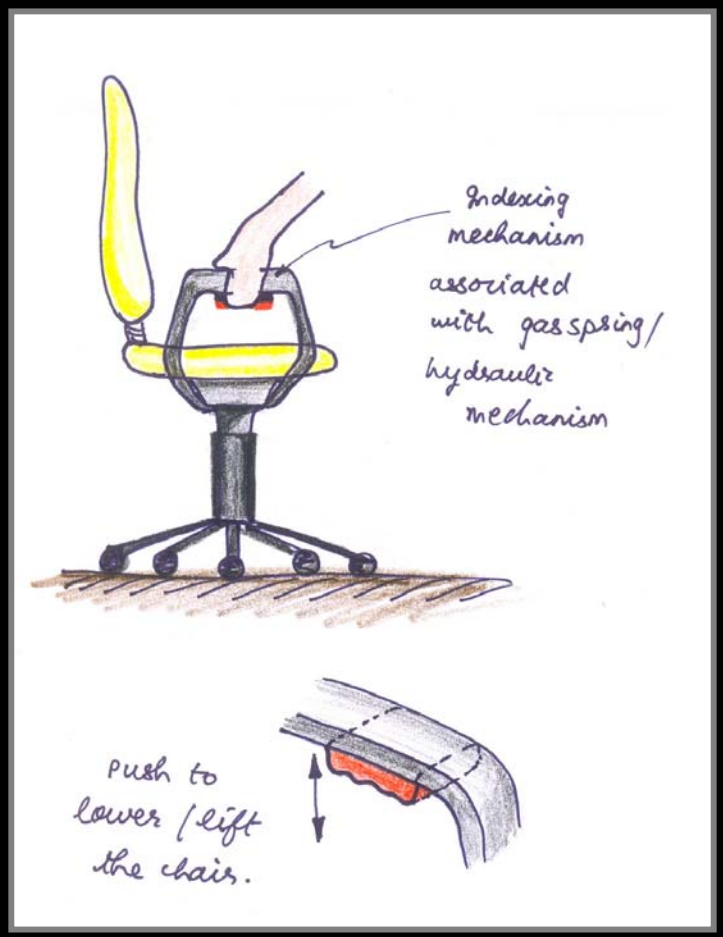
The design shown involves a split kind of concept with a monitor table and a keyboard table that can be easily slided inside and outside with the help of the guides located on the inside surface of the monitor table.



CONCEPT SKETCHES:

Design of chair:

The design of chair basically involves customizing the chair to the needs of the subjects there.

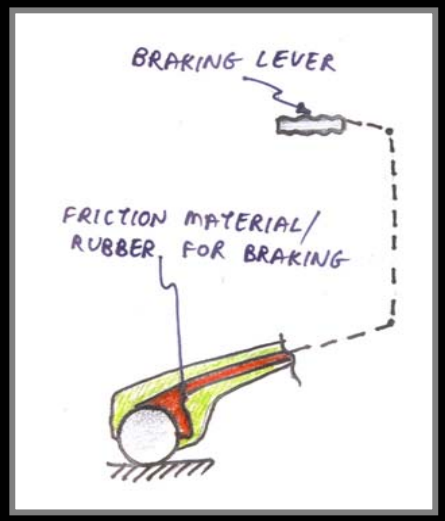


Height adjustment:

The mechanism used for height adjustment is a simple gas assisted caliper type mechanism.When the knob under the armrest is pressed the caliper is released and the height can be adjusted as shown. As soon as the knob is released the caliper locks the chair at a particular height.

CONCEPT SKETCHES:

Chair locking mechanisms:

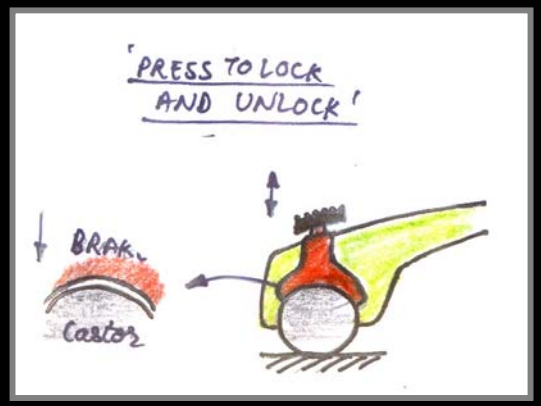


CONCEPT 1:

When the braking lever is pressed the brakes on the castor wheels get actuated and the chair remains in that particular position until it is released.

CONCEPT 2:

This concept uses a foot operated cam mechanism which can be actuated by sliding the foot over the castor wheel arms.the forward sliding of the knob will lock the wheels whereas the reverse will unlock the same.

