Castout files and the Weave » Make Castout File dialog

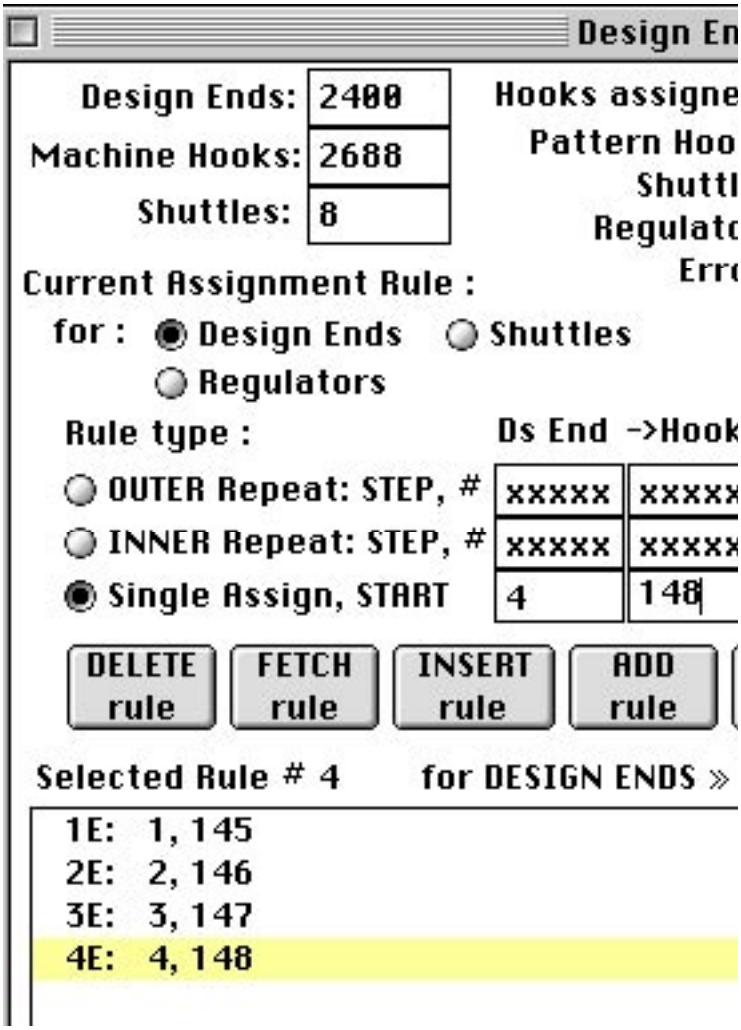
The primary purpose of a Castout is to connect or associate Ends in a Design with corresponding Hooks in a loom-control file. When we "cut" weaves into our Design we are painting black the Ends which indicate a raised warp, i.e. a lifted hook in the Jacquard head. Punching (creating a loom-control file) simply looks for Black (255) Ends in the Design and lifts the corresponding Hooks in the loom file, using the Castout to guide it.

Often not all the hooks in the Jacquard head are used. For example a 2688-hook Jacquard might be used to weave a 2400 warp design. It is common practice to center the harness in the head, leaving banks of unused hooks along each side, so in this example the 288 unused hooks (2688 - 2400) might be divided into two groups of 144 each, #1..144 and #2545..2688, while the harness (and pattern) would use Hooks 145...2544.

Generally the Design itself is left-justified so that End #1 is the first End in the design.

So in this example the task of the Castout would be to connect:

Design End #1 to Hook #145
Design End #2 to Hook #146
• • • •
Design End #2400 to Hook #2544



Castouts are created in the *Weave»Make Castout* dialog, shown in part to the right.

Design Ends = **2400**, the width of our design
Machine Hooks = **2688**, the width of our Jacquard

We are creating "Design Ends" rules which connect Design Ends to Hooks; the other two rule flavors (Shuttles and Regulators) will be discussed later.

We could use the "Single Assign" rules as shown. Each such rule (4 are shown in the list) associates a singe Design End to a single Hook.

