J A Q U A R D S - A REPORT

DEVELOOMENT ALTERNATIVES

NEW DELHI

RULES OF THE GAME.

Dear reader, what you have in your hands is a part of the report on the work done in about 18 months, from November, 1985 to July, 1987.

We have tried to make this report a cross between a design paper and a communication package, it being more of the latter.

The whole report is divided into 7 different modules or chapters. As each chapter is complete in itself, we also call them 'books'.

- #1 explains the basic principles of cloth manufacture.
- #2 describes the project statement, the rationale behind the aim and the approach, the design criteria that governed the work and gives a summary of achievements.
- #3 is about jacquards, their history, a description of the mechanism, its operation and the problems.
- #4 is where the beef is. It is a documentation of the actual design process from the begining onto the end. It tells of (hopefully) all the routes, diversions and blind alleys we wandered on to reach where we are now.
- #5 evaluates the work in terms of achievements and compromises, gives a direction to the future work required and provides what could be called general information.
- #6 is a list of vendors and fabricators we worked with or know of, and the people and agencies with similar concerns in the country and outside.
- #7 is a glossary of the technical terms used in the previous 6 modules. As you read, any technical term that comes in the text for the first time, is printed in bold italics and is explained in #7. If it is a Hindi term in popular usage it is in single quotes also e.g. ***reed*** or '***charkha***'.

Though each chapter assumes that you are familiar with the information in the preceding ones, it is complete in itself. You can (or may?) read it by itself, and hopefully, not be obliged to read the others.

The technical terms are explained in as non-technical manner as possible.

We hope you find this report useful and interesting (not necessarily in that order). Thanks anyway for trying it out.

Hopefully, the ideas, collected and tried out during the course of the project and reported in this document, will serve as a starting point and a catalyst for further development and improvement of the existing tools available to the weaver - not as the final design brief that would result in a product that would wipe out the tears from the eyes of every oppressed weaver in the country.

CONTENTS.

TEAM WORK.

The design team consisted of Comrade Sriram alias Pratap, Kishori Lal, Puneet Kishor, S. Valmeekanathan, Rahul Varma, Shakeb Afsah, and Dinesh Mehta.

Dr. Ashok Khosla was the main accelerator, carburettor and the sounding board for the ideas which carromed off him to hit us with a different perspective, from a different angle. He helped keep the ideas in Brownian Motion.

A lot of `trial and hit' (as different from `hit and trial') was done with invaluable help from Mr. Yadav, Satpal or `Aispee', Yashpal and Ramakant at the workshop.

Shelter group did give us space to work and never let us forget it. Thanks to them also.

Others with similar interest never let us feel lonely. Outsiders and visitors helped with their interest and questions.

This report was put together by Puneet Kishor, Soumitri Vardarajan (who did the art work), IBM-PC's, and a printer that mysteriously broke in the process. Inspite of all the inclemencies (including Soumitri's toothache), it is now in your hands.

Thank you for reading this much. You are an important part of the team. Please read on...

THE PRINCIPLE OF CLOTH MANUFACTURE

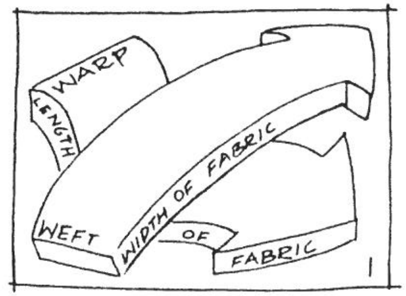
Cloth is formed by the interlacement of two sets of yarns, viz.-***warp*** or ***ends*** which run along the length of the cloth and ***weft*** or ***picks*** running across the width of the fabric.[1]

The ***heald wires*** in the ***heald frames*** have ***heald eyes***. Warp, coming from the ***warp beam,*** pass through these eyes and then through the ***reed*** before being tied on to the ***cloth roller***.[2,3 & 4]

The operation of passing the warp through the heald eyes is called ***drawing in***. The pattern in which the warp threads pass through the eyes of the heald wires in the different heald frames is called the ***draft***.[5]

The heald frames are connected to the ***treadles*** or ***pedals***. Pressing the treadles with the feet makes the heald frames go up and down.[6]

As the heald frames move up and down, the heald wires and so the warp passing through the corresponding heald eyes move.



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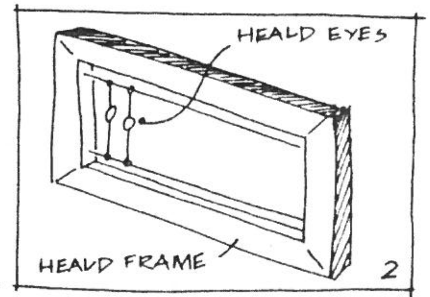

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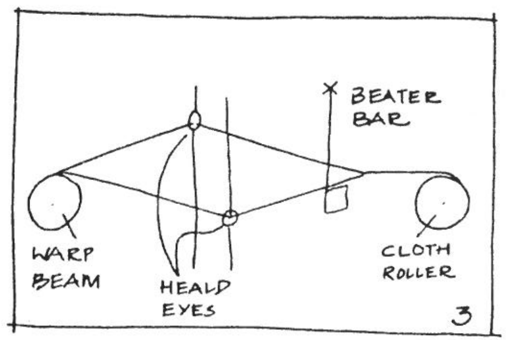

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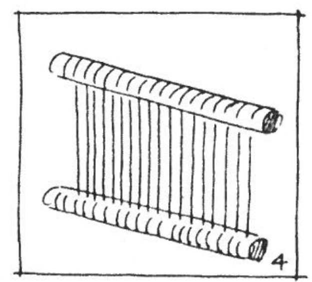
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DRAFT FOR 3/1 TWILL WEAVE.

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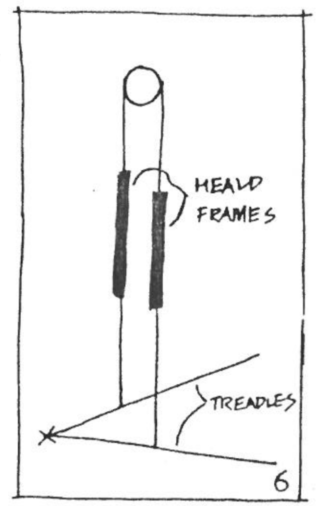

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The weft is wrapped on ***Pirns*** or ***bobbins*** which are carried by the ***shuttle***. Pirns are made by a ***pirn winder*** or ***'charkha'***.[7]

Different kinds of designs can be produced depending on the draft, the way in which the heald frames are connected to the treadles and the order in which the treadles are pressed by the feet.

Their are other ways of producing designs which have larger ***repeats*** and are more complex.

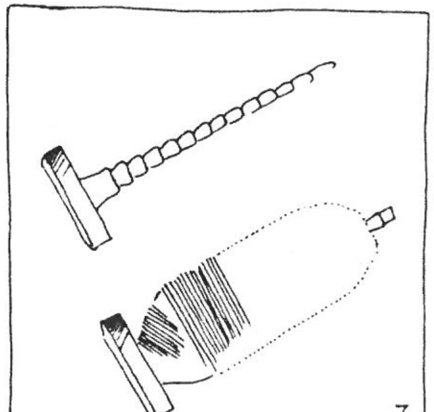
PLAIN WEAVE :

Plain weave or plain woven fabric is the simplest kind of cloth that can be woven. It is also the most commonly woven fabric.

In a plain fabric the warp and weft go over and under each other alternately.[8]

Incidentally, because of its structure, the plain weave has the maximum possible interlacements of the two sets of threads and, therefore, is the strongest fabric structure possible.

Two heald frames, each connected to a treadle, are used.



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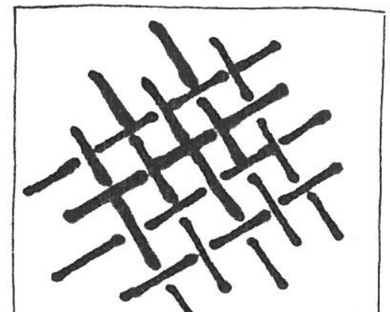

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Warp passes through the eyes in the heald wires, alternating between the two frames.[9]

The heald frames move up and down causing the warp in the frames to move correspondingly. Because of the drafting pattern half the warp will go up and the other half consisting of every alternate thread will go down.

Because half the threads have moved down and the other half have moved up, an open space is created between the threads. This open space is called the ***shed***.[10]

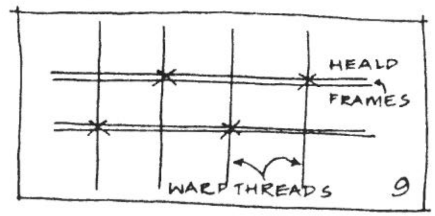
The weft is inserted in the shed from one side with the help of the shuttle.[11]

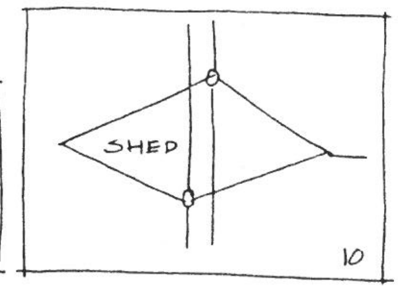
After the shuttle has reached the other side, the shed is changed. This means that the set of warp that was in the ***top shed*** moves to the ***bottom shed*** and the other half of the warp threads that were in the bottom shed move up. This causes the weft to get interlaced in the warp, going above one, below the next and so on.

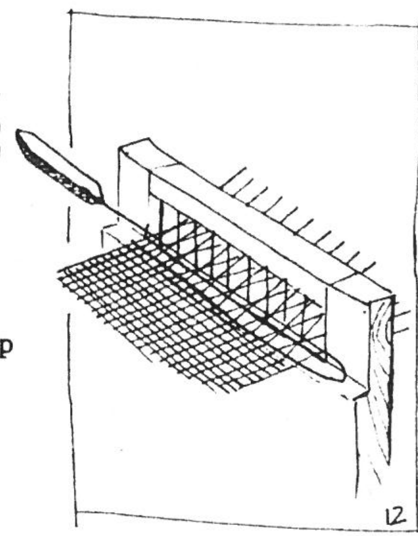
The shed is changed and then the weft is beaten-up into the body of the fabric with the help of the ***beater bar*** which has the reed.[12]

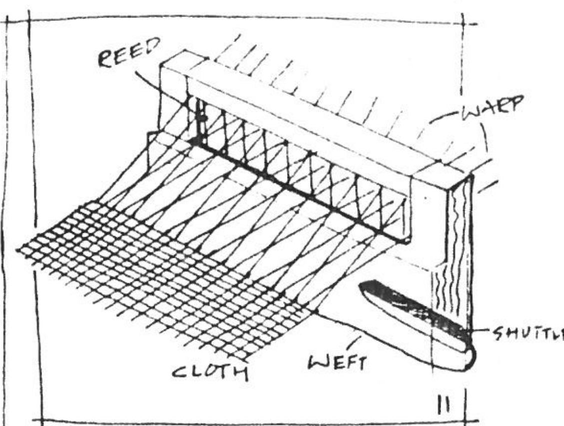
The shuttle is then made to retrace its path through the shed thus putting in the next weft.

Successively repeating this process makes the cloth.









FABRICS WITH DESIGNS :

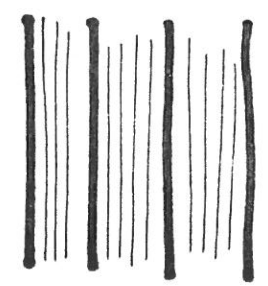
Simple designs :

Simple designs can be put in the fabric using different colour threads in both warp and weft directions.[13 & 14]

In the warp direction different colour threads are used while preparing the beam itself. For the weft, pirns with different colour threads are prepared and changed in the shuttle as and when required.

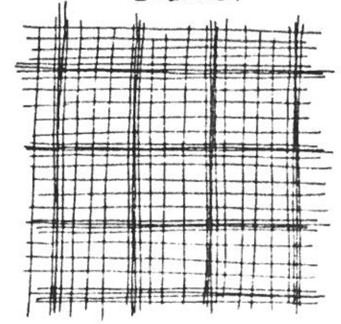
Designs can also be made in the fabric by using more than two heald frames and varying the draft and their movement.

Different designs can also be made in the fabric by changing the tie-up of the treadles with the frames so that more than one frame is controlled by one treadle and/or vice versa. This is known as Jala.



WARP IN 2 COLORS 13

BOTH WARP AND WEFT IN TWO COLORS.



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Intricate designs :

The above implies that the kind of designs, their size and their complexity is dependent on the movement of the warp threads. With smaller sets of threads that can be controlled separately, more permutations can be achieved. The ideal situation would be if all the threads could be controlled individually.

Because of various reasons, however, the number of heald frames that can be used is limited at the most to 16.

Dobbies and *Jacquards* are mechanisms that help dis-aggregate the threads so that small groups of warp can be controlled and moved as desired.

While dobbies do increase the design possibilities, with them also the maximum number of heald frames that can be controlled is not more than 32.

Jacquards are mechanisms that theoretically offer limitless possibilities of warp control. In practice also, they allow a large degree of control over the movement of the warp thereby making it possible to weave simple to very intricate designs.

