

# Jacquard Weaving: How a Jacquard Machine Works and How a Jacquard Design Is Made

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## In one paragraph

Jacquard weaving is weaving in which a Jacquard machine above the loom lifts warp ends individually instead of in heald shafts, so a figure can run across thousands of ends: damask, brocade, tapestry-style upholstery, woven labels. Each hook in the machine carries a neck cord, and the neck cord carries one harness cord for every repeat across the cloth, down through the comber board to the heddle eye holding one end. On every pick the machine selects the hooks that the rising knives (the griffe) will lift, once by punched cards pressing on needles, now by electromagnets reading a design file. A Jacquard design is made by drawing the figure to the size of one repeat, laying it on a grid in which each column is one end (one hook) and each row one pick, filling each part of the figure with a weave, and saving the grid as cards or as the file the machine reads. One repeat is as wide as the hooks used divided by the ends per cm: 2,400 hooks at 40 ends per cm repeat every 60 cm.

## At a glance

### Jacquard weaving at a glance

| Question                 | Short answer                                                                                                                           |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| What it lifts            | Single ends, each through a hook, neck cord, harness cord and heddle; one hook lifts one end in each repeat                            |
| What chooses the ends    | Punched cards pressing on needles, from Jacquard's machine of 1804 to 1805; electromagnets fed by a design file on electronic machines |
| Machine size             | 100 to 1,200 hooks were common in 1887; one maker's current range runs from 80 to 51,200 (two machines combined)                       |
| Widest repeat            | hooks used for the figure ÷ ends per cm                                                                                                |
| Repeats across the cloth | reed width ÷ repeat width = harness cords on each neck cord                                                                            |
| Picks in a repeat        | repeat height (cm) × picks per cm; one card, or one file row, per pick                                                                 |
| Against a dobby          | A dobby lifts shafts: 16 to 24 on one maker's rotary dobbies, up to 30 on its technical ones                                           |
| Fabrics                  | Damask, brocade, lampas, matelassé, Jacquard tapestry, terry, labels, velvet, one-piece woven airbags                                  |
| Invented                 | By Joseph Marie Jacquard in 1804 to 1805, finished in Lyon, after Bouchon (1725), Falcon (1728) and Vaucanson (1745)                   |

### History: from the draw boy to Babbage

| Date | Event                                                                                                                                                | Source               |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 1725 | Basile Bouchon controls a loom with perforated paper rolls                                                                                           | Science Museum Group |
| 1728 | Jean-Baptiste Falcon uses punched cards in an endless chain, the first machine of any kind controlled by punch cards; a draw boy still presents them | Science Museum Group |

| Date             | Event                                                                                                                                                              | Source                                                                                                                         |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| 1745             | Jacques de Vaucanson designs a loom made “completely self-acting” by a pierced cylinder                                                                            | Fondation Napoléon; Posselt                                                                                                    |
| 23 December 1801 | Jacquard, born in Lyon in 1752, is granted a patent for, in translation, “a machine intended to replace the draw boy in the making of brocaded and figured cloths” | Fondation Napoléon                                                                                                             |
| 1803             | At the Conservatoire des Arts et Métiers in Paris, he reassembles Vaucanson’s loom                                                                                 | Fondation Napoléon                                                                                                             |
| 1804 to 1805     | The card-controlled Jacquard machine is developed; Jacquard finishes it after returning to Lyon in 1804                                                            | Science Museum Group; Computer History Museum; Posselt                                                                         |
| 15 April 1805    | An imperial decree signed at Lyon pays him 50 francs for every machine delivered, for six years; a 3,000-franc pension from Lyon follows in 1806                   | Fondation Napoléon                                                                                                             |
| 1806 and 1811    | 41 machines delivered to Lyon in 1806, 57 in 1811                                                                                                                  | Fondation Napoléon                                                                                                             |
| Before 1810      | Lyon’s silk weavers, fearing for their work, turn on him, and machines are broken up in public                                                                     | Fondation Napoléon; Posselt                                                                                                    |
| 7 August 1834    | Jacquard dies at Oullins, near Lyon                                                                                                                                | Fondation Napoléon                                                                                                             |
| About 1839       | Michel-Marie Carquillat weaves a silk portrait of Jacquard for Didier Petit et Cie from about 24,000 cards                                                         | Computer History Museum; Science History Institute                                                                             |
| 1843             | Ada Lovelace: the Analytical Engine “weaves algebraical patterns just as the Jacquard-loom weaves flowers and leaves”                                              | Lovelace’s Note A to Menabrea’s Sketch of the Analytical Engine, in Scientific Memoirs, vol. III (London, 1843); transcription |
| 1983             | Bonas launches its electronic Jacquard at ITMA Milan                                                                                                               | Bonas                                                                                                                          |

## Formulas

Set the repeat first and the hooks follow:  $\text{hooks needed} = \text{ends per cm} \times \text{repeat width}$ , and the repeat must divide the reed width.