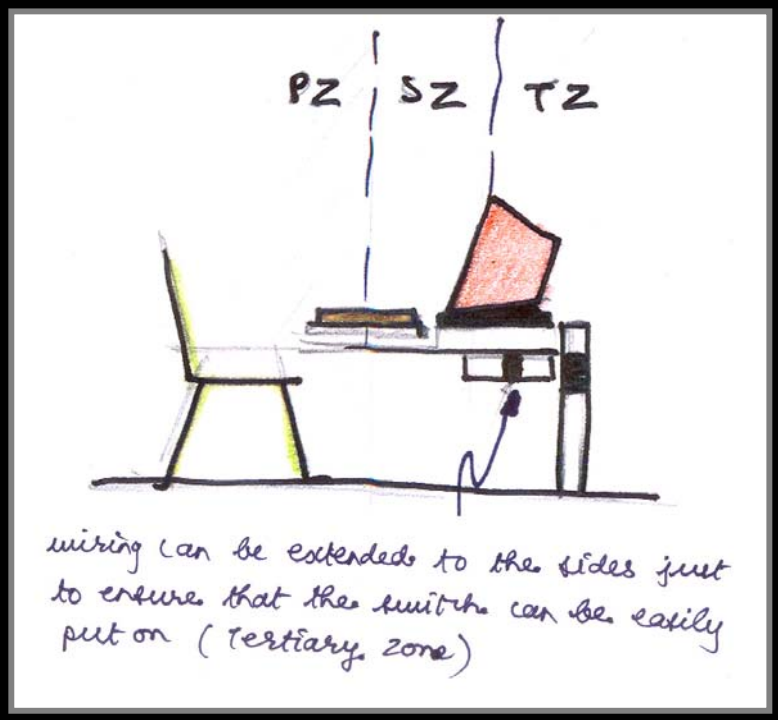


CONCEPT 3:

This uses the 'press and lock' kind of a mechanism operated by foot

CONCEPT SKETCHES:

Wire harnessing:



Wire harnessing is also taken into consideration wherein the individual sockets for CPU and monitor are being replaced by a single spike guard.This spike guard is placed at the left side rear end of the table that is in the tertiary zone.

It is placed in the tertiary zone mainly because it is least used and also to avoid the accidental switching OFF of the computer workstation.

CONCEPT GENERATION:

CONCEPT 1: ‘C’ SHAPED TABLE :

CONCEPT GENERATION:

Table Design:

1. Specially designed to keep the CPU on the table.
2. Table height can be adjusted with an automated telescopic mechanism.
3. It is divided into monitor table and the keyboard table hinged at the center.
4. The monitor table has a ‘C’ groove to accommodate the document holder in the center.
5. The keyboard table has a ‘C’groove in the center to accommodate the subject.
6. The keyboard table has cutouts for arresting the affected hand of the subject.
7. The keyboard table has a provision to be adjusted at a particular angle.
8. Concealed wire harnessing with a spike guard.

CONCEPT GENERATION:

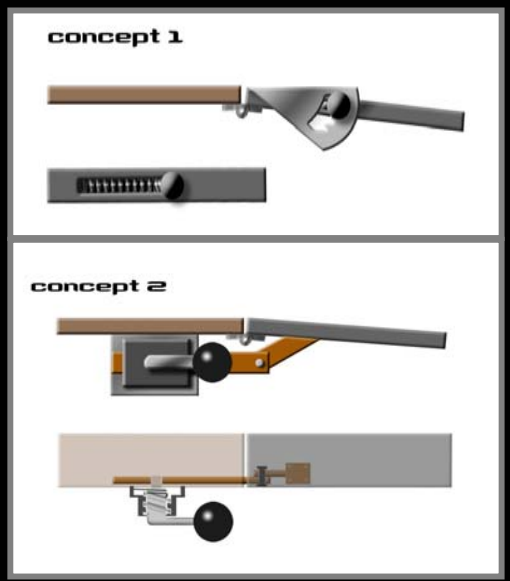


Table Adjustment mechanism:

Height:

The table is incorporated with a telescopic mechanism which can be operated automatically with the press of a switch placed in the secondary zone.