PROJECT STATEMENT

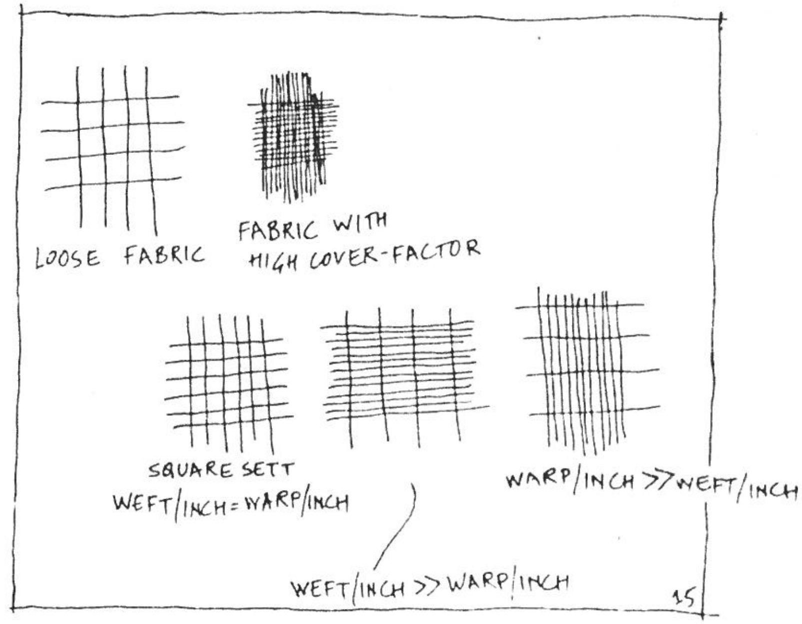
Development of a viable package of low cost appropriate textile technologies for self-reliance through self-employment and sustained income generation for weaker sections.

RATIONALE.

After agriculture, textiles is the second largest industry in India. Under the DST sponsored project, development and design of textile machinery was undertaken in the light of textile manufacture as an income-generating activity.

Besides social and economic constraints, the income generating potential of weaving is dependent on two factors, viz. - the quality of the fabric and quantity produced in a given time. The quantity produced in a given time or the number of picks inserted in the fabric in a minute (***ppm***) is dependent on the ***take-up*** and related mechanisation. The quality of fabric is reflected in the final appearance of the cloth. This rather subjective evaluation is actually based on some very objective machine dependent parameters.

The appearance of the fabric is determined by the uniformity of pick spacing or the number of picks per inch of the cloth (***ppi***); the packing density of the warp and weft in the body of the fabric or the ***fabric cover factor***; the ratio of the warp density to the weft density or the sett; the different colour warp and weft used for weaving, and the designs formed by changing the movement of the warp threads.[15]



The productivity depends not only on the mechanisation but also on the quality of the cloth and what kinds of designs it has.

Making complex designs on the fabric lowers the productivity but the resulting mark-up in the price of the fabric much more than offsets the compromise.

Infact, with mechanisms like the jacquards, the productivity, depending on the complexity of the design, can go down by a significant amount but the returns are very high.

For e.g., making a bed sheet or a shawl on a jacquard loom, with a design on it, can fetch the weaver anything from Rs.10/- onward per metre. Though he can weave only about 4 to 5 metres in a day, he gets a lot more than what he would get weaving about 15 metres ofplain fabric for which he would be paid about Rs.2/- per metre.

DESIGN CRITERIA.

The jacquard with the loom to be of a height that fits inside an average village house without any major changes required in the house.

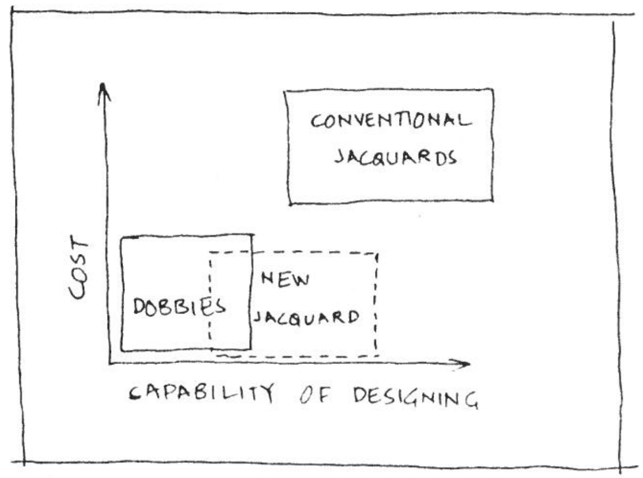
The overall mechanism to be simplified so that it is lighter and easy to maintain.

The linkages and the frame to be designed in such a way that the set-up and start-up time is reduced.

The mechanism designed in such a way that the weaver is no longer dependent on any outside system, like that of the ***card-punching machine*** owner/operator.

The operation to be simplified and made easier by attenuating the operating effort and using a simpler machine.

The new jacquard mechanism to fill the gap between dobby mechanisms and conventional jacquards in considerations of the level of work possible and the capital and recurring investments required thereby creating a niche for itself.[16]



The new technology package to be supported by appropriate infrastructure for production, distribution, financing, training and maintenance.

As a result of the above, the mechanism to be made friendlier and more accessible by reducing costs, thus bringing it within the grasp of the common individual village weaver.

The last of the above criteria being the most important for, and of direct and immediate impact on, the target group i.e. the common weaver.

SUMMARY OF ACHIEVEMENTS.

In the current project the problems of complicateness of the mechanism and the height have been tackled.

A working model has been developed that has been successfully tried out in the laboratory conditions.

A design concept for decreasing the effort required for operation has also been developed.

The forecast of the cost of the production model of the new jacquard design is very encouraging as it is substantially lower than that of the existing mechanisms.

JACQUARDS, A SHORT HISTORY.

A SHORT HISTORY :

The jacquard was invented in the begining of nineteenth century quite by accident.

It owes its existence to the early *drawlooms* probably first used in the far-east for silk weaving and introduced in Italy in the Middle Ages.

Work continued on improving the drawloom through the early 17th and begining 18th century. In 1725 the selection of the warp threads, which was done by an assistant to the main weaver, was mechanised by Basile Bouchon.

In 1745 the mechanism was further improved by Jacques de Vaucanson, but was still very complex and it is not known to have been popularly adopted.

The French inventor Joseph-Marie Jacquard was asked to improve Vaucanson's loom but was not given any directions or design brief.

In 1801 he demonstrated an improved drawloom at the Paris Industrial Exhibition. In 1805 he introduced a separate mechanism which could be attached to this loom. This mechanism has since been known as the Jacquard attachment and the loom to which it is attached is called the Jacquard loom.

CONVENTIONAL MECHANISMS :

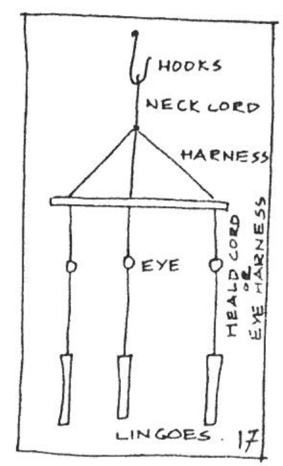
Jacquards are devices that help form the warp shed in the desired manner.

They comprise two parts, viz.- a selection device for choosing which warp threads are to go up and which are to remain down; a lifting mechanism to lift the warp that has to be lifted.

Lifting mechanism :

Warp pass through the eyes in the ***heald cords*** instead of the heald wires as in the case of ***frame shedding***.

Warp threads are divided into groups which are connected to hooks resting above them by a system of ***harness*** which is guided by the ***comber board***.[17]



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The ***kives*** constantly move up and down and lift the hooks that are resting on them.

If a particular hook is required to stay down, i.e. the warp threads are supposed to stay down, then it is made to disengage from the knife. When the knife goes up, the selected hook stays down while the others go up.

Selection device :

The selection of the hook is done by a mechanism which is pre-programmed to control the hooks as per the design.

The design program is in the form of a ***card*** in which holes have been punched.[18]

Each card represents an individual pick while each hole on the card (or the space where the hole could be but is not) controls an individual group of ends.

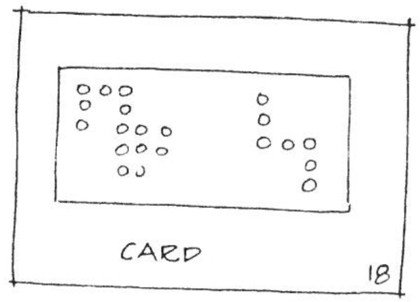
A chain of cards, with holes punched in them, is used as required. The number of cards in the chain is equal to the number of picks in the length of the repeat of the design along the warp.[19]

The chain of cards moves on a quadrangular ***cylinder*** which rotates to present a new card to the ***needles*** after every pick.

The needles are perpendicular to the hooks and loop around the them. When a needle moves horizontally the hook catches in the loop and bends away from the knife.[20]

The needles are arranged in such a way that they are aligned with holes (or the places where the holes could have been) in the card.

The cylinder on which the chain of cards moves can also oscillate back and forth horizontally. This is done to facilitate the rotational movement of the cylinder.



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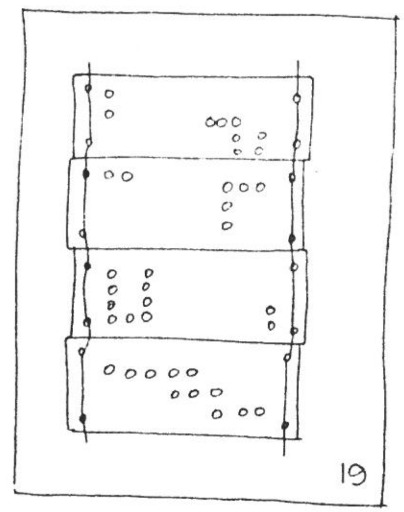
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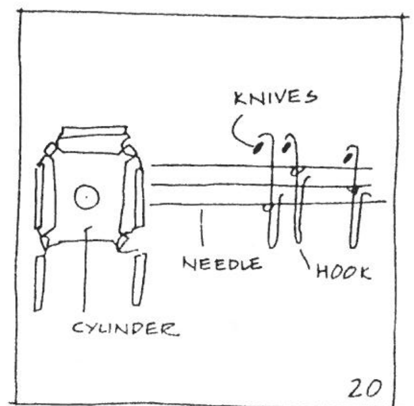

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JACQUARD OPERATION :

When the cylinder moves forward the card comes in contact with the needles.

If there is no hole punched in the card, the corresponding needle is pushed away horizontally - the loop in the needle catches the hook and bends it away from the knife - as a result the hook disengages from the knife.[21]

If there is a hole punched, the corresponding needle end passes in the hole and so remains stationary. The hook remains engaged in the knife and when the knife goes up the hook also goes up.

After the cycle the cylinder moves back to its original position and rotates to present a new card.

PROBLEMS :

Effort :

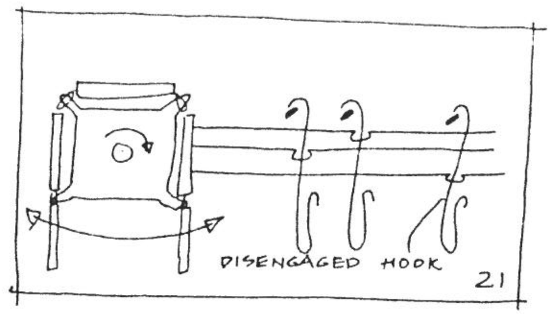
When the warp threads are in their natural position, i.e. in a straight line between the warp beam and the cloth roller, they are said to be in the ***center shed*** position. When they have moved to the top position they are said to be in the top shed and when they are in the bottom position they are said to be in the bottom shed.[22]

In the center shed the warp are in least tension. Because they are distorted out of their straight line in both, the top or the bottom shed, the tension in the warp increases and tries to bring them back to the center shed.

In a jacquard the normal position for the warp is the bottom shed.

The warp are normally distorted in the bottom shed position. When a shed is formed, the threads that are supposed to be above during that pick go up while the other threads remain down.

This means that a jacquard is a ***negative mechanism*** i.e. it can move the threads in just one direction. It can only raise the threads which then come down due to gravity.



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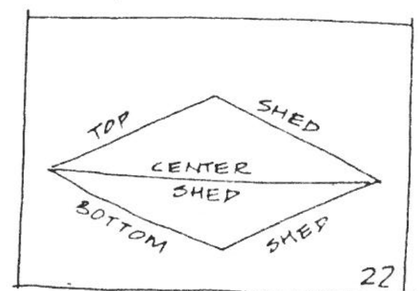

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Because the threads in the normal bottom shed are distorted out of shape, the tension in them tries to pull them up. It is very important for them to remain in a clean bottom shed line is required. If the threads are not at the same level, the shuttle flying over them will get caught in them and break them.[23 & 24]

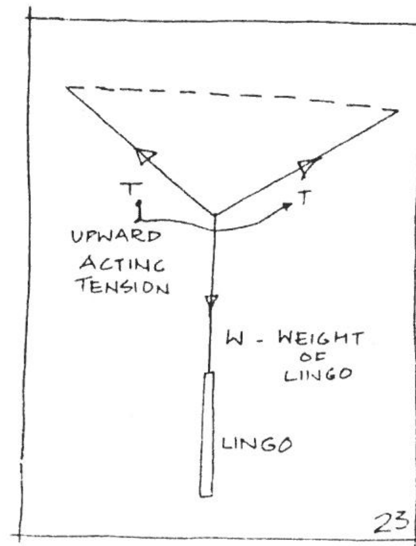
To keep the warp threads down in the bottom shed, a downward force has to be applied on them to keep them pulled down.

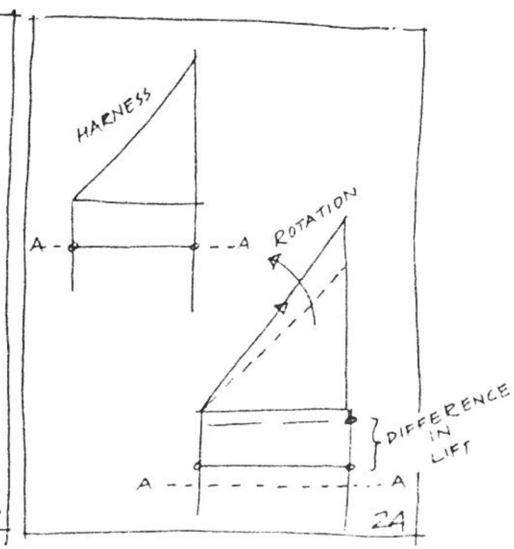
In existing jacquards this is done with the help of *'Lingoes'* which are lengths of wire with a specified weight. These lingoes hang from the *eye harness* keeping the warp in the bottom shed position.[23]

With the warp groups,the corresponding lingoes also have to be lifted up. The weight of these lingoes adds up as usually a couple of thousand odd threads are worked upon. For e.g. if 2000 threads are being used and 12 gms. lingoes are hanging from each eye harness and if half of the threads are to go up (as in a plain weave), then a dead weight of 12 Kgs. has to be lifted. The problem is severe in the case of very complicated designs when weights close to 40 - 50 kgs. need to be lifted up.