To create such a rule we enter the End in the first box (to the right of (•) Single Assigns, START) and the corresponding Hook in the second column, then click on Add Rule to append it to the list.

However, the thought of laboriously entering 2400 such rules is too painful to contemplate seriously.

The solution is to use "repeats", much in the same way as you would design a single motif and then use Copy Paste to repeat it across a design rather than hand-painting each individual copy.

The key to using repeats is finding a repeating pattern.

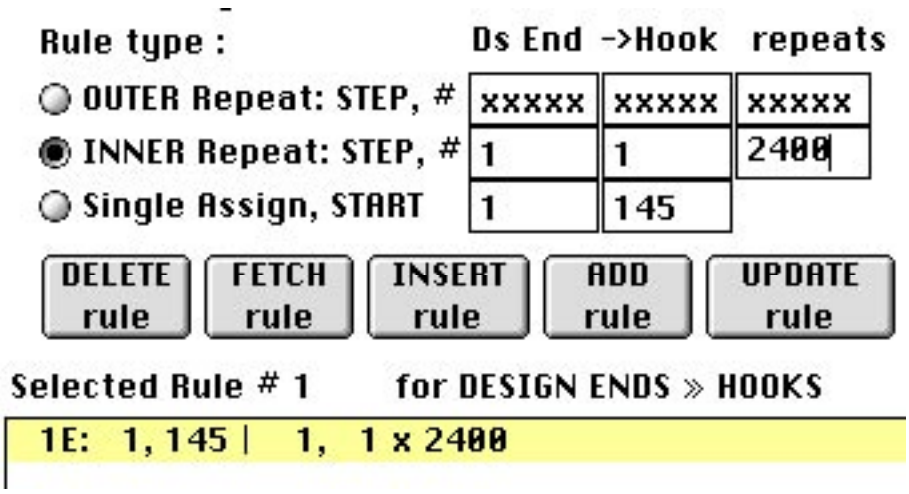
Looking at our assignments we see that for each subsequent rule the End # increases by 1 and the Hook # increases by 1, and that we will be repeating this process until 2400 assignments have been made.

Which very neatly brings us to the need for "Inner Repeat" rules

We still begin by entering our first End (#1) and its associated Hook (#145) in the bottom row "START".

We select (•) INNER Repeat for the Rule type.
Into its STEP,# row we enter
1 for the amount to step the Design End
1 for the amount to step the Hook
2400 for the # of repetitions

Then click on ADD or UPDATE Rule.



This rule still begins by connecting End #1 to Hook 145
but then increases the End by 1 to #2 and the Hook by 1 to 146 and makes that connection
then again increases the End by 1 to #3 and the Hook by 1 to 147 and makes that connection
and repeats on and on until it has created 2400 connections, the last of which connects End 2400 to Hook 2544.
Quite a significant improvement over Single Assigns!

To solidify our understanding of INNER Repeat rules lets work a few more examples:

The direction doesn't matter. For example we could start at the right edge (End 2400 to Hook 2544) and assign right-to-left using:

```
1E:2400,2544 |  -1, -1 x 2400
```

Note that the End and Hook numbers are *decreased* in each repetition so 2400-> 2544, 2399-> 2543... 1-> 145

Suppose that we wanted to End-mirror the design. That means we want End 1 -> 2544, 2->2543,...,2400->145
Easy to do using this rule which *increases* the End # while *decreasing* the Hook number on each repetition. So 1-> 2544, 2-> 2543, 3->2542, ..., 2400-> 145

```
1E:  1,2544 |  1, -1 x 2400
```

Sometimes looms that are set up for "full count" warp are used to weave "half count" fabric. One simply loads in half as much warp using only every other heddle. I.e., End #1-> Hook 145 but End #2-> Hook 147, End #3-> Hook 149, etc., for 1200 Ends and warps. This rule still increments the Ends by 1, but increments the Hooks by 2 so while the Ends are going 1,2,3,4,5... the Hooks are going 145,147,149,151,153... for a total of 1200 repetitions. Of course our "design" needs to be only 1200 Ends wide to match the 1200 warps and hooks that are active in this half-count fabric.

