Unserialed Replacement Sheet Notes

by Joe Farrenkopf

You're likely familiar with star replacement notes such as the 2013 $10 Federal Reserve Note pictured below.

But did you know that there is a second type of replacement note?

Printing and handling imperfections can occur throughout all stages of Federal Reserve Note production. When such imperfections are found during the offset printing and plate printing stages, imperfect sheets are simply discarded without replacement. But when imperfections are found during the serialing stage, those sheets are replaced to maintain an accurate count of sheets, which are gathered into piles of 100 at the end of the serialing process (Bureau of Engraving and Printing n.d.).

After the serial numbers, Federal Reserve seal, the Department of the Treasury seal, and the Federal Reserve identification numbers have been overprinted on a sheet, the sheet is computer-inspected for defects. A sheet flagged as defective is pulled for examination by a Bureau of Engraving and Printing worker. If the sheet is confirmed to be defective, that sheet will be replaced by another sheet from a supply of previously serialed star sheets. Star sheets are identical to regular production sheets except that the star serial number sequence is unrelated to the serial number sequence of the regular notes, and more notably, the serial number suffix character is a star rather than a letter.

Occasionally a sheet is damaged just prior to being loaded into the serialing press, or a sheet could misfeed while going into the press. And sometimes sheets with small defects are discovered immediately prior to serial overprinting. In such circumstances, the sheet may need to be replaced. The replacement sheet is not taken from the supply of star sheets, however, since the serial numbers hadn't yet been applied to the damaged sheet that was removed. Rather, the replacement sheet comes from a supply of previously face- and back- printed but *unserialed* sheets. Notes that come from that supply of sheets are the second type of replacement note. When the replacement sheet passes through the serialing press, it is overprinted with the next set of regular serial numbers for the press run.

At the start of a new series, a small supply of unserialed sheets is set aside for such replacement purposes. As production of the series continues and that supply is used up, a new small supply of unserialed sheets is set aside for replacement purposes. This practice continues throughout the life of the series. Like sheet-replacement star sheets, these unserialed replacement sheets can be inserted at any point during a press run as needed[1]. Yet unlike star sheets, which are identified by the star suffix in the serial number, these unserialed replacement sheets are indistinguishable from all other sheets because they have no special markings of any kind, and their serial numbers are in sequence with the press run. The only way to know if a note came from an unserialed replacement sheet is by examining serial and plate data from other notes in the series. It is sometimes possible to identify an unserialed replacement sheet note by its plate serial numbers.

In determining whether a note may have come from an unserialed replacement sheet, three factors need to be evaluated: (1) the atypicality of the note's plate numbers in the press run; (2) the plate number chronology of the series; and (3) the presence of the plate numbers outside of the press runs where those plate sequences are typically found.

[1]Unserialed replacement sheet notes are often found disproportionately in the lowest sheet numbers of a press run because normally within the last 10,000 sheets of the run, all of the accumulated bad sheets from the run are exchanged for good sheets. Further, after the initial exchange, any additional bad sheets generated are exchanged at the end of the press run in order to complete the run, usually a small amount in the last 100 sheets or so.

Plate Number Atypicality

As an example, consider the three notes pictured below. All are Series 2013 $10 Federal Reserve Notes from the MG-B block, press run 7, whose serial range spans 38400001 through 44800000.

Data recorded from other notes in press run 7 shows that about 85% of the run is composed of face plate/back plate sequence 88-89-90-91/45-46-47-48 while the remaining 15% of the run is composed of face plate/back plate sequence 99-100-101-102/53-54-55-57. The face plates of the second and third notes pictured above (101 on MG39400001B and 90 on MG39604459B) belong to one or the other of those two sequences. But the face plate of the first note pictured above (70 on MG39205952B) oddly does not belong to either of those two sequences. Indeed, face plate 70 belongs instead to face plate sequence 70-71-72-74; the back-plate number of the note is 43, which belongs to back plate sequence 40-42-43-44.

The atypical plates of the first note pictured raise the possibility that the note came from an unserialed replacement sheet.

Plate Number Chronology

Next, the production chronology of the series needs to be examined. That's because prior to the serialing stage, sheets that do not meet quality standards (e.g., those with ink spots or smears, ink deficiencies, etc.) and sheets that are damaged during the face and back printing stages are removed, but are not replaced. The remaining good sheets are collated into batches of 20,000 half-sheets for serial overprinting. Because a varying number of sheets is removed at each step of the manufacturing process, including offline inspection, the resulting new batch of 20,000 half-sheets could be made up of sheets from two or more consecutive input loads. This is seen in run 7 of the MG-B block, which comprises more than one set of face and back plate sequences in the last load of the run. But in the absence of a sufficient amount of data, one cannot know if the MG-B note with face plate 70 merely reflects the combining of a third input load. Hence, it is necessary to look at the chronology of the series.