Height :

The conventional jacquards are very tall mechanisms which can not be easily fitted inside a normal village house with its low ceilings. Either





a special workshed is required (not affordable to a single weaver) or the weaving is done in the open.

This problem occurs because of the geometry of the harness that connects the hooks to the heald cords with the warp running through their corresponding eyes. The warp threads that are not directly below the hook to which they are attached, rise up less than the one that is directly below. Infact, the warp threads further away from the one directly below the hook, rise respectively less and less. The problem becomes very pronounced in jacquards of big widths. The shed opening toward the side ends of the loom is progressively smaller and results in rubbing of the shuttle with the thread.[24]

The height of a conventional jacquard is dependent on the harness which has to be long in order to minimise this problem.

Complicateness and cost :

The existing jacquards are very heavy and complicated mechanisms. The selection device does not act directly on the hooks, but through an interface i.e. the needles.

The heavy and complicated mechanism and the extra linkages contribute to increasing the cost of the jacquard which with the loom and heald cords and harness etc. costs about Rs.10,000/- and is quite beyond the reach of a normal village weaver.

Indirect costs and problems :

The selection device i.e. the *lattice* of the punched cards is difficult to procure as it requires a separate machine for punching out the holes in the cards.

Not only is the machine very expensive (about Rs.10,000/-) it requires a certain level of skill for its operation. The weaver with a single jacquard is dependent on someone with the card-punching machine. Usually, these card-punching machine owners serve a large number of weavers. Long waiting list and overcharging is a common phenomenon.

Once the weaver obtains a set of cards punched for a particular design he is stuck with them. If he wants to change the design, then he has to get another set of cards punched, thereby going through the whole process again.

DESIGN PROCESS.

IN THE BEGINING THERE WAS 'TISTOU' :

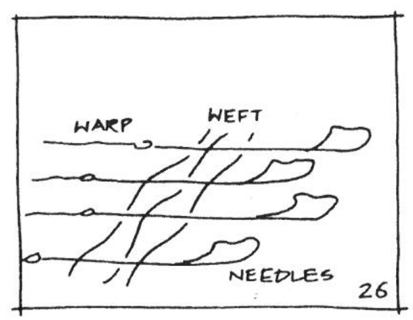
Description, principle and operation :

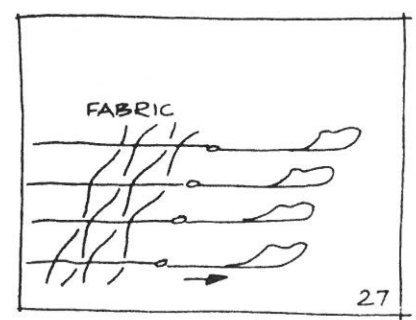
The development process of jacquard did not start at the begining. A series of research, testing and realisations led from a Swiss knitting machine *Tistou* to the present jacquard.

Tistou is actually a small hobby machine for weaving equally small woollen garments.[25]

Made out of injection moulded plastic and anodised Aluminium, it is a modular, portable, table-top, snap-on machine which uses an ingenious integration of both *knitting* and weaving - two rather different methods of producing two rather different qualities of fabrics - to produce woollen fabric suitable for garment applications.

The Al needles (conventionally used in knitting) help form the shed, so the threads trailing behind, tied in the eyes at the end of the





needles, can be laid through it.[26]

Drawing these trailing threads through the opening in the transversely laid threads that are wrapped under and above the needles, results in a plain woven fabric.[27]

Problems :

The process of production of fabric is too slow for it to have a high income-generating potential.

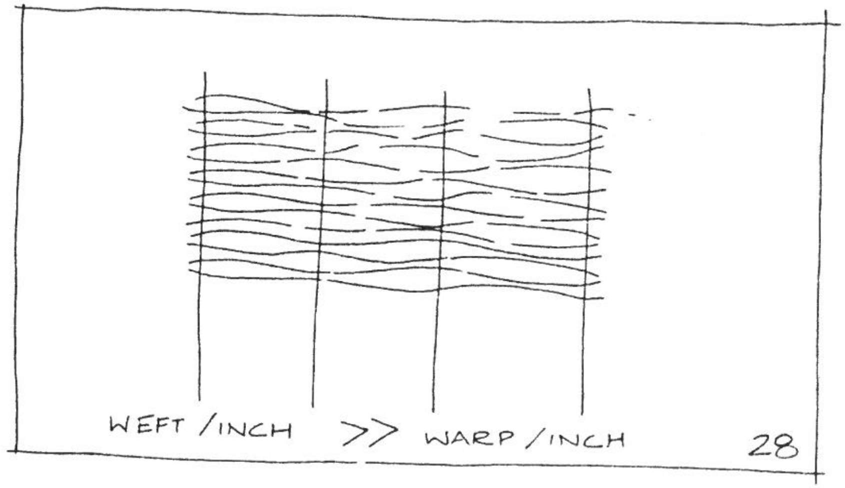
The fabric is too loose and weak in construction. It does not have any ***selvedge*** and the threads in the body of the fabric open up forming holes or gaps. Also, it unravels and gets spoiled very easily if it gets caught in a nail etc. This is due to the negligible warp-weft wrapping and insufficient interlacing force. It is more like threads put inside pipes made of other threads - no or little interlacement. The warp-weft ratio is also too skewed away from 1 to have a *constructionally stable fabric*.[28]

The amount of thread put in per unit area of the fabric is very large. This increases the bulk and so the cost of the fabric without any proportional improvement in qualities.

The initial approach :

One way to increase the warp in ratio to the weft would be by increasing the number of needles/inch. This was tried, but the limit was still 5 or 6 per inch which is a lot less than the number of threads in a normal cloth, which is usually 30-40 and as high as 80-100 in some shirting fabrics.

In order to get better interlacement, the pipe effect created by the weft has to be eliminated or reduced. This was tried by decreasing the needle diameter because the shed opening is formed by the



thread wrapping around the needle. Again this is also limited to at least 2-3 mm as less than that the needle becomes very weak.

Production rate of cloth on Tistou is a major stumbling block.

The initial efforts :

In order to increase the production rate, some kind of mechanisation was necessary to move the needles.

In Tistou, even though their number is not great, each warp can be controlled individually by hand.

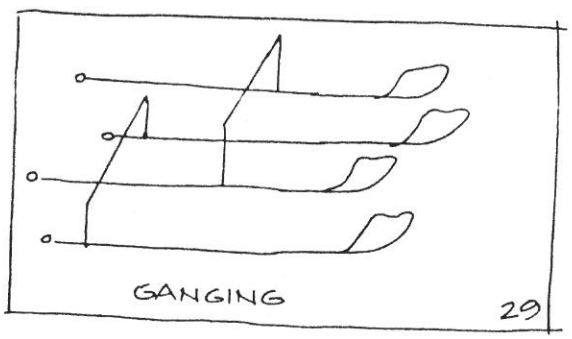
So, if the movement of the needle was to be mechanised then their selection also had to be mechanised.

In summary, the number of needles had to be increased, their width decreased, and their movement and selection was to be mechanised.

The productivity of Tistou is low because each needle has to be moved forward individually by hand.

For a plain weave every alternate needle should move together and in a similar fashion.

If we could gang alternate needles with a transverse piece, forming two groups of needles, they could be moved back and forth at one go.[29]



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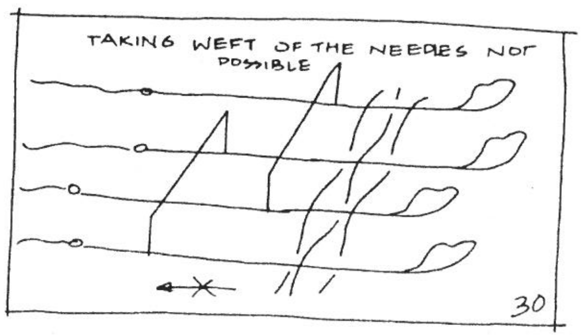

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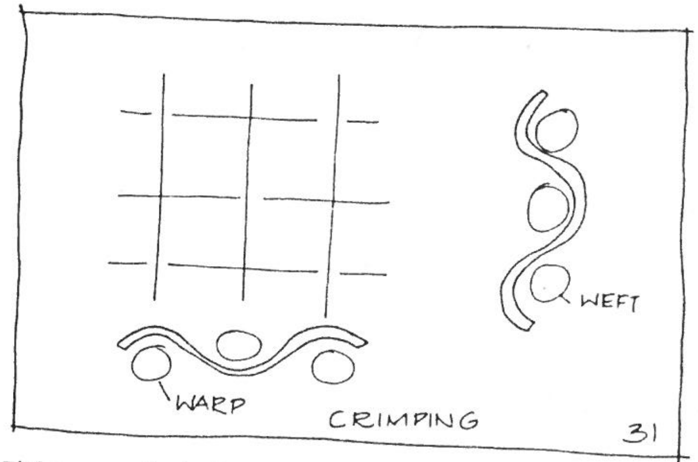

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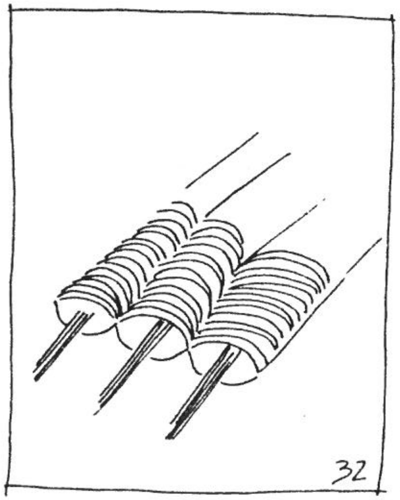
This was tried but it gave rise to a new problem - *doffing* or taking off of the fabric from the needles. In Tistou this was done by pushing the interlaced threads out from the tail end of the needles. Because of the transverse ganging it would no longer be possible or certainly be difficult.[30]

Pivoted Needles :

It was also felt that the fabric was not compact and stable because of the great difference in the numbers of warp and weft per inch and also because of inadequate *crimping* in the threads in the cloth.

In a conventional process (and fabric) the crimping is mutual. As the weft is laid in the warp both get crimped and hold each other in an interwoven grip.[31]



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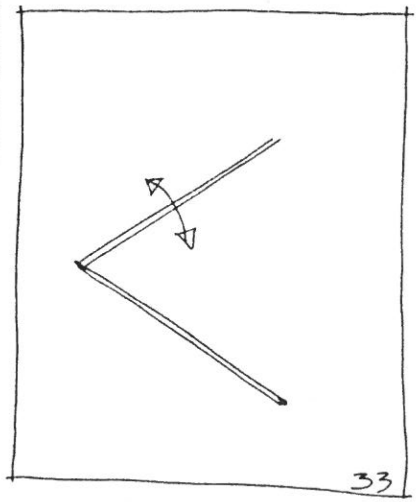

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In Tistou the transverse threads were being laid across the needles and were getting crimped by them.

The needles being of Al were not getting crimps in them by the cross threads. Instead, channels or pipes of weft were being formed and the warp were being pulled through it more like the electrical wiring in its PVC protective hose.[32]

A new design of needles was tried in which instead of moving back and forth, the needles were pivoted and moved up and down, with the end points moving in an arc.[33]

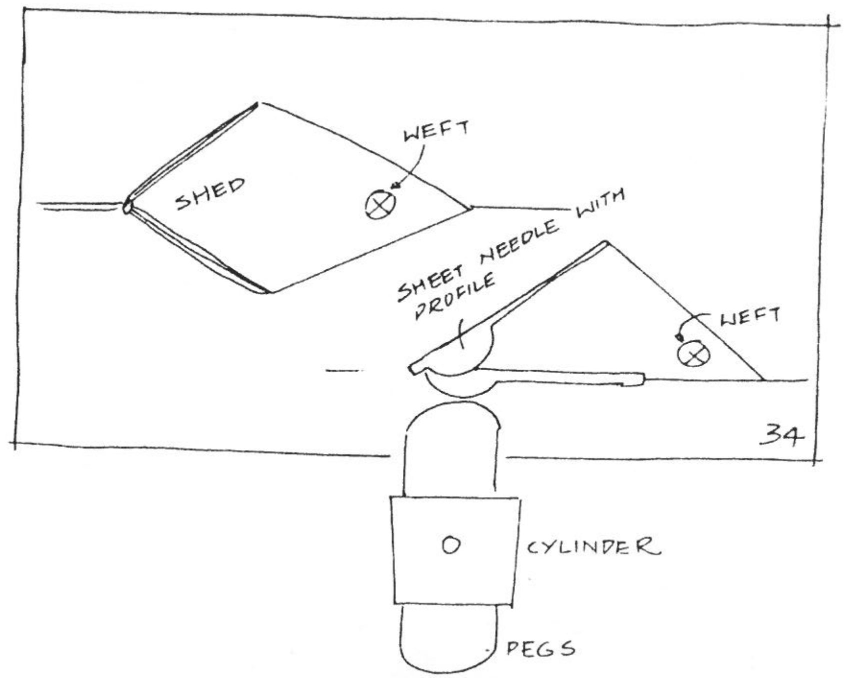
The threads would move up or remain down opening a shed in between through which the weft could be laid.[33]

Sheet Needles :

One solution that came up was using needles cut or punched out of MS sheets.

The needles would be pivoted at the end and would be having a profile in them. The profile would rest on a cylinder with pegs driven in it.[34]

The threads would come from behind, running along the length of the needle, to pass through a hole at the end. Thus, they would move as the needle moved.