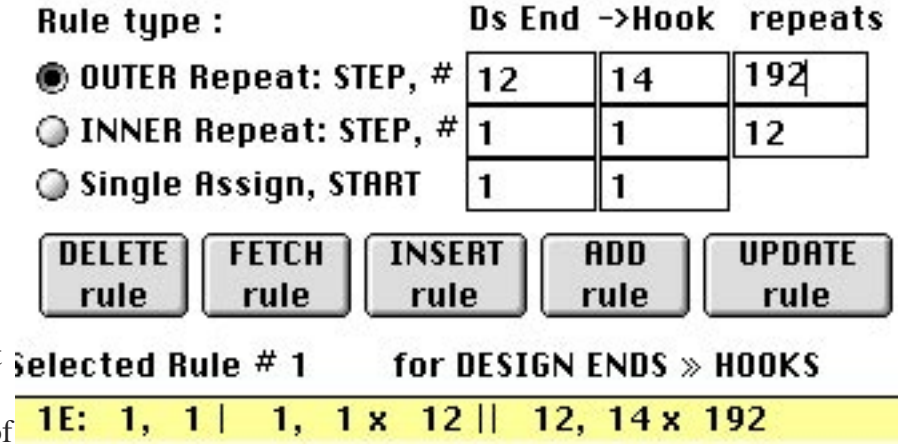
```
1E:  1, 145 |  1,  2 x 1200
```

Sometimes the hooks to be used are not in a single contiguous block - for instance if a modern head and harness was set up so designs for an older dual-head mechanical setup could be woven unchanged. In such a case the used hooks might be #73..1272 and #1417..2616. Here we need 2 rules, the first to connect Ends 1..1200 to Hooks 73..1272 and the second to connect Ends 1201..2400 to Hooks 1417..2616.

```
1E:  1, 73 |  1,  1 x 1200
2E:1201,1417 |  1,  1 x 1200
```

Now for an example which can't be handled efficiently by an INNER Repeat rule. "*Casting out*", often used to spread a narrower harness across the width of a wider head, is the process of skipping over (casting out) some hooks. For example with a 14-deep head one might use the first 12 hooks and skip 2 in each column of hooks. Using only INNER Repeat rules we would need a separate rule for each group of 12 hooks - 192 rules to assign 2304 Ends to 192 rows of 12 hooks each. OUCH!

Which very neatly brings us to the need for OUTER Repeat rules



A Staubli CX860 head is arranged in columns of 14 hooks; a 2688 wide head containing 192 such columns.

The hook numbering is thus 1..14 from back to front in the first column, 15..28 in the second, 29..42 in the third, and so on.

Suppose the harness was designed to "cast out" 2 out of every 14 hooks in each column, resulting in a total of 192 columns of 12 hooks each for a total of 2304 connected hooks.

A 2304 End design needs to be connected to those hooks as follows

Ends 1..12 to Hooks 1..12
Ends 13..24 to Hooks 15..26
Ends 25..36 to Hooks 29..40 and so on for the 192 columns.

Using only INNER Repeat rules we would need

1E: 1, 1 | 1, 1 x 12
2E: 13, 15 | 1, 1 x 12
3E: 25, 29 | 1, 1 x 12 and so on all the way up to 192E:

Looking once again for patterns of repetition we see that for each of those INNER Repeat rules, the START End is increasing by 12 while the START Hook is increasing by 14 because of the 2 skipped hooks.

The OUTER Repeat provides a way of adjusting the START values for each execution of the INNER Repeat.

In the example shown above, the INNER Repeat makes 12 assignments, incrementing the End and Hook each by 1. Then the OUTER Repeat adjusts the START values (Ends by 12 and Hooks by 14) before restarting the INNER Repeat. It does this for a total of 192 repetitions (each of which makes 12 assignments).