## Revision questions

*The questions readers ask most, with the article's own answer.*

### How does a Jacquard loom work?

The Jacquard machine above the loom raises each warp end by its own hook, neck cord and harness cord. For every pick a card, or a row of the design file, selects the hooks the griffe lifts; the raised ends form the shed, the loom inserts and beats up the weft, and the next card selects the next shed.

### What is the difference between a dobby and a Jacquard loom?

A dobby lifts heald shafts, 16 to 24 on Stäubli’s rotary dobbies and up to 30 on its technical ones, so all the ends on a shaft move together and the pattern stays small. A Jacquard lifts ends individually through hooks, from 80 to tens of thousands, so the figure can be as wide as the hooks allow.

### What is a Jacquard design file?

The digital form of the card set: a grid with one column per hook and one row per pick, marking which hooks lift on each pick, exported from Jacquard CAD in the form the machine’s controller

reads. The worked example above is a file of 2,400 columns by 1,800 rows.

#### **How many hooks does a Jacquard machine have?**

Posselt gives 100 to 1,200 hooks as the common sizes in 1887 and Nelson 100 to 2,600 in 1909. Stäubli's current range runs from 80 hooks, for names in selvages, to 51,200 with two machines combined, and Bonas builds single machines with up to 31,104.

#### **When was the Jacquard loom invented?**

Joseph Marie Jacquard developed his card-controlled machine in 1804 and 1805, finishing it in Lyon, building on Bouchon's perforated paper (1725), Falcon's cards (1728) and Vaucanson's loom (1745). His patent of 23 December 1801 was for an earlier machine to replace the draw boy.

#### **What is the Jacquard loom used for?**

Any cloth whose figure is too large for shafts: damask table linen, brocade and lampas for furnishing, matelassé, Jacquard tapestry, bordered terry towels, woven labels and ribbons, velvets and carpets, and technical fabrics such as one-piece woven airbags.

### **Test yourself**

*Ten questions on this topic. Answer them without looking, then check on the last page.*

1. How does a Jacquard machine differ from heald shafts in what it lifts?
2. In a Jacquard machine, what is the griffe?
3. In a card-controlled Jacquard, what happens to a hook where the card is blank?
4. Why does a double-lift Jacquard machine give an open shed?
5. What does an electronic Jacquard replace, and what does it keep?
6. What is the effect of a point (centre) tie on a Jacquard harness?
7. Why must point paper for a Jacquard design take the cloth's proportions of ends to picks?
8. Why is a damask reversible?
9. Did Jacquard invent the punched card?
10. How is the width of one Jacquard repeat found, and what is it for 2,400 hooks at 40 ends per cm?

## Answers

*Each answer is stated in the article; the section to read again is named after it.*

1. **It lifts warp ends individually instead of in heald shafts.**  
See: Opening
2. **A frame of knives, one to each row of hooks, that rises and falls once a pick.**  
See: How a Jacquard machine works
3. **The needle is pushed back and pushes its hook off the knife, so the hook and its ends stay down.**  
See: How a Jacquard machine works
4. **It has two griffes working in turn, each end controlled by a pair of hooks.**  
See: How a Jacquard machine works
5. **It keeps the hooks, knives and harness and replaces the cards, cylinder and needles with electromagnetic hook selection.**  
See: How a Jacquard machine works › From punched cards to the electronic Jacquard
6. **The figure is mirrored and the same hooks cover about twice the width.**  
See: The harness: how one hook weaves several repeats
7. **Otherwise a circle weaves as an oval.**  
See: How a Jacquard design is made
8. **Figure and ground are the same threads in opposite faces, warp floats against weft floats.**  
See: How a Jacquard design is made
9. **No; perforated paper, cards and an automatic loom had all been tried before him.**  
See: History: from the draw boy to Babbage
10. **Hooks used divided by ends per cm; 60 cm.**  
See: Opening

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