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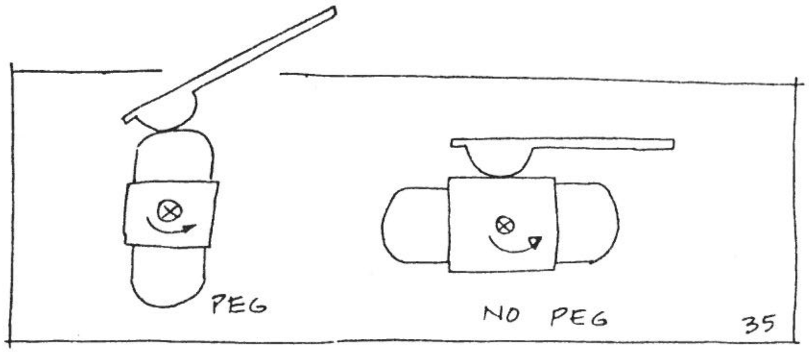
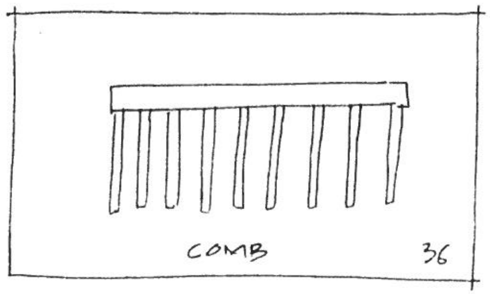




As the cylinder rotated, its pegs would act against the needles and lift them up. If there was no peg, the corresponding needle would not rise.[35]

As some threads would have gone up and others would have remanied down, a shed would be created between them.

Through the shed the weft could be put, shed changed and the weft patted into the fabric with a comb.[36]

The pegs would be controlling the movement of the needles and hence, of the threads. By changing the pegging pattern in the cylinder, different designs could also be incorporated in the fabric.

This was the genesis of the developmental work on the Jacquard.

JACQUARD :

There is a major problem with pivoted wire or sheet needles. As the shed depth has to be at least 4" at the maximum, the needle has to be very long from its tip in order to move that much.

The pegs and the needle profile also has to be large and pronounced to get such a movement.

Long needles would bend due to the downward acting warp tension on them. It would also be expensive to produce big needles and pegs and it would be difficult to operate.

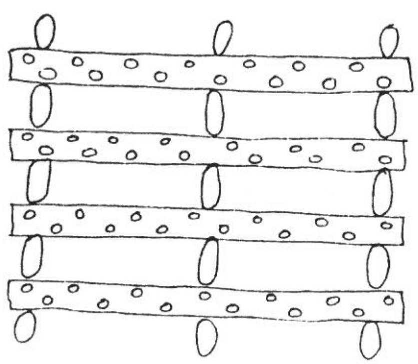
Also, a cylinder would have at the most 4 to 8 sides as more than that would be difficult to manufacture and also would leave very little space for the pegs to go in.

This would restrict the design to come on only 4-8 picks, as after that it would just repeat.

A different approach :

By separating the thread selection and the thread lifting functions of the needles, they could be made to occupy less space.

By using a dobby lattice kind of an endless chain instead of just a 4-8 sided cylinder, one could get bigger repeats.[37]



DOBBY LATTICE 37

We were already entering the realms of jacquards having started from Tistou. The principle of working of jacquards seemed to be an alternative solution to the problems of Tistou.

It seemed to make more sense to use the traditional principle of the jacquard alongwith insights gleaned from investigations into Tistou, also identifying and refining the problems of jacquards at the same time.

After a careful survey , discussions with weavers, technologists etc. and a study of available literature, the problems with conventional jacquards were identified.

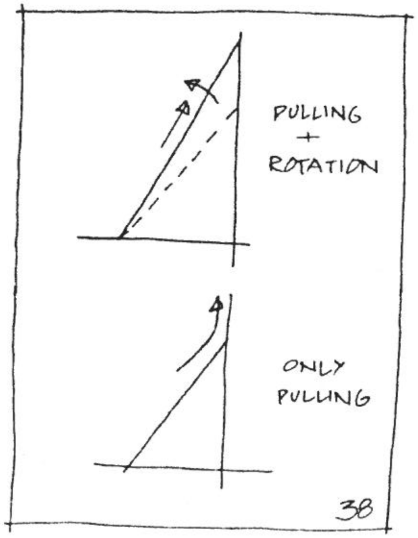
The problems of height, complexity, operating effort and cost seemed to be what were keeping the jacquards out of the grasp of the common weavers.

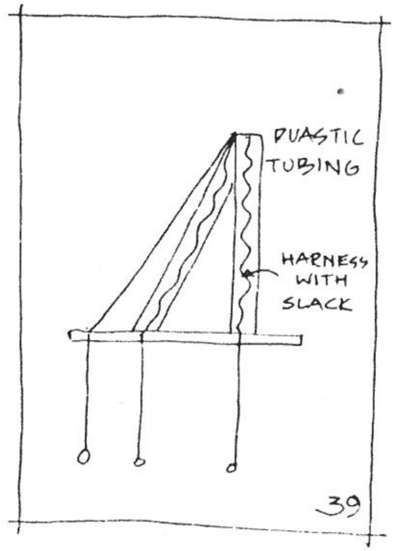
The returns on jacquard fabrics (even though their production rates were far below that of ordinary loom fabrics) seemed obviously very attractive.

Adding a fabric designing capability in a loom which would be easily obtainable by a common weaver would give him a distinct advantage for income generation over just plain fabric production.

Problems attacked initially :

The problems of height and effort were attacked almost simultaneously.





The cause of the height problem was identified as the geometry of the harness that was being pulled up as well as being rotated.[38]

One or two reliable text books corroborated the cause but almost no one in the field seemed to be having the correct idea about it.

An extensive survey in the four southern states also revealed a lack of correct understanding of the real reason.

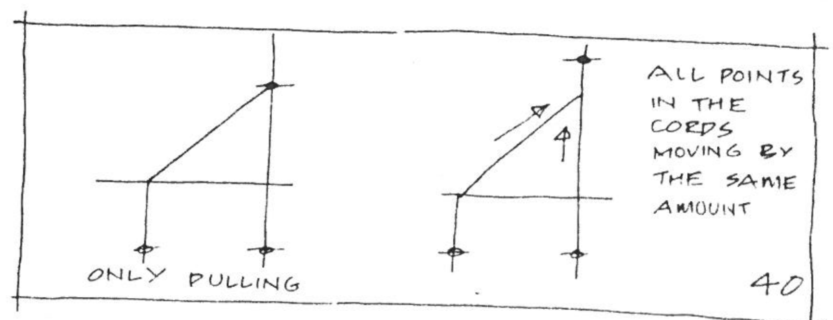
Everyone said that the harness was long in order to avoid it from becoming an entangled mess between the hooks and the comber board. Nobody talked about the problem of differential lifting.

Books did list solutions which did not seem very transparent and certainly not popular. They talked about using something called *hecks* or employing harness cords with slack, in plastic tubings.

The idea with the plastic tubing was that the slack in the harness cords could be contained in them and that would help phase out the lifting in such a way that the net lift would be the same for all heald eyes. It seemed to require fairly accurate work and was a complicated solution which would leave us with a mess of plastic tubing above the comber board.[39]

Hecks seemed to be like collars or rings which would allow only the pulling up of the harness ends, preventing their rotational movement.[40]

It was clear that as long as the cords were pulled along their length only, they would rise up by the same amount. This would be because all points on them would be moving by the same amount irrespective of the number of bends or turns they took.[40]



Hecks seemed slightly vague. But an extra *comber board* would do the trick. We decided to say to hell with the hecks and concentrated on comber boards.

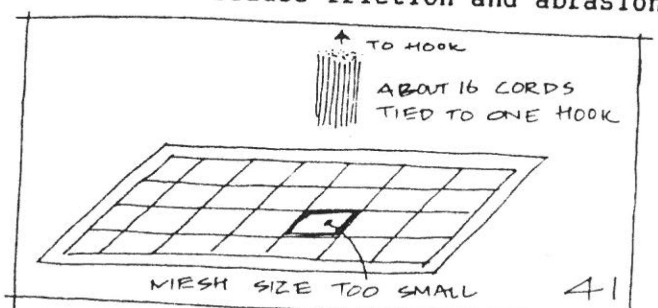
Comber boards were not without their share of problems. The mesh size was not big enough to accommodate 16-18 cords of the same hook.[41]

The wire of the mesh would cut the cords as they rubbed against it while moving up and down.

One solution was to drill big enough holes in a piece of wood in which the harness cords could move. They would also keep the hooks in place not letting them move horizontally sideways. This would be like a '*fatti board*' already used for the *neck cords* or the '*jothraas*'.[42]

This wood could get cut or the thread could get abraded and still break, but these problems had solutions.

Ceramic beads could be used in the holes or enamelled trumpet shaped liners could be used which would reduce friction and abrasion.[43]



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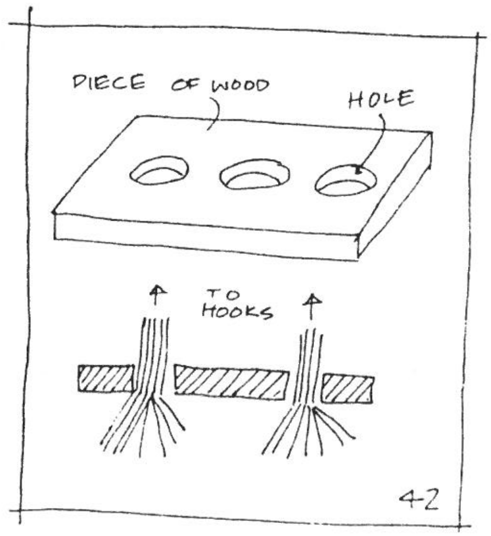

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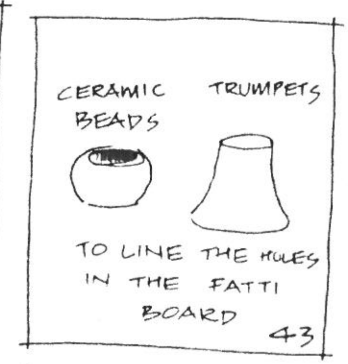

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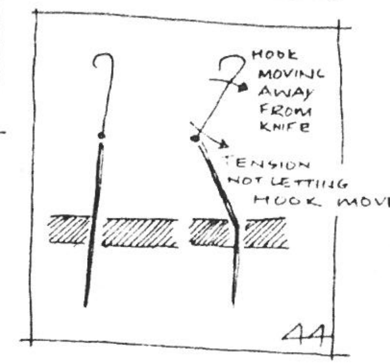

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One problem which was raising its head constantly was that the effort required for moving the hooks off the knife (i.e. the effort required for rotating the selection device which would be rubbing against the hooks) was becoming considerable.

This was because the walls of the holes in the fatti board would restrain the harness cord's movement sideways as the hook tried to slip off the knife.[44]

It was realized that for the hooks, restriction was required on their movement sideways. They could not move on their pivoting shaft sideways but could be free to pivot on it in such a way that they would slip on or off the knife easily.

A grating with a dent size the diameter of the holes in the fatti board would be adequate to control the movement of the hooks as desired, as long as the dents were long enough to allow the movement of the harness cords.[45]

Such a grating was made using pieces of wires of cross-section 3 mm fitted in a frame of wood with holes drilled in it at 6mm distance.[45]

This worked satisfactorily. The shed formation was without any discernible differential lifting and the increase in effort was minimal.

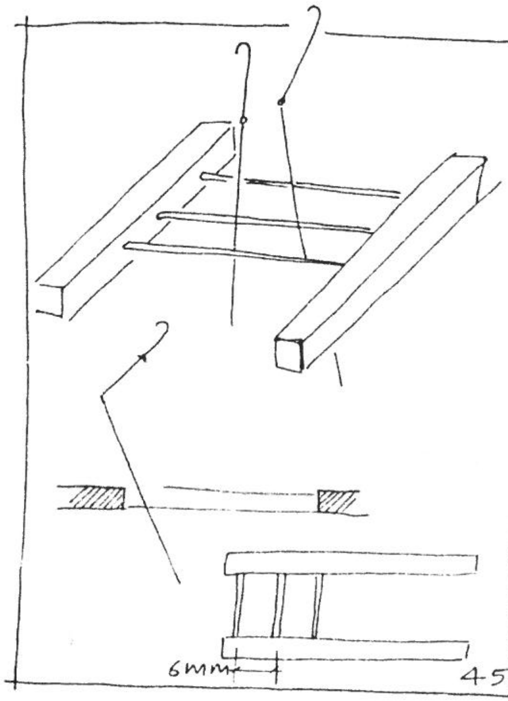
Use of lattice :

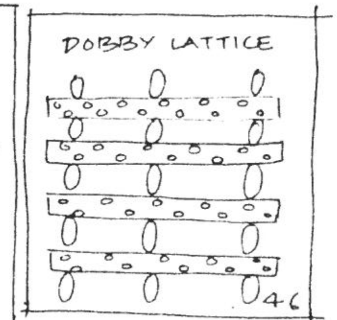
Using a ***dobby lattice*** for selection of hooks seemed to have many advantages over the conventional system of punched cards.[46]

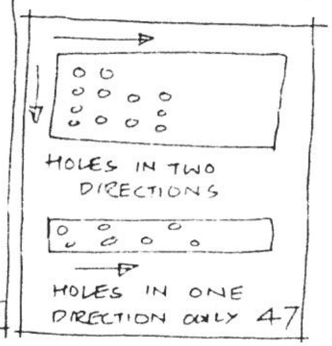
But it also brought its quota of problems.

The most convenient situation is if most of the parts being used in the new machine are standard ones already available. This was desired in the lattice's case also.

The biggest size standard lattice available has 80 holes. It is used for dobbies with 40 levers and







has holes spaced out by 6 mm centre to centre.