So, the first time through the INNER Repeats does: 1-> 1, 2-> 2, ..., 12-> 12
then the OUTER Repeat adjusts the START values to **13** (*1+12*), **15** (*1+14*)
so the INNER Repeat now does 13-> 15, 14-> 16, ..., 24-> 26
then the OUTER Repeat adjusts the START values to **25** (*13+12*), **29** (*15+14*)
INNER Repeat: 25-> 29, 26-> 30, ..., 36-> 40
and so on through 192 repetitions of the INNER Repeat, each of which makes 12 assignments for a total of 192 x 12 = 2304 assignments.

Again note that the order doesn't matter. This rule creates exactly the same 2304 assignments, but goes left-to-right first assigning to one hook in each of the 192 columns before moving down to the next row.

1E: 1, 1 | 12, 14 x 192 || 1, 1 x 12

Study this rule and work examples until you understand why it produces the same set of assignments as the previous one. It is important to understand that you often can use any repeating pattern you can find, no matter which direction it runs, to reduce a large number of Single Assign or INNER Repeat rules into a smaller number of OUTER repeat rules... Neither End nor Hook increment needs to be one - as long as there is some constant step you can make use of it in a Repeating rule.

The designer is sometimes the last to be consulted about a new harness, which leads to a need for especially "interesting" castouts.

For example Terry cloth is woven with alternating "ground" and "pile" warps; the ground warps coming under normal tension from one beam and the pile warps under very little tension from a second beam. The warps are arranged across the loom and Design in alternation, G P G P G P G P..., but often the hooks are divided into separate front and back groups, one for the ground the other for the pile. Certainly makes drawing-in easier.

In such an arrangement the hook sequence might be G G G G G G G P P P P P P P back to front in the first column of 14 hooks (#1..14) and similarly in all other columns.

So the Castout needs to connect:

Ends 1..14 to Hooks 1, 8, 2, 9, 3, 10, 4, 11, 5, 12, 6, 13, 7, 14 *(G P G P...)*
Ends 15..28 to Hooks 15, 22, 16, 23, 17, 24, 18, 25, 19, 26, 20, 27, 21, 28 *(G P G P...)*

and so on.

There are several "patterns of repetition" here which could be exploited: alternate Ends to sequentially numbered hooks (1-> 1, 3-> 2, 5-> 3,...), adjacent Ends to Hooks that differ by 7 (1-> 1, 2-> 8), and the difference of 14 between columns. Lets look at some possible approaches:

First thinking only in terms of INNER Repeats we can see the following possible forms of repetition

1,1 | 1, 7 x 2 1-> 1, 2-> 8
1,1 | 2, 1 x 7 1-> 1, 3-> 2, 5-> 3, 7-> 4, 9-> 5, 11-> 6, 13-> 7
1,1 | 14, 14 x 192 1-> 1, 15-> 15, 29-> 29, ... for all 192 columns

Now looking at ways to use these with an added OUTER Repeat:

1) a difference of 7 in the hook numbers between adjacent Ends, but this only repeats for 2 assignments
(End 1 -> Hook 1, End 2 -> Hook 8) so **E: 1,1 | 1, 7 x 2 || 2, 2 x 7** would do one column
but only one column, so 192 rules would be needed to cover all 192 columns, not very attractive

2) we could use the same difference of 7 to do 2 hooks in each column but then repeat across the columns:

E: 1 ,1 | 1, 7 x 2 || 14, 14 x 192 does Hooks 1 & 8 in each column
E: 3, 2 | 1, 7 x 2 || 14, 14 x 192 does Hooks 2 & 9 in each column
E: 5, 3 | 1, 7 x 2 || 14, 14 x 192 does Hooks 3 & 10 in each column
E: 7, 4 | 1, 7 x 2 || 14, 14 x 192 does Hooks 4 & 11 in each column
E: 9, 5 | 1, 7 x 2 || 14, 14 x 192 does Hooks 5 & 12 in each column
E: 11, 6 | 1, 7 x 2 || 14, 14 x 192 does Hooks 6 & 13 in each column
E: 13, 7 | 1, 7 x 2 || 14, 14 x 192 does Hooks 7 & 14 in each column

which is only 7 rules, a big improvement over the 192 rules

3) use the INNER Repeat to do 7 hooks in the column, OUTER Repeat to do the columns