Angular adjustment:

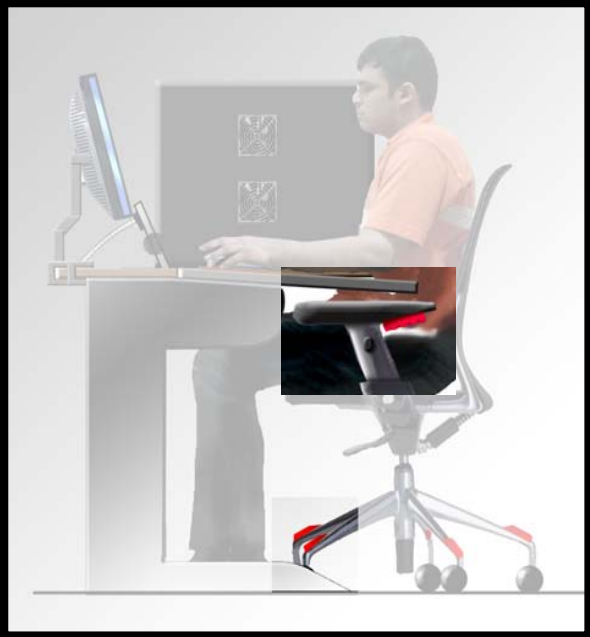
Mechanism 1:

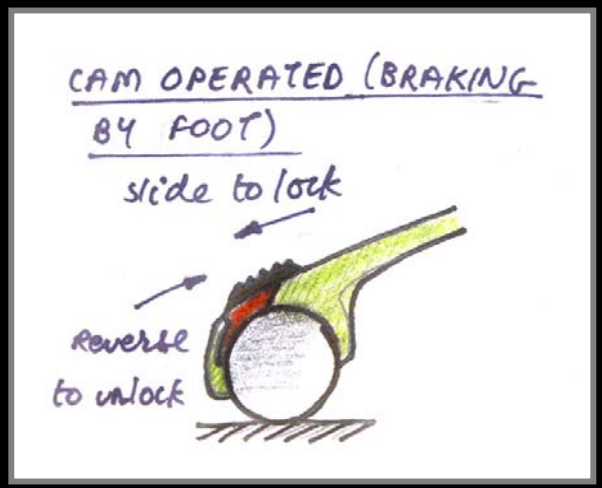
A type of indexing mechanism which operates when the knob is pushed forward which is held by a compression spring.

Mechanism 2:

A multi-start thread like mechanism incorporated with a pin in the front which fits into a hole on the lever which is guided.

CONCEPT GENERATION:





Chair Adjusting mechanisms:

Height:

The chair height can be adjusted with the help of the lever situated below the armrest.This lever when pressed in turn releases a caliper which makes the chair free so that it can be adjusted.

Also it is provided with a collapsible arm rest which helps the chair to slide under the table easily

Locking the chair:

The chair can be locked at a particular position with the help of the mechanism shown.

It consists of a friction pad at the castor wheel surface which in turn is actuated by foot that slides the friction pad onto the wheel surface hence locking the motion of the chair.

CONCEPT GENERATION:

Document holder:

The document holder as shown in Fig.7.1.5 can be fixed at a particular position on the monitor table with the help of a gooseneck and then it can be adjusted accordingly to place it besides the monitor or in front of the monitor.

CONCEPT GENERATION:

MERITS:

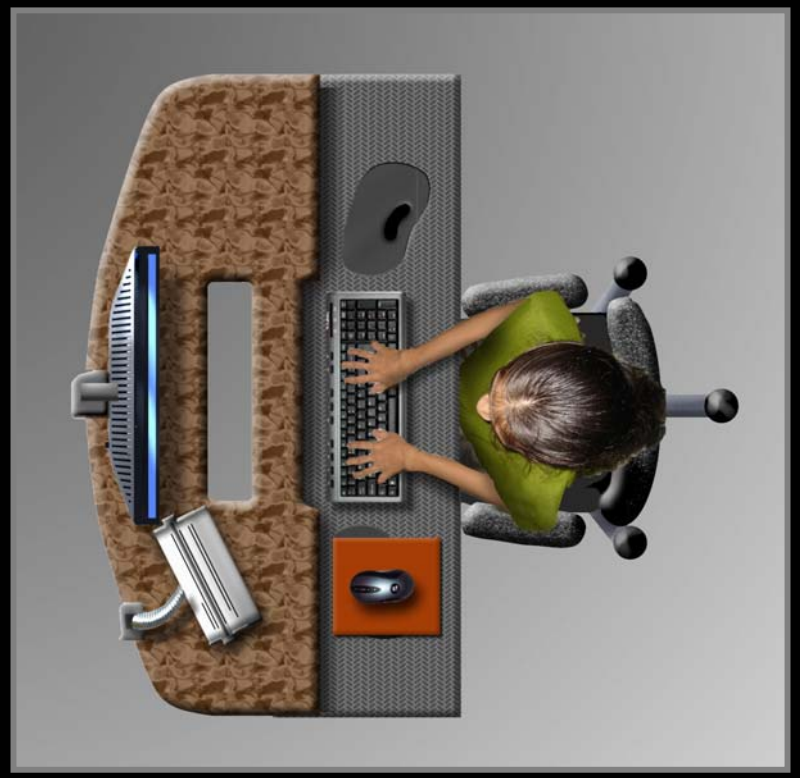
1. Due to the ‘C’ shaped table the subject is always compelled to sit in the right way.
2. The table is designed in a way that when he sits in the relaxed posture he can adjust the keyboard and the mouse angle accordingly.
3. The armrest of the chair is collapsible which helps the subject to slide the chair easily under the table.
4. The mains are located on one side of the table and placed in the tertiary zone which avoids accidental switching ‘OFF’ of the computer workstation.
5. The automated mechanism is easy to operate.
6. The monitor adjustment can be done very easily with just a touch of the fingertip.