Using it imposes a limit on the maximum number of hooks that can be used, their size and shape etc.

The advantage with cards is that holes can be punched in a 2-d array fashion letting us use 200 - 800 hooks. With the straight line linear arrangement of holes in the slats of the dobby lattice, only 80 hooks are possible - at most 2 machines can be used side by side to give 160 hooks.[47]

Also, since the centre to centre distance is given and fixed, the hook thickness is limited to less than that.

Instead of using the standard available lattice, getting one made to suit the needs is possible but involves very high capital expense. Also the number of holes could be increased, but at the most to about 100 or 150. More than that would make the lattice very long and difficult to operate on the machine. Infact, with 200 or more hooks the slat would be so long that it would make the mechanism wider than the loom.

The lattice could be made out of wood or injection moulded in plastic but both options would be very expensive except in very large production runs.

Hooks :

The design of hooks was governed to a large extent by the lattice.

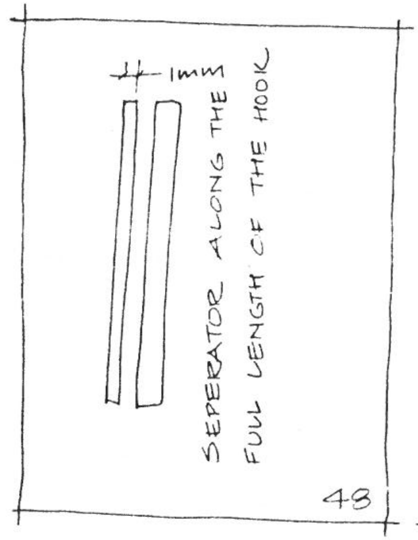
Some kind of a separator was required to ensure that the hooks moved vertically up and down and that one peg was not acting on more than one hook or vice versa.

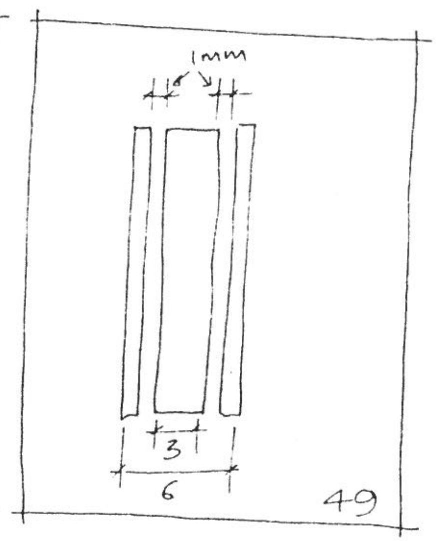
These separators had to be stiff and designed in such a way that they would guide the hooks through their full travel. Whatever the material, they would be at least 1 mm thick. [48]

With 1 mm for each separator, 1 mm clearance on each side of the hook all fitted between 2 holes, i.e.in 6mm, left 3mm for the allowable thickness of the hooks.[49]

We wanted at least 4 1/2" shed depth so the hook lift was fixed at 5" or 125 mm.

Since the hooks could not be more than 3 mm thick, they were made flat and about 30 mm broad to give them structural strength.





The pivot shaft on which the hook would be guided would have to be strong enough to be able to support 80 hooks with about 1500 lingoes hanging from them and would have a span of about 20". A 10 mm diameter drawn rod was found to be adequate. For the hooks to move freely on the shaft, the slot had to be 11 mm wide.

The hook head would have to be long and curved so that the knife caught in it easily and securely. It would also have to be broad enough to give it strength.

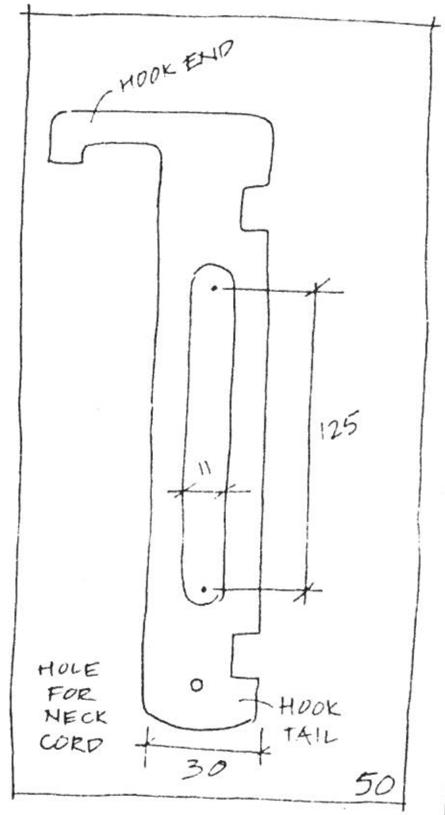
The initial designs had notches in them to provide for the locking system that were a part of the twin-jacquard design discussed later. These notches got redesigned later and finally only 1 notch remained.

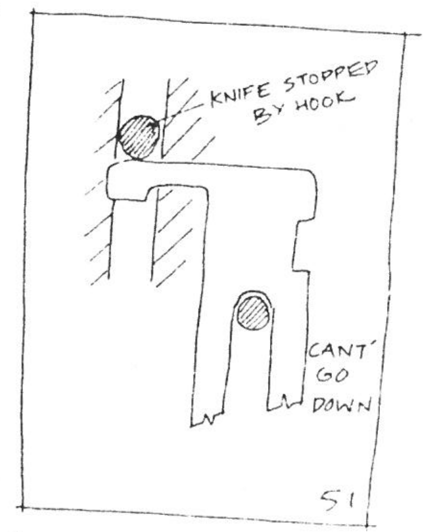
With the above criteria the first design of hook was tried out in plywood. Though not very accurate, it gave valuable leads.[50]

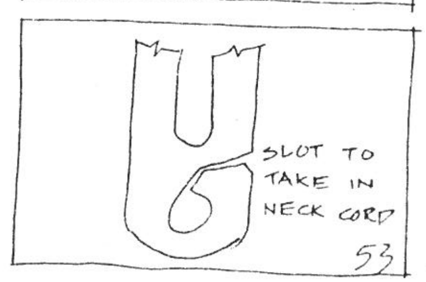
The hook head was found to be too flat. If any hook slipped off the knife, the knife would bang against the top edge and either break the hook or just stop there resting against it.[51]

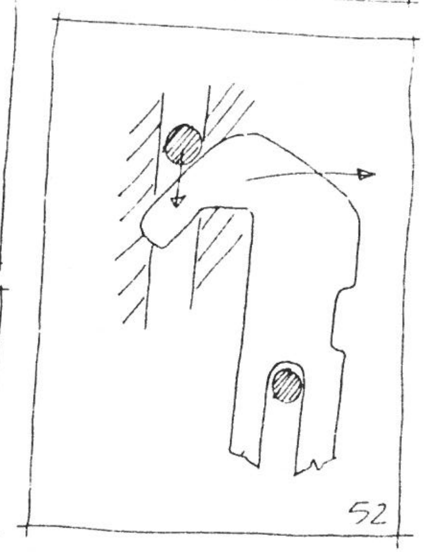
Adequate curvature was given to the top edge to facilitate the slipping down of the knife past the hook. It would still knock against the hook but would push it away slipping down to the bottom-most position.[52]

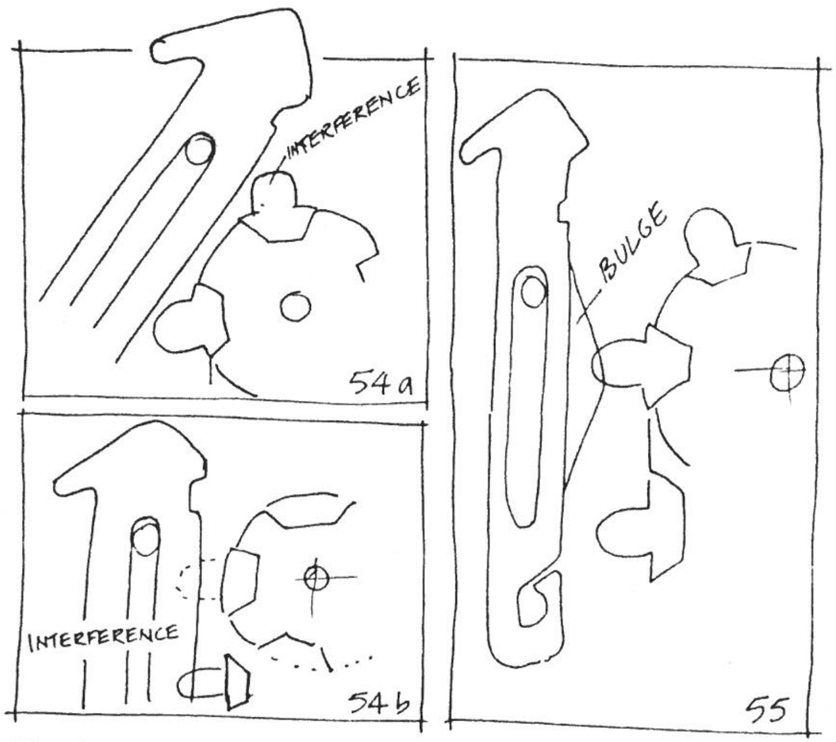
Initially, a hole was drilled below the slot in which the neck cords could be tied. It was felt that tying/untying of the neck cord was a tedious process. Infact, usually they had to be cut. Solution - provide a built in notch or slot in the tail. The neck cord would have a loop at the end which would slip in the tail end but not come out by itself.[53]











The hooks had flat and parallel sides in the initial designs.

This brought up an unexpected problem. Instead of just 1 slat's pegs acting on the hooks, the slats on either sides of the one acting would also interfere with the movement. This was because the distance between the hooks and the pegs was not adequate. The dislodged hook's upper portion would come too near the slat above and the vertical hook's lower portion would be too near the slat below.[54]

A bulge was incorporated on one side of the hook at the place where the peg would act. This increased the space between the hook and the adjacent slats and there was no interference any longer.[55]

Separators :

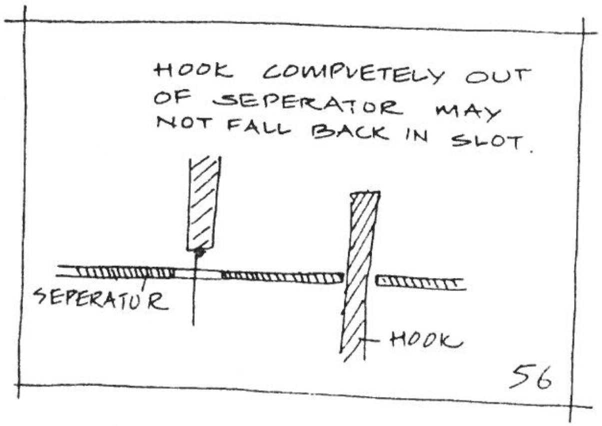
These turned out to be perhaps the most frustrating, time consuming and dis-heartening components.

As mentioned earlier, they became necessary to ensure that the pegs acted only on the hooks they were supposed to act. They could not shift side ways in relation to each other or there would be defects in the design.

As long as the cylinder shaft, on which the pegs were rotating, stayed in place, the pegs would not shift. But the hooks were the uncertain element. Left free on the shaft they could go any where. Even a little variation would result in a mismatch or an incorrect match.

Initially, thick, stiff paper separators were fitted in slotted wooden pieces and tried out. They were a mess. They would bend every which way, the gaps between them would not be uniform, the wooden supports would come in the way of the hooks and anyway setting them up turned out to be nightmare.

The separators had to be such that they guided the hook through their full travel. Otherwise, the

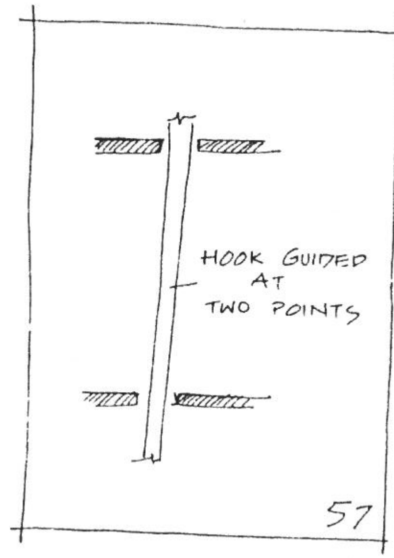


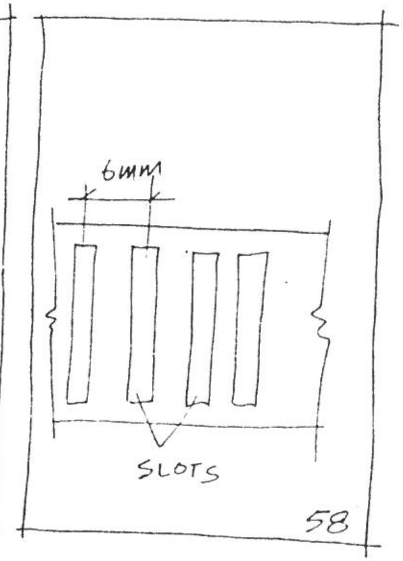
hook could get out of the separator and not fall in the same slot.[56]

So initially the separators were cut out from a sheet designed in such away that they ran all along the sides of the hooks.

After the paper ones, we were tried cutting them out from 1 mm thick MS sheet. The problems of non-uniform spacing, wooden (or whatever) supports getting in the way and difficulty in assembling persisted.

After a number of changes and about 12 months of tough time, a different approach was tried. If the hook is guided at atleast 2 points in its length, both being spaced out by some distance, the hook will move in a straight line that connects the points.[57]





Slots, long enough to facilitate the pivoting of the hooks on the shaft and wide enough to just let the hooks move freely in them were punched out from a MS sheet using a die punch. 2 such sheets were enough to guide the hooks.[58]

Problem - The lower sheet would have to be placed at such point that even when the hook has risen to the top most point its tail would still be in the slot. Otherwise, it might not come back in the same slot. This meant the spacing between the 2 sheets could not be much. Also the lower sheet would come in the way of the cylinder with pegs.