E: 1, 1 || 2, 1 x 7 || 14, 14 x 192 does Ends 1, 3, 5, ... , 13 to Hooks 1..7 in each column
E: 2, 8 || 2, 1 x 7 || 14, 14 x 192 does Ends 2, 4, 6, ... , 14 to Hooks 8..14 "

which is clearly the best solution!

The "take home" point is to first look for all the patterns of repetitions you can spot, then think about the various ways you might be able to exploit them in repeating rules...

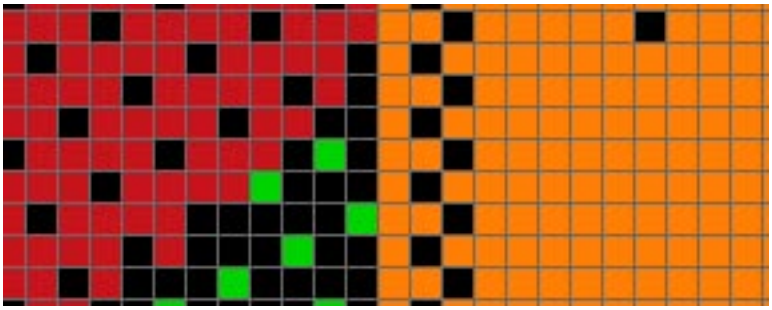
So far we have been considering only “pattern hooks’, i.e., those hooks which control heddles and lift warp ends. These are by far the most numerous and, as we’ve seen, can require complicated castouts.

However, Jacquard mechanisms normally include a small number of “control” hooks, whether real physical hooks or electronic functions, used for weft selection, and controls such as regulators, fringe, pile height, weft density, loom speed, or other special functions.

From the perspective of a loom control file these are simply other hooks, no different from the pattern hooks; at the loom instead of connecting to heddles they connect to other mechanisms. In modern looms they never actually lift a physical hook, being instead rerouted into the electronics. In an older loom they will literally lift a hook which in turn pulls on a lever to, say, select a weft or disengage a pawl on a gear (regulator).

A common approach is to simply add some extra Ends, usually to the right side of the Design, in which one can paint the desired actions for the controls.

In the example to the right we are looking at the right edge of a design (with weaves cut in) followed by a dozen added Ends (colored orange for contrast) in which has been painted a “box motion” (Wefts 3 2 3 2 3...) and a Regulator on the top pick (# 9 in the controls).



^ 2401

If our pattern was 2400 Ends wide, these added Ends might start at 2401 (as indicated in the figure).

Since these “controls” are simply extra Ends, we again use a “Design End” rule to connect them to the appropriate “hooks”. Often Hooks 1..32 are reserved for such controls, with Hooks 1..8 being the Weft Selectors and Hook 9 being the Regulator, so our rule could be

E: 2401, 1 | 1, 1 x 9 connects Ends 2401..2409 to Hooks 1...9

Sometimes separate files are “punched”, one for pattern hooks and another for controls - often used with Staubli JC4 controllers. In this case we simply have 2 separate castouts, one for punching the pattern file and a second for punching the controls. The latter castout would consist only of the above rule for copying our painted in controls on Ends 2401... into Hooks 1... of the control file.

In most cases I recommend this “painted in” approach. It has the great merit of making ***everything*** visible - both the pattern (weaves) and the weft selection and other controls - in a single easy to understand and to check format. There is no need to worry if the box motion (weft sequence) is aligned correctly, or if the other controls are active where they should be - it is all there in plain sight.

And it is quite easy to use. A single repeat of box motions, such as shown above, can be painted with the Pencil, then selected and loaded as a Brush to fill in the entire height. JacqCAD’s *Lookup in Notebook* can be used to enter hard to remember hook patterns, e.g., for setting weft densities, etc.