DEMERITS:

1. Although the castor wheel chair can be pulled into the cavity easily, there is a possibility that the subject might get hurt due to involuntary motion of his hand making the chair to hit the C-edge.
2. The main disadvantage with the chair is that the locking has to be provided on all the five castors,so it becomes difficult for the person to judge which castor wheel was locked.
3. The mechanism involved here for keyboard adjustment is located at one of the sides, so becomes difficult for different kind of spastic subject to use it.

CONCEPT GENERATION:

CONCEPT 2: SPLIT TABLE TYPE CONCEPT :



CONCEPT GENERATION:

Table Design:

1. Designed to keep the CPU under the table to avoid clutter on the table
2. Table height can be adjusted with a rack and pinion mechanism operated automatically
3. It is divided into monitor table and the keyboard table, the latter being slided under the monitor table.
4. The monitor table has a slot to accommodate the document holder in the center.
5. The keyboard table has cutouts for arresting the affected hand of the subject.
6. The keyboard table has a fixed sliding angle of about 5 degrees..
7. The wires in this case pass through hooks to avoid the wires hanging down to the ground.

CONCEPT GENERATION:

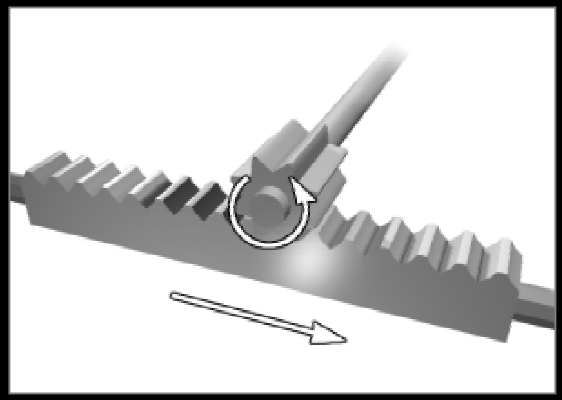
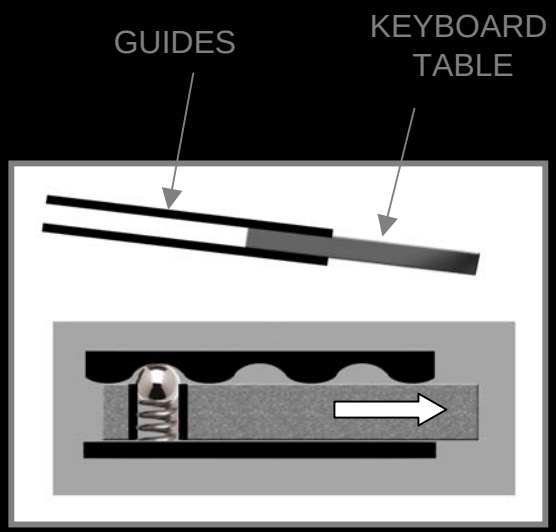


Table Adjustment mechanism:

Height:

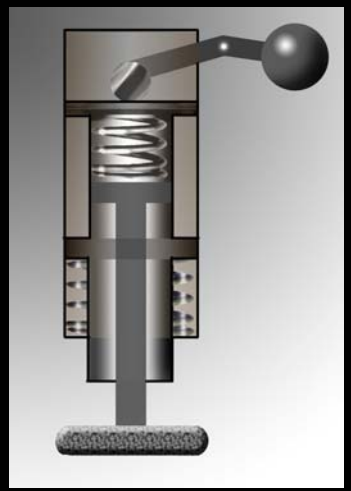
The table is incorporated with a rack and pinion mechanism which can be operated automatically with the press of a switch placed in the secondary zone.



Keyboard table locking mechanism:

A type of indexing mechanism which uses a steel ball and a compression spring which locks into the grooves of the guide ways.

CONCEPT GENERATION:



Chair Adjusting mechanisms:

Height:

The chair height can be adjusted with the help of the lever situated below the armrest.This lever when pressed in turn releases a caliper which makes the chair free so that it can be adjusted.