Solution - have the slotted sheet below the hooks, with the harness cord running in it. Eliminate the neck cord thereby replacing the fatti board with the guiding sheet - thus hitting 2 targets with one stone and all that.[59]

The harness cord hanging in tension from the hook would keep the lower end of the hook in place. The other sheet would be placed above the shaft and below the knife.[59]

Also the problem of hooks not pivoting easily because of the loading on them would get attenuated because the harness cord would not be moving in a restraining hole but a long slot.[60]

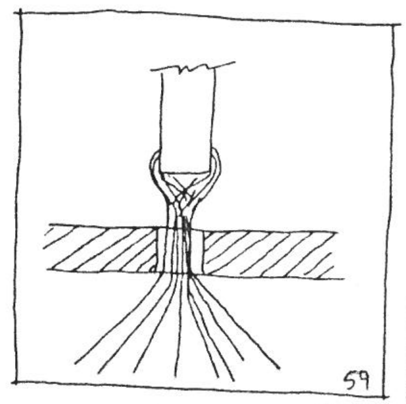
There was one problem and what a problem it was.

No matter now accurately we punched out the slots in the sheet they would not match with the holes in the lattice.

There seemed to be a variation in the centre to centre spacing between the holes in the slots - a variation so small it could not be measured from hole to hole but over a number of holes it seemed to accumulate enough to go out of phase with the slots.

On measuring the distance between the 1st and the 80th hole and dividing it by 79 (the ***pitch***) we get the actual spacing, just a bit less than the 6mm got on measuring from hole to hole.

Finally, it was decided to change the die punch to be able to punch out 80 holes in a length as much as that of a slat instead of holes at every 6 mm. [61]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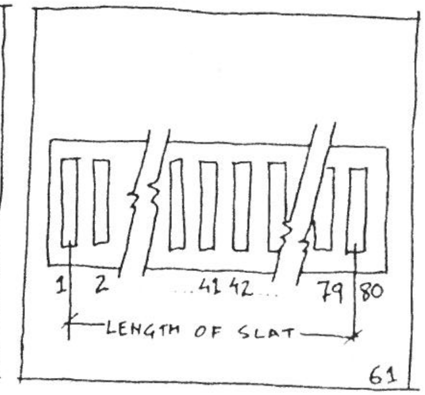

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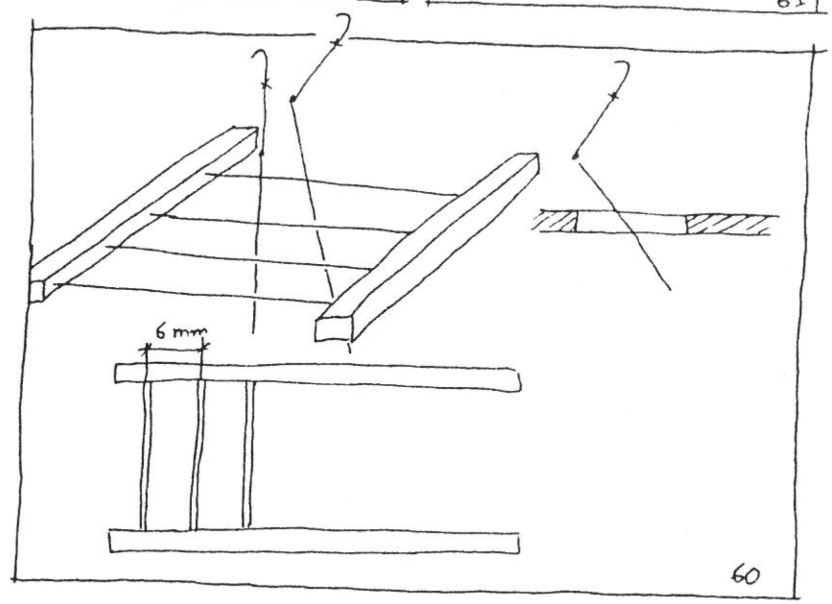

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A parallel approach was to cut equal lengths of wire 10 cms long and fit them in the holes in slats using two slats to form a frame. As the slat themselves were being used to space out the separators they would match perfectly with the pegs in the lattice also. [62]

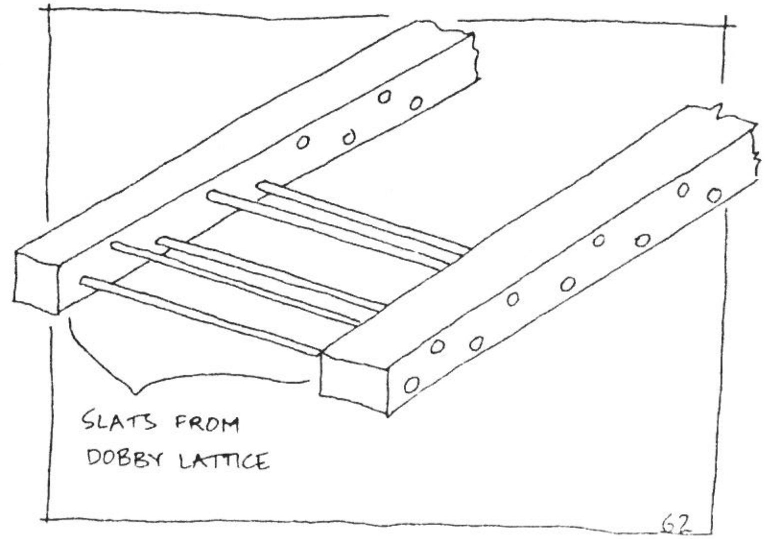
Effort :

This problem turned out to be one of the most time consuming which even after repeated design evolutions could not result in a pre-productionable model or prototype. Though, finally the design idea was proved to have a high potential of success and scope for development.

Considerable amount of work remains to be started, carried through and finished on this problem, as a part of directions for future work. It is an area of large enough scope to be treated as a sub-project which should be given full time by a design team.

The cause of the problem has been dealt with in detail in book #3 on jacquards.

The increased effort is primarily because the warp has to be kept in the bottom shed line. A downward pull has to be applied on them to counteract the upward tension in them. This downward force comes from the lengths of wire called lingoes that are hanging down from the heald ends that are carrying the warp in their respective eyes. The weight of the lingoes (of the order of 10-15 gms) is enough to keep the threads down.



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The problem is that when the threads are remaining down then the action of the lingoes is fine. But when a certain warp has been selected to go up, the lingoes on them still keep on hanging and have to be lifted also. This dead-weight is what contributes to the operating effort.

Their weight, though not much individually,is a lot when 2000-4000 threads are taken into account. 2000 times 10 to 12 gms is of the order of 25 to 30 kgs. If a plain woven portion comes in the design, then half the threads are to be lifted, i.e., a dead weight of 12-15 kgs is to be lifted. In fact, in some very complicated designs in very wide fabrics of 5000-7000 threads, weight of 60-80 kgs. could be required to be lifted.

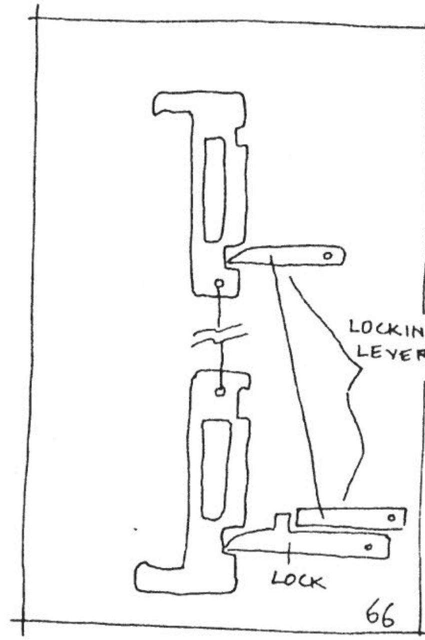
Selection device for the 2nd mechanism :

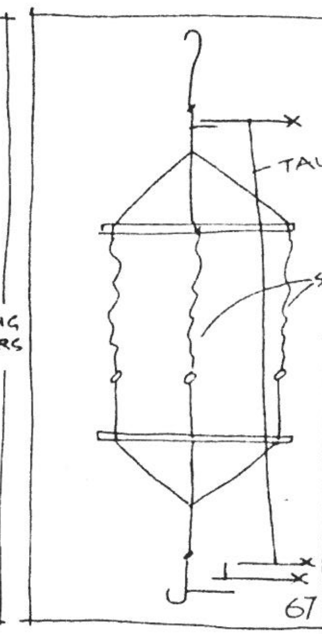
The second problem, that of the selection mechanism is more severe. Whether we are using punched cards or dobby lattice, duplicating them because of the second mechanism is an expensive proposition. For e.g. a standard 80 hole dobby lattice is sold in the market @ Rs.200/- per slat. If a lattice of 100 slats is being used (for a design repeat on 100 picks) the lattice would be Rs.200/-. Duplicating it would mean an extra expenditure of Rs.200/-.

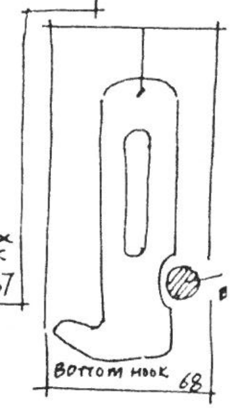
To get over this problem a system of locks and locking levers was devised which would be controlled by the selection device in the top mechanism. As the top hook would rise it would move the top locking lever which would pull the bottom locking lever thereby freeing the lock and letting the bottom hook move up.[66]

Two problems - first, the cross connection of threads between the top and bottom locking levers would get entangled in the sheet of warp in between. It would certainly be a mess and an unnecessary complication of an already complicated situation. Second, an accurate slack would have to be incorporated in the harness cord so that the connecting thread would release the locking levers and lock etc., before the cord became taut and started pulling the bottom hook.[67]

Variations of the locking system were tried but all based on the same principle presented the same problems.







Finally a solution? :

One locking system thought up along the way was based on a different principle.

It would consist of a notch in the hooks which would get caught in a lock bar of a suitable cross-section.[68]

The pull of the warp tension would not be enough to release the hook off the lock bar. But if the top hook was going up and pulling the bottom hook, that would cause the bottom hook to slip past the lock bar.

The first thing that springs to the mind for getting around this problem is that the lingoes should be more intelligent.

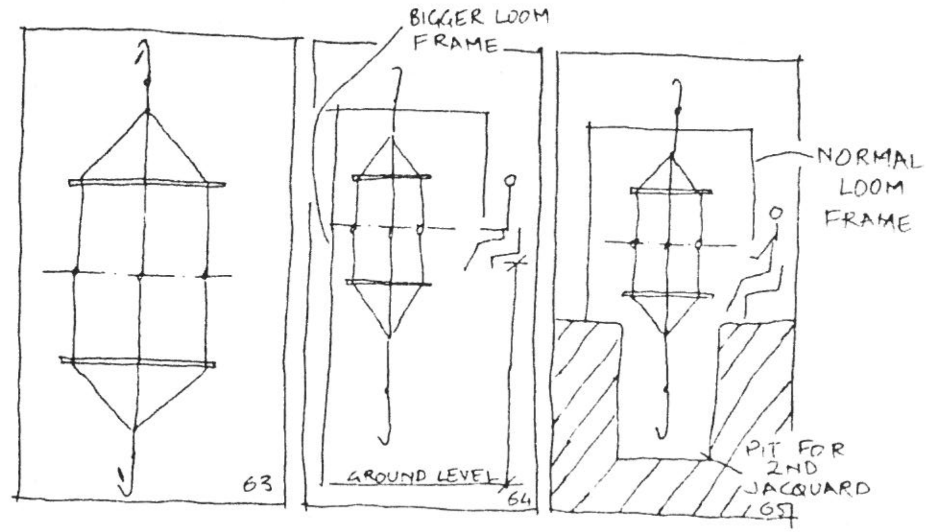
They should hang from the heald cords keeping the warp down when it has to remain down. When any warp has to go up the lingo acting on it should detatch itself from the harness, letting the thread go up almost without any weight.

This could be achieved by using some mechanism which would act in place of the lingoes. It would catch hold of the end keeping the warp pulled down. When that warp had to go up, the mechanism would release it only to catch it again when it came down.

Such a mechanism already exists - the jacquard itself. If we could take another jacquard and place it below the normal mechanism in a mirror-image fashion it would be able to keep the threads selectively down or let them go up, in synchronisation with the top mechanism.[63]

When the top mechanism would take a thread up, the bottom mechanism would release it. When it would select a hook to let it remain down, the corresponding bottom hook would keep that thread down.[~~63~~]

There were two problems with this solution - that of space below the shed area for a second mechanism to fit, and that of selecting the threads to be released or to be kept down by the mechanism below.



There would be a space problem because of the harness. Even if the length of the harness is reduced because of the new 'fatti board' solution, the total space required by two such harnesses, that of the top and bottom mechanisms, would be considerable.

Or, the seat of the weaver, the beater bar, the shed area, the back and front breast beams etc. all have to be raised to such a height that the bottom mechanism is accommodated. This would have a net effect of increasing the height of the jacquard, may be back to that of the conventional mechanism, if not more.[64]

Or a pit would have to be dug below the loom in which the second mechanism would fit in. In the pit-loom fashion this jacquard loom would also get fixed in one place.[65]

Selection device for the 2nd mechanism :

The second problem, that of the selection mechanism is more severe. Whether we are using punched cards or dobby lattice, duplicating them because of the second mechanism is an expensive proposition. For e.g. a standard 80 hole dobby lattice is sold in the market @ Rs.200/- per slat. If a lattice of 100 slats is being used (for a design repeat on 100 picks) the lattice would be Rs.200/-. Duplicating it would mean an extra expenditure of Rs.200/-.