One limitation is that JacqCAD is not smart enough to separate the actual design from the area being used for controls - and this interferes with Repeat View and Window of Repeats by including both areas in the repeats. Consequently it is best to first complete the editing of the design by itself, using Repeat View or Window of Repeats as needed to correct the seams, before adding the extra Ends into which you will paint the weft selector and controls.

However, there are some types of design in which simply painting the weft selection and controls into added Ends is not the best solution.

These arise most often when Complex Expansion or Color-Strip Expansion is used to create a complex fabric.

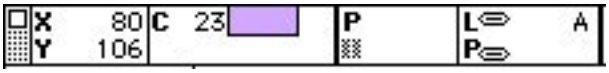
In such designs each Pick in the original (condensed) design expands into a variable number of actual weft insertions depending on the colors seen in the Design (Complex Expansion) or in its associated expansion color strip (Color Strip Expansion).

Some of the weft insertions occur in every expanded Pick ("Always Active") while others may occur only in some expanded Picks ("Conditional"). The latter 'tissue picks' are often 'Regulated' in order to prevent fabric advance since they purely decorative rather than being an integral part of the fabric's structure. In addition, the weft selection is usually determined by the expansion rules.

In other situations assigning box motions (weft sequences) via JacqCAD's *Weave»Assign Boxes & Regulators* is more efficient than painting in long and complex sequences.

Either situation makes use of JacqCAD's expanded Pick / Logical Shuttle / Box assignment information, shown in JacqCAD's Results Window.

A *condensed* (unexpanded) design displays only the cursor's X,Y (End, Pick) position plus the color.



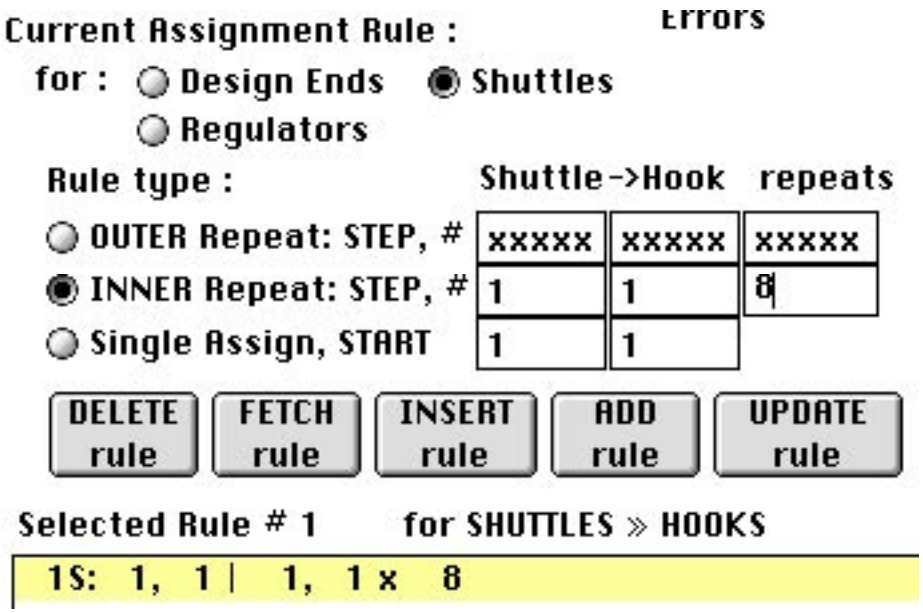
An *expanded* design in addition displays the Pick (#141), Card (#178), Logical Shuttle (#3), Physical Shuttle, Box, or Weft Selector (#5) and Regulator (F) settings.

The Pick, Card and Logical Shuttle values are established solely by the Expansion process. The Physical Shuttle (Box/Weft Selector) and Regulator values, initially set during Expansion, can be modified in various ways using the tools provided via *Weave»Assign Boxes & Regulators*.