Also it is provided with a collapsible arm rest which helps the chair to slide under the table easily

Locking the chair:

The chair can be locked at a particular position with the help of the mechanism shown.

It consists of a friction pad at the base which in turn is actuated by a spring that increases the surface frictional area hence locking the motion of the chair.

CONCEPT GENERATION:

MERITS:

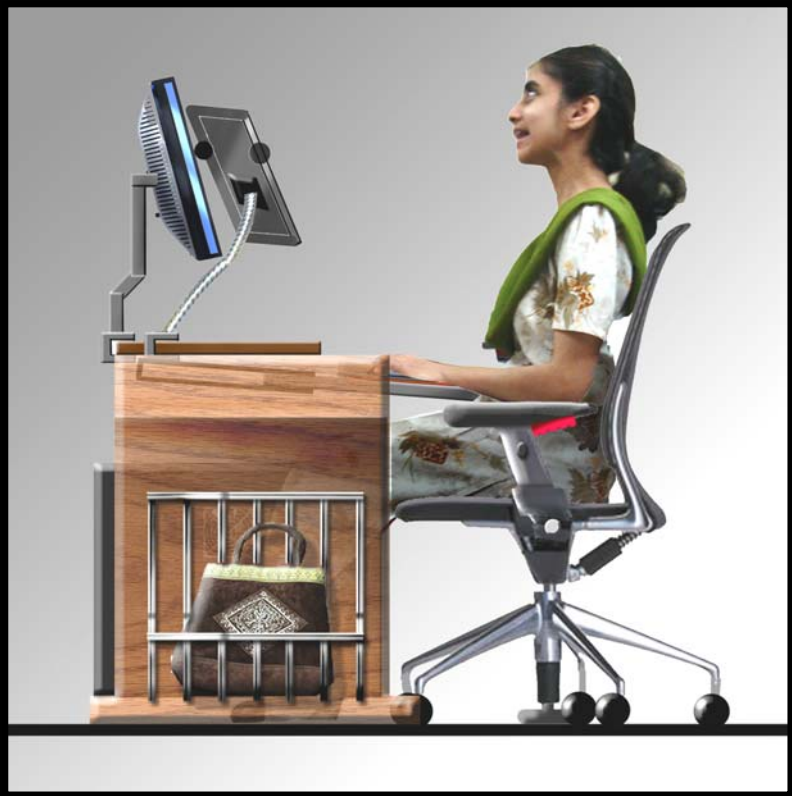
1. There is nothing like ‘C’ shape here so the subject will not get hurt if he pulls the castor chair towards his table.
2. The table is more or less symmetrical with the spaces used on either sides for storage and CPU respectively.
3. Monitor and document holder can be adjusted effectively.
4. Uses an automatic telescopic mechanism for table height.

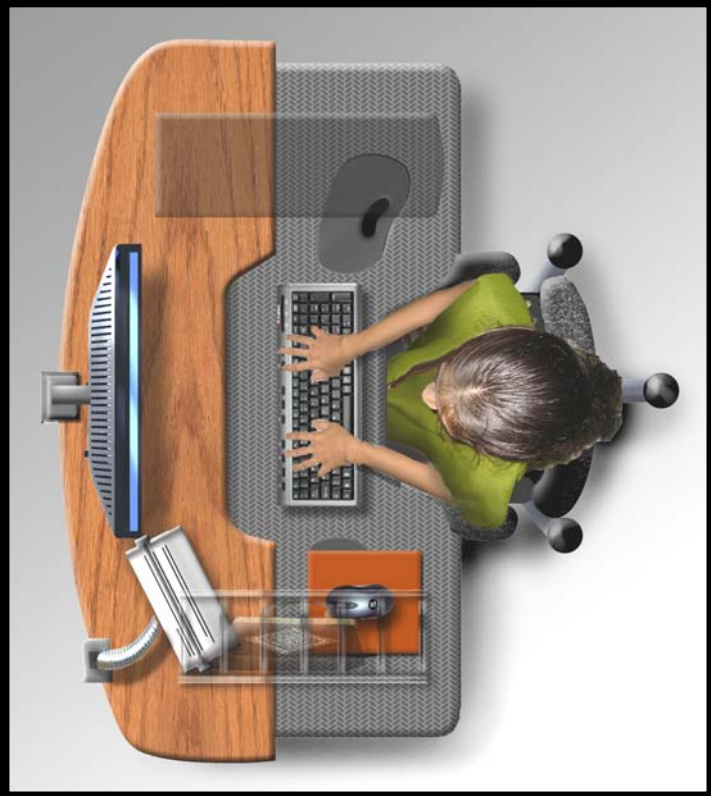
DEMERITS:

1. No automatic correct positioning of the subject.
2. The keyboard angle here is kept as 5 degrees by default.
3. The chair locking is done by a central vertical arm with a pad at the base. This may cause the chair to pivot and overturn if the subject gives a sudden jerk to the chair.
4. CPU is placed at the bottom so the person has to bend to switch it ‘ON’.
5. The chair armrest may prove out to be spaced apart than their normal armrest position, so the subject arms might be floating in air for the time they are typing.