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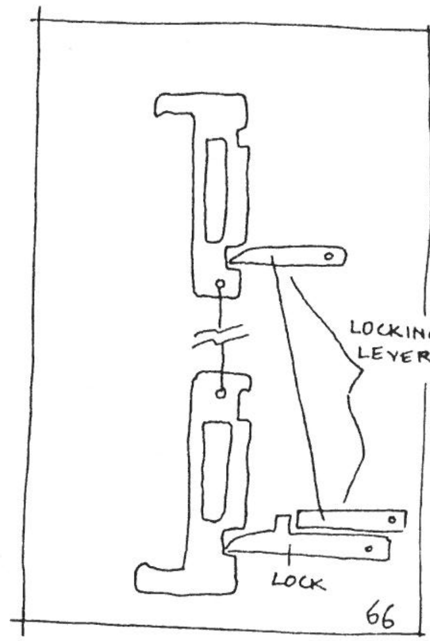

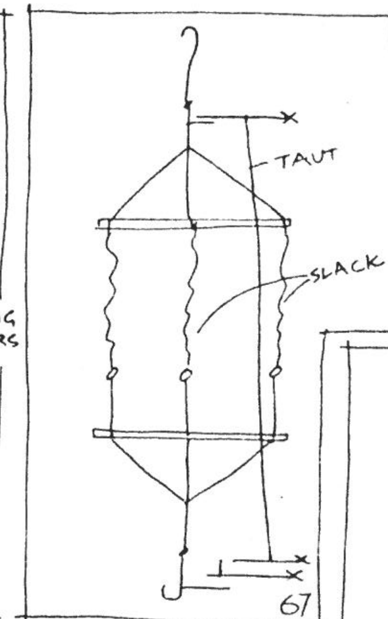

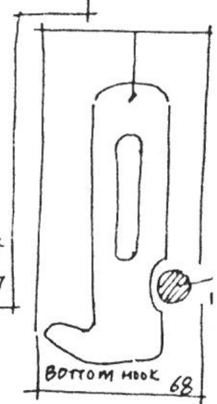

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The pull of the warp tension would not be enough to release the hook off the lock bar. But if the top hook was going up and pulling the bottom hook, that would cause the bottom hook to slip past the lock bar.

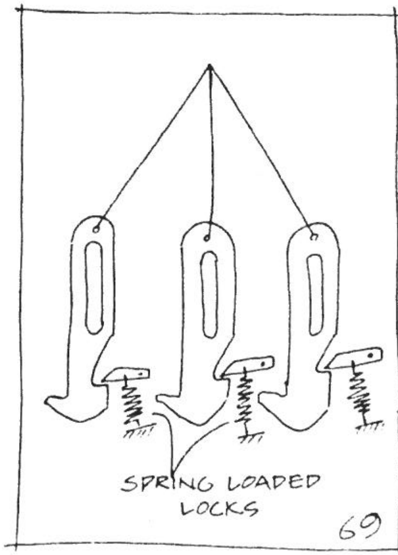
The snag was that the lock bar profile and the notch etc. would require extremely careful designing so that the hook would slip up only after a certain pulling force was exceeded. Still it would not be 100% reliable. Also the vibrations (normal in jacquard operation) would possibly shake the hook off the lock bar giving rise to defects in the fabric.

One solution (based on the above principle) that seemed practical was to have independent locks that would fit in notches in the bottom hooks. The locks would be spring loaded in such a way that they would not let the hooks go up because of the warp tension. But the pull of the top hook would be enough to pull the bottom hook past the lock. When the hook came down it would slip past the lock and get locked again.[69]

The argument against it is that the spring should have such a ***spring constant*** that it will stretch only when a certain force is exceeded. This force would have to be at least equal to the tension in the warp, i.e., same as the weight of the lingoes.

One could say, no advantage in that.

But actually the springs would be stretched only for a fraction of the total movement of the hook - just enough to let the hook slip past the lock. After that, for a major part of the hook's upward travel there would be no downward force on the hooks. Just an initial peak of force being helped by the upward acting warp tension anyway.[70]



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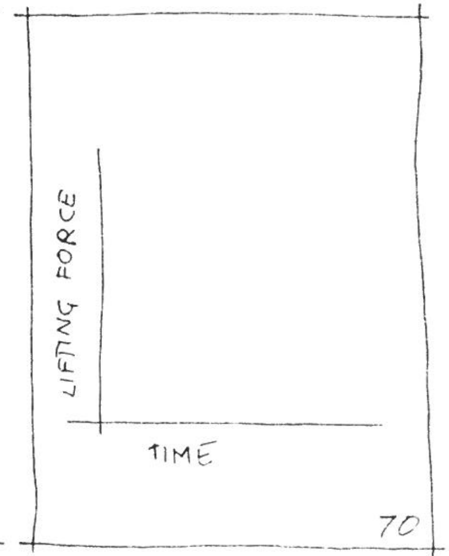

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The problem would be of -

- building/manufacturing springs of desired spring constant.
- arranging/assembling about 2000 of them with their respective locks
- the jerk that would occur because of the hooks caught by the locks being released suddenly

Only considerable research, iterative development and design refinement would be able to prove the viability of production of the spring loaded locks which seem to be not too 'hassle-free' on the paper and are theoretically possible. Try, try and try again till you....

Drive Chain and Linkages :

Most of the work on drive chain and linkages went on during the whole developmental process.

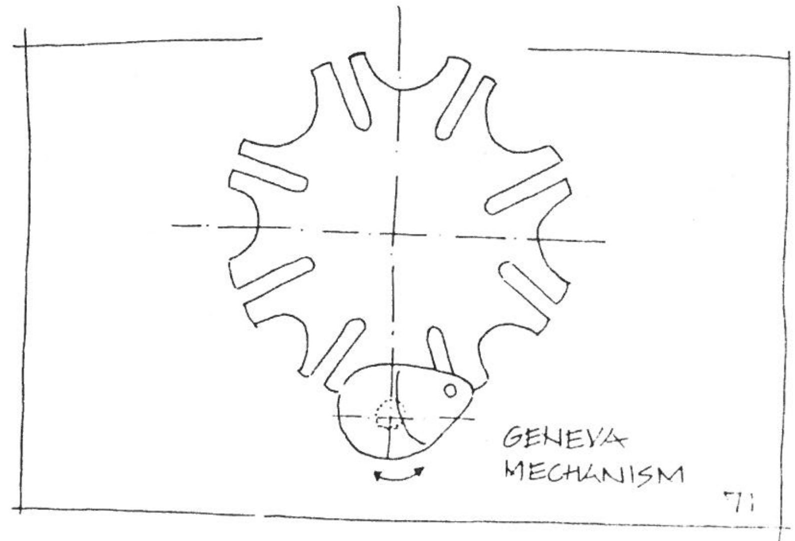
When the twin-jacquard was occupying our prime attention, the drives were thought out to be accordingly working the two mechanisms. When the twin-jacquard relegated to the background, other drives evolved and were considered.

During the twin-jacquard part of the process basically 2 types of drives were considered - an oscillatory drive with pedals and a rotating drive with chains, sprockets and pulleys.

The fling with the rotating drive was primarily because the cylinder with the pegs had to rotate. Though it was possible to rotate the cylinder with the updown motion of the pedals (by employing a *pawl-ratchet*). We thought using a *Geneva mechanism* might be more certain and accurate.

A rather dispropotionate looking Geneva mechanism that would rotate by 45 degrees in every cycle, was designed. This was because the dobby cylinder and lattice are such that the cylinder rotates by 45 degress to present a new slat. That is why the ratchet has eight teeth.[71]

The Geneva mechanism did work but the problems arose in giving a cyclical input (one would not know when a cycle ended and the next one began) and in fabricating the mechanism. It would require very high tolerances and would be very



expensive to make.

As the work drifted more towards a refined single jacquard, it was decided to use pedals with as simple a drive as possible. The idea was to give the best possible leverage and synchronise the shedding with lattice change.

The first set-up tried out was on the first model of the jacquard mechanism. It worked inasmuch it gave the required leverage and changed the lattice but did not do the two in synchronisation.

After the shedding and beat-up, the cylinder would have to be rotated separately. Also because of the increased leverage the *Velocity Ratio* would increase a lot. So the lever would have to be pulled 2 or 3 times to get the required movement.

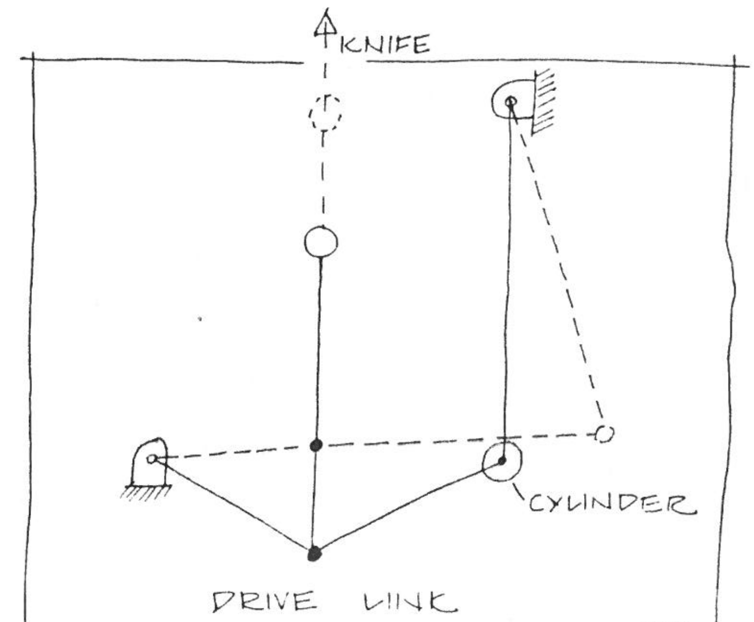
Then, as we found that the effort for rotating the cylinder was a lot because of the loading on the hooks, we thought it might be a better idea to move the cylinder away from the hooks before it rotated - like in conventional jacquards.

The conventional jacquard's drive works very well but is huge and heavy. We decided to slim it down by both refining the design and fabricating it out of MS flats and angles instead of casting it out.

Most of the work on drives was done by a student trainee who was with us for about 8 weeks. Though finally none of his designs were incorporated, his work gave valuable lead as to what should be done. His report is attached in his words as he wrote it.

A new design was tried. It turned out to be fairly complicated and required very accurate fabrication. We spent more time arranging whether it was a 5-bar linkage or a twin 4 bar and never got very far with the actual drive.

Finally, a simple link was designed and fabricated in our own workshop. Though it gave us a tough time in the begining, it finally worked to our satisfaction.[72]



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The only problem with it is that since the pawl-ratchet is on one side, the force required on that side is more than on the other. Therefore, the force required to lift the knife is not balanced - it only works well when jerked, not when pulled slowly.

A REPORT.

A report on the "Drive to the Jacquard"

Objectives :

- Work out the drive linkages to
  (a) the knife, and
  (b) the dobby cylinder

Drive :

Essentially we can consider two types of drives for the machine:

1. Where the dobby cylinder is stationary and only rotates about its own axis. That is it has no axial or outward movement. This sort of a drive is suitable in a dobby because the pegs act indirectly on the selection mechanism (comprising of needles, hooks). So there is no chance of some jumbling in selection.[1]

In our jacquard the selection is direct. In our jacquard the hooks are directly manipulated by the selection mechanism (i.e. in our case dobby cylinder with lattice and pegs). Hence the need for an accurate selection mechanism.

If a hook has been raised for one pick, and brought back to its original position, the selection for the second pick has to be accurate.

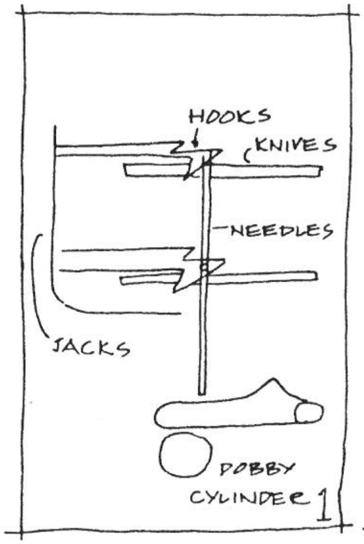
2. The second type of drive is in which the cylinder moves out in either perfectly horizontal fashion or in an arc. The objective is to remove it out of line of action with hooks, rotate it until the next slat comes into position and bring it back into contact with the hooks.

The lifting and lowering of knives and the movement of dobby cylinder (to & fro after the change) have to be synchronised.

The distance of 1.5 cm is the clearance between the hooks and the knife at rest position.

The knife first rises by 1.5 cm when it comes into contact with hooks. Then for another 3 cm, it rises along with the hooks.[2]

Now the linkages are such that the cylinder starts moving out, rotates by 1/8th of a revolution and again comes back to its original position.



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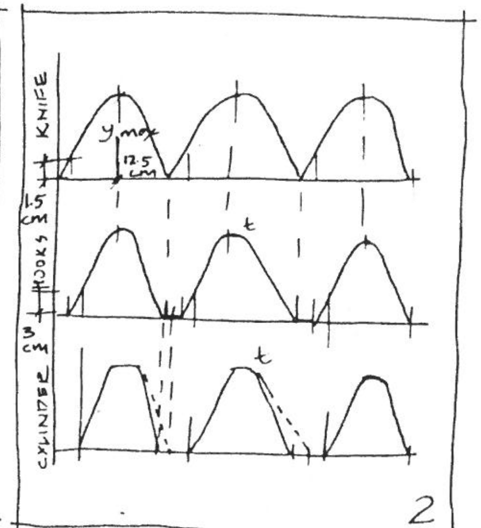

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Mechanisms based on the above principle :

Such a drive can be operated by a slider-crank mechanism (In our case it is a 4 bar-slotted link mechanism with guiding elements).[3]

According to calculations, the displacement of the slider crank should be 28.35 cm but in effect it is less due to friction in the straight line motion. This would make the jacquard a little difficult to operate.

Also for the constant effort applied by the weaver the displacement was found to be less due to the frictional losses. Hence this model was rejected.