When being used, Box / Weft Selector and Regulator values need to be included in the 'punched' loom control file; which means they must be specified in the Castout via Shuttle and Regulator rules.

Shuttle Rules are used to connect a physical shuttle value (range of 1..16) to the appropriate hooks.
Regulator Rules are used to connect the regulators (#1 and #2) to their hooks.

The format of these rules is the same as for Design End rules, the only difference being in the flavor of the rule as indicated by the leading "n**E**:" for Design End, "n**S**:" for Shuttle or "n**R**:" for Regulator rules, where "n" is simply the sequential rule number.



For example, the Shuttle Rule shown above connects Physical Shuttle / Box/ Weft 1...8 to Hooks 1..8 in the punched file.

While this Regulator Rule would connect Regulators 1 and 2 to Hook 9 (i.e., if either or both Regulators were enabled they would lift Hook #9):

2R: 1, 9 | 1, 0 x 2

Having explored how the rules are defined and what they do, we now turn to a brief review of the rest of the *Make Castout File* dialog.

First stop is the dialog's upper left corner where you set up some dimensions:

Design Ends:	2416
Machine Hooks:	2688
Shuttles:	8

Design Ends: here you specify the width of the expanded design from which you will be punching. In the example at the right I have specified 2416 which would be appropriate for a 2400 End wide design which also included 16 extra Ends which I might be using for painted-in weft selectors & other controls. Any rules you enter will be checked to make sure they don't ask for a Design End higher than what you enter. Also, if you try to punch from a design that is a different width, you will get an error warning. Just set it to match your design's width.

Machine Hooks: this is the "width" of the loom control file to be created. It ***must*** match the loom's requirements. For example, Bonas .EP files always begin with 32 "Electronic Function" hooks followed by the normal pattern hooks - so for a 2688-hook Bonas Jacquard the Machine Hooks (file width) must be **32 +** 2688 = 2720. A Staubli JC5 file often includes electronic functions, either as the first or last 32 hooks depending on how it has been set up, but sometimes does not. In short, check with the loom's operators. The most reliable approach is to get a loom file that is known to weave on that loom and use JacqCAD's *Weave » Card Image From...* to inspect it.

Shuttles: this is only relevant if you are using Shuttle Rules, in which case your Shuttle Rules will be checked to make sure they don't ask for a higher-numbered shuttle than what you have entered here. Maximum value is 16, and you can ignore this entry if you are not using Shuttle Rules.

Next stop, the Rule Editing area and Rule List.

Clicking on a rule in the Rule List selects and highlights it in yellow. Double-clicking on a rule, or selecting it and then clicking on the Fetch Rule button, loads it into the Editing area above where you can make changes (as shown with rule 2E)

After changes have been made you can click on:

UPDATE rule to copy those changes into the currently selected rule

INSERT rule to create a new rule containing the edited values in front of (above) the currently selected rule

Current Assignment Rule : Errors 0

for : ◉ Design Ends ○ Shuttles ○ Regulators

Rule type :	Ds End	->Hook	repeats
○ OUTER Repeat: STEP, #	xxxxx	xxxxx	xxxxx
◉ INNER Repeat: STEP, #	1	1	2400
○ Single Assign, START	1	129	

DELETE rule | FETCH rule | INSERT rule | ADD rule | UPDATE rule

Selected Rule # 2 for DESIGN ENDS » HOOKS

```
1S:  1,  1 |  1,  1 x  8
2E:  1, 129 |  1,  1 x 2400
```

ADD rule to append a new rule containing the edited values to the end of the list

Note that the changes you make in the Edit Rule area have no effect until you use INSERT, ADD or UPDATE to copy those changes into the rules in the List area.

DELETE rule simply deletes the currently selected rule.

The Rule kinds (Ends, Shuttles or Regulators) and Types have already been discussed in detail.

When you enter the dialog there are some default rules - mostly as a reminder. Simply replace these with your own rules.