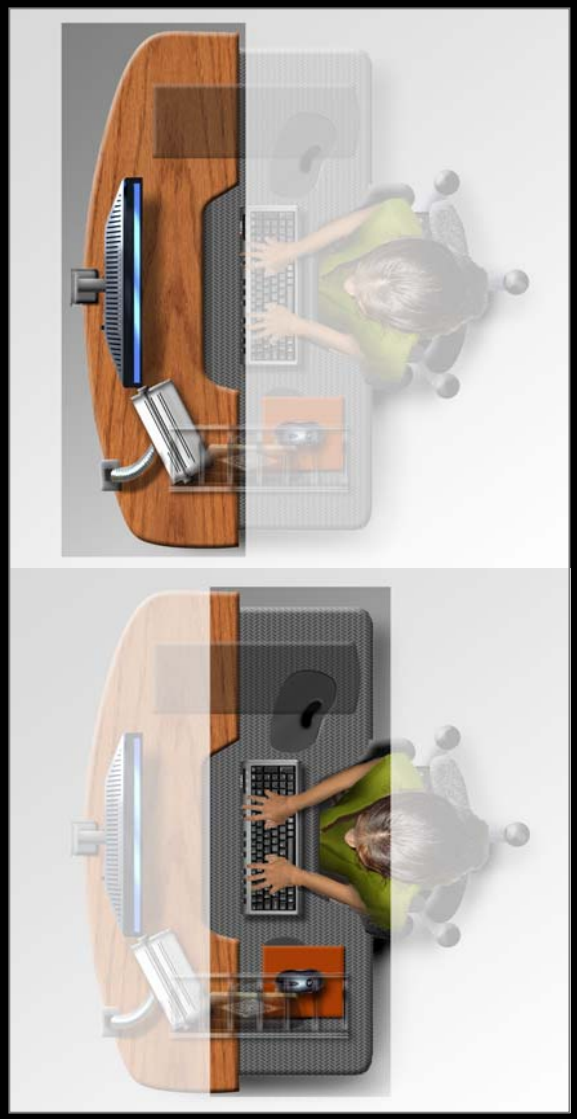
FINAL CONCEPT:

’C’ TYPE TABLE WITH SLIDING MECHANISM :





FINAL CONCEPT:

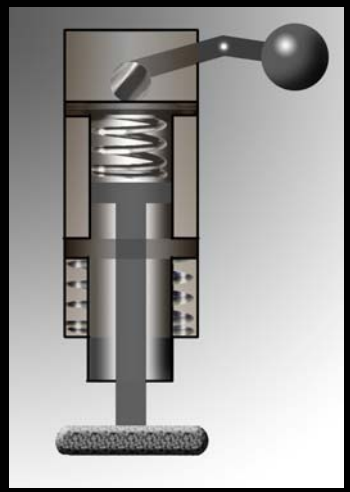


This concept is made considering the advantages of both the concepts.

Table Design:

1. Designed to keep the CPU under the table.
2. Table height can be adjusted with an automated rack and pinion mechanism.
3. It is divided into monitor table and the keyboard table, the latter being slided under the monitor table.
4. The monitor table has a ‘C’ groove to accommodate the document holder in the center.
5. The keyboard table has a ‘C’groove in the center to accommodate the subject.
6. The keyboard table has cutouts for arresting the affected hand of the subject.
7. The wires in this case pass through hooks attached to the underside of the monitor table to avoid the wires hanging down to the ground.

FINAL CONCEPT:



Chair Adjusting mechanisms:

Height:

The chair height can be adjusted with the help of the lever situated below the armrest.This lever when pressed in turn releases a caliper which makes the chair free so that it can be adjusted.

Also it is provided with a collapsible arm rest which helps the chair to slide under the table easily

Locking the chair:

The chair can be locked at a particular position with the help of the mechanism shown.

It consists of a friction pad at the base which in turn is actuated by a spring that increases the surface frictional area hence locking the motion of the chair.