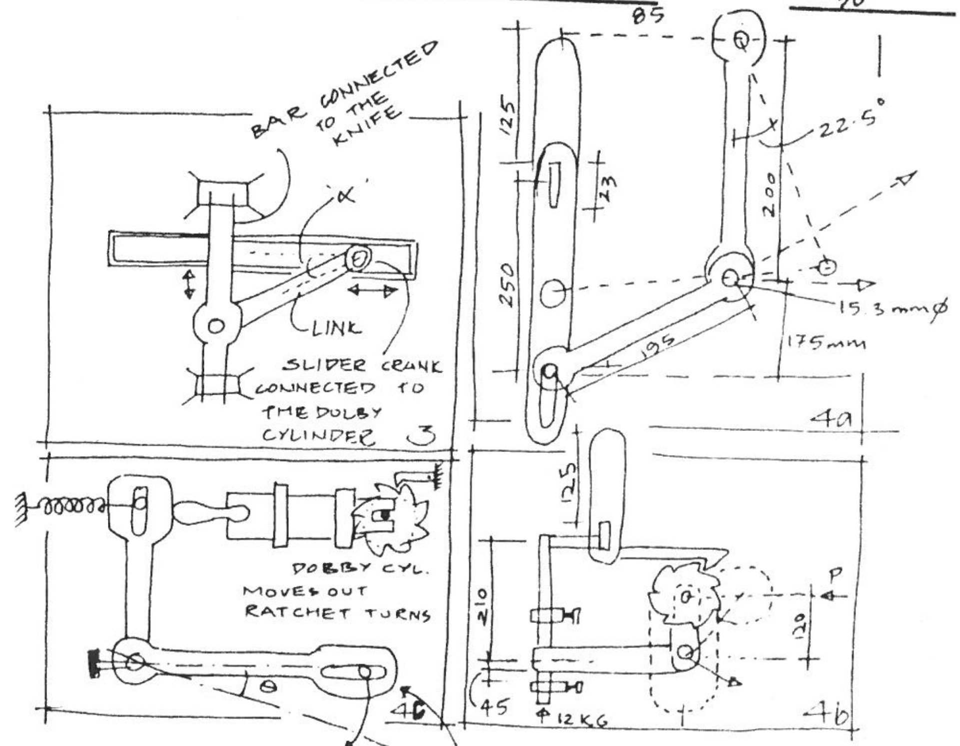
Two possibilities exist for running this mechanism -

- Pivoted at the top
- Pivoted at the bottom

Pivoted at the top :

If there is a four bar linkage with the dobby cylinder moving in an arc rather than in a straight line the frictional loss can be reduced to a great extent.

Thus, in a machine where the pivot is at the top, the dobby cylinder moves in an arc.[4]



Pivoted at the bottom :

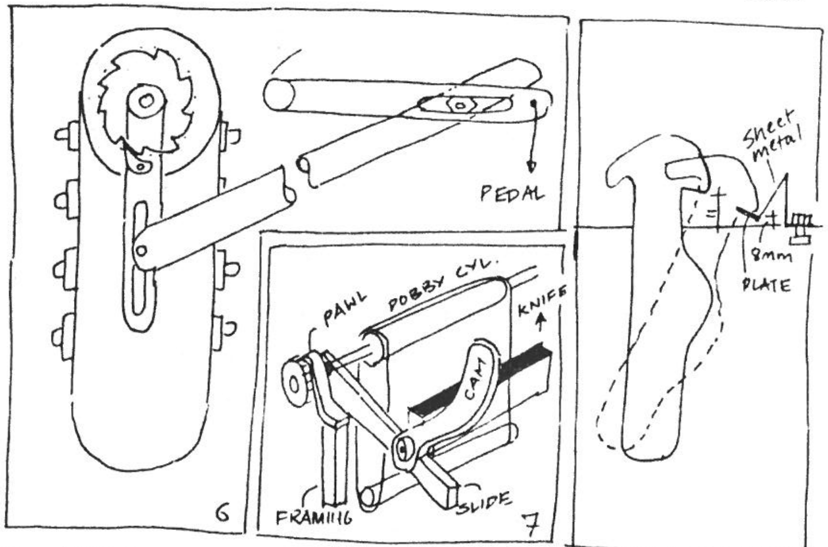
In this machine the dobby cylinder moves in an arc with the pivoted end at the bottom.

The above two mechanisms are such that a single pedal operates both the knife and the dobby cylinder thus easing the work of a weaver. After intensive trials if we find that the load on the weaver is too much, we have alternative systems involving the use of two pedals (1) one to lift and operate the knife and (2) to rotate the dobby cylinder.[5]

If there is a mechanism which can synchronise both these motions with the above motion it would be another design possibility.

Another mechanism can rotate the dobby cylinder with the use of another pedal.[6]

If a suitable mechanism can be connected such that



the lifting of knives and the above rotation of dobby cylinder can be synchronised then it could be tried out.

The standard drive to the jacquard involving an inclined cam to move the cylinder out would be slightly more difficult because the cam profile and its fabrication is slightly more difficult.[7]

As already explained this drive gives better results in the sense that since the dobby cylinder moves up and incline in its motion in an arc, it comes down exactly to its original position by gravity. Thus, the selection for the second pick is accurate enough.[4]

But in this and in the straight line mechanism we encountered problems in straight line movement of the knife. The knife which moves in a slide gets slightly bent due to the different linkages.

This bending prevents a smooth downwards movement and it gets jammed in the slot.

By providing guides we could minimise the jamming but could not eliminate the defect.

So a possibility of using round cross-section knives would have to be tried out.

Another different type of problem that arises is as follows -

Once the required hooks are lifted and the others pushed back, the hooks that are pushed back tend to become vertical as soon as the dobby cylinder moves away. This will prevent the knife from coming down smoothly. The knife would hit the top of the hooks and cause damage in the long run.

One solution to this problem would be to devise a holding catch for the hooks.[8]

The pushed hooks get caught by a catch. After the knife descends, a projection on the dobby cylinder shaft pushes the bent hooks to the original position before the dobby cylinder reaches its original position.

EVALUATION.

ACHIEVEMENTS :

A working prototype/pre-production model of the jacquard is ready. It has proved the viability of the new concepts introduced and has also served to highlight its compromises and limitations.

The new jacquard incorporates modifications which make it lower, simpler (to set-up, learn, operate and maintain), self-reliant and cheaper, both in terms of capital and recurring investments.

The extra fatti board allows a short harness and eliminates the differential lifting effect. The wire construction of the grating also helps reduce the wrap around friction and cuts down on the wear and tear of the harness ends.

Fabrication with the Mild Steel angles and flats instead of the conventional Cast Iron mechanism helps achieve better tolerances, reduces weight and makes the mechanism cheaper and easier to set up.

The simple mechanism with the minimum number of linkages makes it friendlier, easier to set up, operate and maintain. At the same time it helps cut down on cost and make the machine affordable to the weaver. Elimination of the needles means there is one link less to go wrong.

Using the dobby lattice in place of a punched card lattice makes it a one time expense instead of a recurring one. No cards need to be punched everytime the design is to be changed. The weaver does not have to depend on another person with the expensive machine to punch cards for him. It makes the operation very easy.

This results in dramatically lower capital and recurring expenditures in comparison to a conventional jacquard.

The new jacquard would cost about Rs.1000/- to Rs.1500/- besides the basic loom, about a third of a small conventional jacquard.

The design concept of the mirror image twin jacquard has also been developed and proved. This would help in reducing the operating effort by eliminating the lingoes.

Using new materials like plastic for the injection moulded hooks and pegs and mild steel angles results in cheaper production costs and better strength and increased durability. At the same time it reduces the weight that has to be lifted, thus reducing the operating effort.

PROBLEMS, LIMITATIONS AND COMPROMISES :

The major and infact the only limitation of the new jacquard is the number of hooks that can be used.

This limitation is due to the dobby lattice being used for selection of the hooks.

As the holes in the slats are in a straight line the hooks also have to be arranged similarly. In a conventional jacquard the cards can be punched to form a 2-d array of holes so that the hooks can also be arranged that way. This allows a large number of hooks (200 to 800 or 1000) to be used.

In order to have good designs it is necessary to have atleast 200 hooks.

Existing slats have 80 holes. It is not practical to increase the length of the slats to accommodate 200 or more holes because not only will it be expensive but also make the slat too long, weak and difficult to operate.

One solution is to use two jacquards side by side giving 160 hooks which is definitely better. This has to be tried out and checked for any resulting problems.

CONCLUSION :

The new jacquard is a compromise between a dobby and a jacquard.

It can be seen as an extended dobby with at least 80 and at the most 160 levers instead of a maximum of 32 in convention mechanisms.

It can also be seen as an attenuated jacquard with a limit on the number of hooks but with advantages in terms of cost, single and independent use, simple set-up, operation and maintenance.

In fact, the machine bridges a wide gulf between a dobby and a jacquard creating a niche for itself, by bringing the capability of producing designed fabrics in the grasp of the individual, poor village handloom weaver.

It satisfies a cost/benefit criteria somewhat similar to that set in the beginning for the Swiss hobby machine Tistou.

All in all, a satisfying and rewarding development and design project, as we did not drift away much from the path set up by us in the beginning.

DIRECTIONS OF FUTURE WORK >>

RESEARCH :

Continuing design development of the minor image twin- jacquard mechanism.

Continuing investigation into the possibilities of increasing the number of hooks in the jacquard.

Continuing improvement of the current model based on the feedback from use in the field.

PRODUCTION :

Development of full fabrication and assembly facilities including injection moulding for plastic parts and fixtures for metal parts.

Identification of fabricators/contractors for the production, and setting up of terms and delivery systems.

Identification of vendors/suppliers of standard items in the machine and setting up of terms and delivery systems.

All of above with the perspective of minimising capital and recurring investments to get the best quality and quantity of production.

MARKETING, TRAINING AND EXTENSION :

Developing a marketing/training strategy for a viable and effective distribution of the technology.

Identifying franchisees for manufacture, distribution and publicity of the technology.

Identifying **NGA's** and **GA's** for publicity and training programs.

Developing a comprehensive training package comprising booklets, manuals with photos and diagrams, av's and video capsules necessary for effective instruction.

Organising workshops/training courses for weavers and instructors from time to time at different places.

Developing and supplying designs and design kits for fabrics as separate items for sale.

For information of the central design unit, setting up feedback/complaint monitoring cells in the areas where the machines have been distributed.

GENERAL INFORMATION >>

List of vendors and fabricators can be found in book #6.

The above has been graded on a scale of 1 to 5 in the increasing order of difficulty in terms of party's business relationship, accessibility of factory, punctuality of delivery schedules, costs and quality of service. 1 is for the best available party with 5 being incorrigible. 0 means we are not sure and would not rate.

Also attached is a list of different organisations and contact persons all over the country and abroad, working in same, similar or related fields.

A word about the frame :

The frame of the mechanism, though not a technically demanding component, is an important part inasmuch, it provides rigidity, stability and durability to the jacquard.

Initially, a wooden frame was tried out because wood is easy to work upon and the designer can afford to change his mind often. But it was not a rigid structure and, due to the stresses acting on it, became loose and started shaking.

But, using the wooden frame gave us an idea of the way the components would be arranged in the mechanism with respect to each other.

When the second model of the design, its frame was made from MS angles 1"x1"x1/8". This not only cut down on the weight, increase the strength, but also gave a lot more working space.

As we said above, the frame is not a technically demanding component and does not need critical dimensions and fabrication. That is why no dimension has been provided. Mostly, it is dependent on the size of the lattice which governs the width of the mechanism.

A sketch has been provided but the stress is again on the concept rather than on the actual dimensions. It does require good quality fabrication work and is an important component on which the final performance of the machine is dependent.[73]

A final note on the design process :

As would be clear from the report on the design process, the whole approach was mostly iterative.

We followed a general path from which we diverted, wandered, came back or forged a new path.[74]

The work was more on the concepts and was an effort to actualize these ideas. Seldom was it based on rigorous theoretical analyses which did not necessarily detract from its quality. The approach was governed more by a sense of designing something new with a rigorous design analysis of the existing machine and its basic concepts and principles - kind of trying out new recipes governed by the basic principles of everyday cooking.

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GLOSSARY.

Beater bar = The mechanism carrying the reed. Used for for knocking the weft into the cloth.

Bobbins = Packages that carry weft.

Bottom shed = Bottom most position of the warp in the shed.

Card = A cardboard card with holes punched in it for selecting the warp.

Card punching machine = A machine for punching holes in a card to control the movement of threads in a jacquard.

Centre shed = Centre most position of the warp in the shed.

Charkha = Machine to wind weft on the pirns.

Cloth roller = Roller on which the cloth wraps as it is made.

Comb = A comb used for beating the weft into the fabric.

Comber board = A machine used to guide threaded cards.

Cover factor = Ratio of the amount of area covered by the fabric to the total area of the fabric.

Crimping = Bending and wrapping around of warp and weft around each other.

Cylinder = The mechanism on which the chain of cards moves.

Dobby = Mechanism for cont rolling the movement of the large number of heald frames.

Doffing = Taking-off

Draft = The pattern in which drawing-in is done depending on the design.

Drawing in = The process of putting the warp through the heald eyes.

Drawloom = Earliest type of looms for making designs in the fabric.

Ends = Threads running along the length of the fabric.

Eye harness = Used in place of heald wires (in Jacquards).

Fatti Board = Mesh or guides for grinding the neck cords.

Frame shedding = Using heald frames to control the warp movement and open the shed.

GA = Government agencies

Geneva mechanism = Mechanism to convert continuous circular into intermittant circular motion.

Harness = Threads connecting the hooks to the eye harnesher heald cords.

Heald cord = Used in place of heald wires (in Jacquard)

Heald eyes = Openings or loops in healdwire, through which warp passes.

Heald frame = A frame of wood that holds the heald wires.

Heald wire = Twisted wire with loops in the centre for controlling the warp movement.

Hecks = Collars or wings around harness to prevent it from rotating.

Injection moulding