You must use ***CALCULATE ALL RULES & DISPLAY RESULTS*** before using SAVE (or LIST or PRINT) - it is what actually uses your rules to create a castout and updates the display of the hook assignments which result.

CALCULATE ALL RULES & DISPLAY RESULTS =====>

Calc & Disp Selected Rule Only only calculates and displays the currently selected rule; it is very useful for verifying that a rule does what you wanted and for trouble-shooting.

Calc & Disp Selected Rule Only

For example, if we had selected this rule: **1S: 1, 1 | 1, 1 x 8**

then ***Calc & Disp Selected Rule Only*** would display the results of only that single rule - which, as expected, assigns Shuttles 1..8 to Hooks 1..8 as shown by the list to the right.

```
S 1: 1
S 2: 2
S 3: 3
S 4: 4
S 5: 5
S 6: 6
S 7: 7
S 8: 8
```

Reviewing the results of each rule one-by-one is the most effective way of tracking down mistakes in your rules.

Each time you use either Calculate button the assignments displays are updated (either for the selected rule or for all rules depending which button you clicked). These have 2 parts, a summary section near the dialog's top center (shown at right) and a detailed section along the right edge.

Hooks assigned :	#	First	Last
Pattern Hooks	2400	129	2528
Shuttles	8	1	8
Regulators	1	9	9
Errors	0		

"Errors" would include out of bounds (higher than maximum or lower than 1) Ends or Hooks, and End being used multiple times, etc. However, multiple assignments to the same hook are not considered an error since they are sometimes intentional - for example when assigning either Regulator to lift the same hook so you don't have to remember which is which...

The detailled listing along the right edge can be sorted in several ways:

DISPLAY mode:
- (●) End»Hook(s)
- ( ) Hook«End
- ( ) Shuttles/Regs»Hook(s)
- ( ) UNASSIGNED Ends || Hooks

End»Hook(s) sorts the assignments by End #, showing only the Ends or controls which have been assigned to hooks

Hook«End sorts instead by Hook #, useful when you want to find out which End or control is being assigned to a particular hook. A "**+**" indicates that several Ends are connecting to the same hook, of which only the first is listed.

Shuttles/Regs»Hooks(s) limits the listing to Shuttles and Regulators

UNASSIGNED Ends || Hooks lists only the Ends (first column) and Hooks (2nd column) which have NOT been used in assignments. Used to double check that nothing important has been forgotten...

Here are examples of the 4 different sortings:

Note in the Hook«End listing that 9:R 2+ indicates the multiple assignements to Hook 9 via **+**.

The Unassigned listing shows that Ends 2401-2416 were not used, and Hooks 10..28 (...) were not assigned to.

End»Hook	Hook«End	Shuttles/Regs	UNASSIGNED End || Hook
1:129	1:S 1	S 1: 1	2401 || 10
2:130	2:S 2	S 2: 2	2402 || 11
3:131	3:S 3	S 3: 3	2403 || 12
4:132	4:S 4	S 4: 4	2404 || 13
5:133	5:S 5	S 5: 5	2405 || 14
6:134	6:S 6	S 6: 6	2406 || 15
7:135	7:S 7	S 7: 7	2407 || 16
8:136	8:S 8	S 8: 8	2408 || 17
9:137	9:R 2+	R 1: 9	2409 || 18
10:138	129: 1	R 2: 9	2410 || 19
11:139	130: 2		2411 || 20
12:140	131: 3		2412 || 21
13:141	132: 4		2413 || 22
14:142	133: 5		2414 || 23
15:143	134: 6		2415 || 24
16:144	135: 7		2416 || 25
17:145	136: 8		|| 26
18:146	137: 9		|| 27
19:147	138: 10		|| 28

SAVE creates the castout (.Hook) file needed for punching. **LIST** and **PRINT** provide documentation of the castout. **LIST** will optionally provide a "comber board" layout which is useful for comparing with the actual harness.

LOAD let one load in an existing castout file.

SAVE DEFAULTS provides comedy relief, sometimes needed by Castout creators...