FINAL CONCEPT:

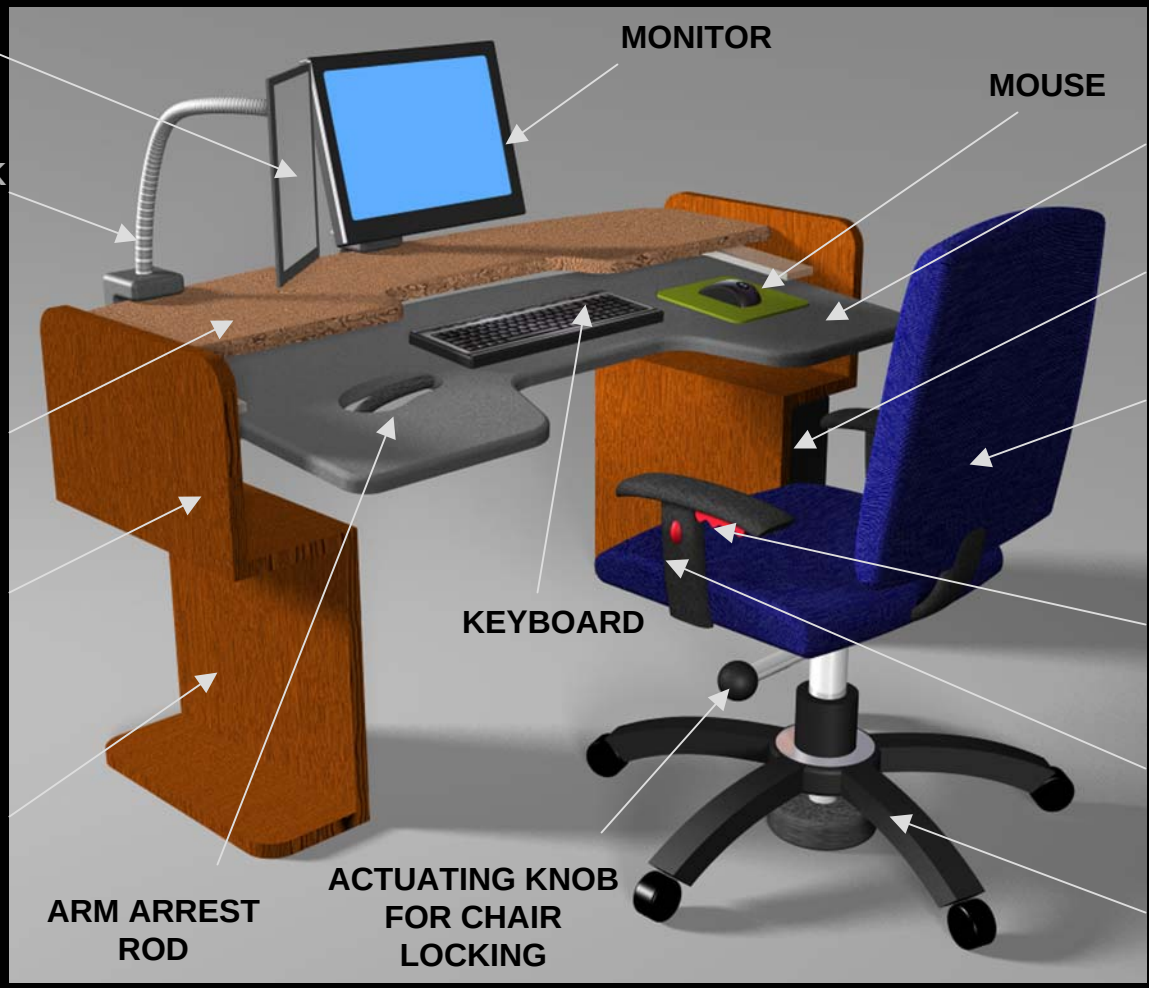
MERITS:

1. Due to the ‘C’ shaped table the subject is always compelled to sit in the right way.
2. The armrest of the chair is collapsible which helps the subject to slide the chair easily under the table.
3. The mains are located on one side of the table and placed in the tertiary zone which avoids accidental switching ‘OFF’ of the computer workstation.
4. The automated mechanism is easy to operate.
5. The monitor adjustment can be done very easily with just a touch of the fingertip.
6. The entire unit is rigid and does not involve the use of mechanisms that are difficult to operate,hence making it simple and better for use by the CP persons.
7. The table is more or less symmetrical with the spaces used on either sides for storage and CPU respectively.

DEMERITS:

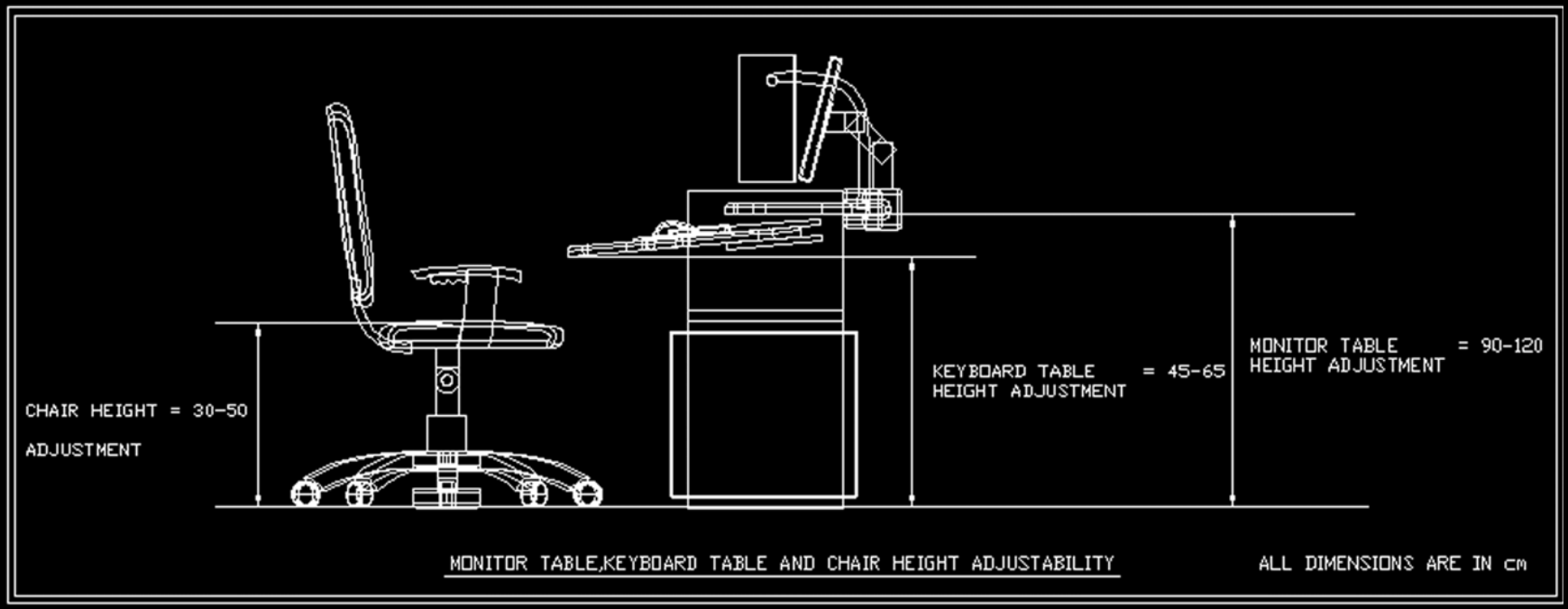
1. The main disadvantage of this concept is that the keyboard angle is kept constant as 5 degrees by taking the consideration of their seating posture.
2. The chair locking is done by a central vertical arm with a pad at the base. This may cause the chair to pivot and overturn if the subject gives a sudden jerk to the chair.

FINAL CONCEPT RENDERING:



FINAL CONCEPT DRAWINGS:

MONITOR TABLE, KEYBOARD TABLE AND CHAIR HEIGHT ADJUSTABILITY:



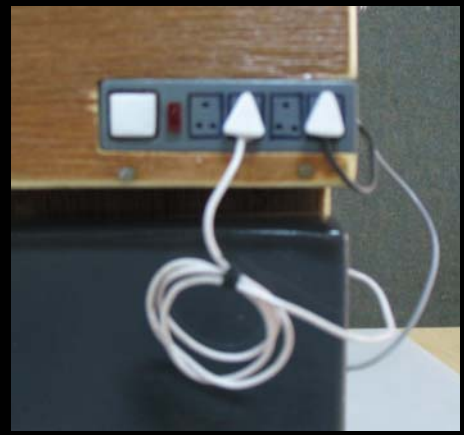
Chair height adjustment = 36.8 cm – 46.0 cm

Keyboard table height adjustment = 47.3 cm – 61.0 cm

Monitor table height adjustment = 92.3 cm – 118.0 cm

FINAL SCALED MODEL:

SCALE: 1:5



FINAL SCALED MODEL:

SCALE: 1:5

WHEN WORKING THE TABLE CAN BE SLIDED OUT

WHEN NOT WORKING THE TABLE CAN BE SLIDED IN

ACKNOWLEDGEMENT:

I am thankful to Mrs. Vandana Garware and Ms Anjana C. Barot of NJDC (National Job Development Center) to give me insights into Cerebral Palsy people and their lives. I am also grateful to other NJDC members who helped me in my initial study.

I would also like to thank all the persons interviewed as users namely Atiya, Parmanand, Sarfaraz, Gargi and Amit for their valuable inputs during user study.

Last but not the least I am grateful to Prof.G.G.Ray, my project guide for his guidance and support throughout the course of this project and to all the faculty members for their valuable advices and critical comments given during the preliminary project presentations.