Face plate/back plate sequences 88-89-90-91/45-46-47-48 and 99-100-101-102/53-54-55-57 appear primarily in press runs that were serialed June 2016 through October 2016 plus February 2017 (a brief hiatus of $10 production occurred in late 2016/early 2017). Had face plate/back plate sequence 70-71-72-74/40-42-43-44 been contemporaneous with those other two sequences, notes with face plates 70, 71, 72 and 74, and with back plates 40, 42, 43 and 44 would also appear in press runs serialed around the June 2016 to February 2017 time frame. Yet data from observed notes show that face plate/back plate sequence 70-71-72-74/40-42-43-44 appears primarily in press runs that were serialed much earlier – in October and November 2015. The note pictured below, serial MF68493485C, with face plate 70, is such an example; it belongs to the MF-C block, run 11, serialed in October 2015.

Thus, face plate/back plate sequence 70-71-72-74/40-42-43-44 was not contemporaneous with 88-89-90-91/45-46-47-48 and 99-100-101-102/53-54-55-57. It is worth noting that the vast majority of notes with face plate 70, like the note from the MF-C block, run 11, did not come from an unserialed replacement sheet. So, the appearance of a note with face plate 70 in a press run serialed many months later than most notes with face plate 70 is another indicator that the MG-B note with face plate 70 could have come from an unserialed replacement sheet.

Presence of Plate Sequences Outside their Typical Press Runs

The Bureau of Engraving and Printing is essentially a manufacturing facility that mass produces a product (currency) and sells that product to its customers (the Federal Reserve Banks). As a general rule, the BEP manages its inventory using the first-in, first-out method, meaning that sheets usually travel from the back-printing stage to the face printing stage to the serialing and finishing stages in relatively quick succession; that is, while rare exceptions exist, sheets are not typically stored in quantity for any length of time between production stages. Storage may occur following occasional production stoppages, but upon resumed production, the stored sheets are usually serialed and finished first followed by the new production.

Because of using the first-in, first-out method, when worn plates are removed from a press and are replaced by new plates, the transition between old and new plate sequences in the data tends to be fairly abrupt. That is, once sheets from the old sequence are used up, the old plate sequence usually disappears completely from the data in a short time frame. For example, in Series 2013 $10 FRNs, face plate sequence 26-27-29-31 first appears in the MA-A block, run 6, serialed in October 2014. After those plates were worn, they were replaced by plates 32, 33, 34 and 35. Face plate sequence 32-33-34-35 first appears in the MD-A block, run 12, serialed in February 2015. The MD-A block, run 12, is also where the last notes with face plate sequence 26-27-29-31 show up. In this instance, the transition between face plate sequences 26-27-29-31 and 32-33-34-35 occurred within a single press run.

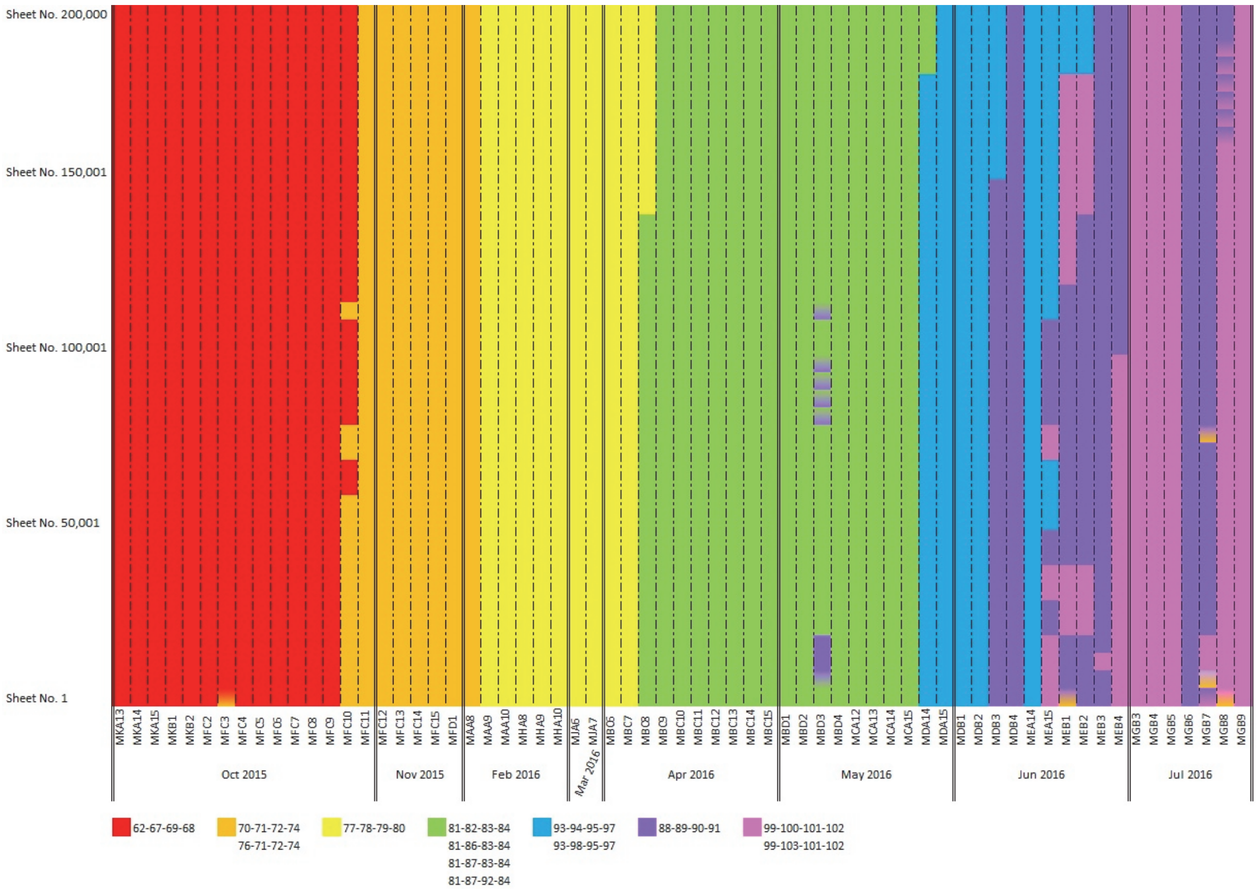
For a larger example, consider one segment of Series 2013 $10 FRN production in which sixty-five press runs were serialed from October 2015 through July 2016:

Oct 2015	MFC block,	runs 2 through 11	(serials 06400001 to 70400000)
	MKA block,	runs 13 through 15	(serials 76800001 to 96000000)
	MKB block,	runs 1 through 2	(serials 00000001 to 12800000)
Nov 2015	MFC block,	runs 12 through 15	(serials 70400001 to 96000000)
	MFD block,	run 1	(serials 00000001 to 06400000)
Feb 2016	MAA block,	runs 8 through 10	(serials 44800001 to 64000000)
	MHA block,	runs 8 through 10	(serials 44800001 to 64000000)
Mar 2016	MJA block,	runs 6 through 7	(serials 32000001 to 44800000)
Apr 2016	MBC block,	runs 6 through 15	(serials 32000001 to 96000000)
May 2016	MBD block,	runs 1 through 4	(serials 00000001 to 25600000)
	MCA block,	runs 12 through 15	(serials 70400001 to 96000000)
	MDA block,	runs 14 through 15	(serials 83200001 to 96000000)
Jun 2016	MDB block,	runs 1 through 4	(serials 00000001 to 25600000)
	MEA block,	runs 14 through 15	(serials 83200001 to 96000000)
	MEB block,	runs 1 through 4	(serials 00000001 to 25600000)
Jul 2016	MGB block,	runs 3 through 9	(serials 12800001 to 57600000)

Figure 1 illustrates this segment of production, with different colors representing different face plate sequences (or combination of sequences on occasions when a single plate had to be replaced):

Color	Face Plate Sequence
Red	62-67-69-68
Orange	70-71-72-74, then 76-71-72-74
Yellow	77-78-79-80
Green	81-82-83-84, then 81-86-83-84, then 81-87-83-84, then 81-87-92-84
Blue	93-94-95-97, then 93-98-95-97
Purple	88-89-90-91
Pink	99-100-101-102, then 99-103-101-102

Figure 1. Serial and plate data recorded from a random sampling of 2,602 Series 2013 $10 notes serialed from October 2015 through July 2016 reveals the evolution of face plate sequences during that time frame.



The areas on the graph in red, for example, identify the press runs where face plate sequence 62-67-69-68 is found. That means notes from those press runs will have either face plate serial 62 or 67 or 68 or 69. For example, the note pictured below, serial MF28920407C, with face plate 62, belongs to the MF-C block, run 5, which falls in the red region of the graph.

Two or more colors within a single press run means that more than one face plate sequence is found in that press run.

Notice in Fig. 1 how the horizontal transition between colors is generally sharp; there isn't much overlap between colors, and once a color ends, it doesn't usually show up elsewhere. The two exceptions in the figure are the orange sequence 70-71-72-74 (and 76-71-72-74) and the purple sequence 99-100-101-102 (and 99-103-101-102).

Let's start with the purple sequence, which needs some explanation. At times during FRN production, only one pair of face and back presses will be in operation. When that is the case, the plate sequences in the data will be largely self-contained. That is, a single plate sequence will be found in many consecutive press runs with little overlap on either the beginning or the end of the sequence's appearance. This phenomenon is seen in Fig. 1 at the juncture of the red/orange regions, the orange/yellow, yellow/green, and green/blue regions. A single pair of face and back presses was in operation for several months, and the evolution of face plate changes on the face press was as follows:

• 62-67-69-68 replaced by 70-71-72-74
• 70 replaced by 76, resulting in sequence 76-71-72-74
• 76-71-72-74 replaced by 77-78-79-80
• 77-78-79-80 replaced by 81-82-83-84
• 82 replaced briefly by 85, which was quickly replaced by 86, resulting in sequence 81-86-83-84
• 86 replaced by 87, resulting in sequence 81-87-83-84
• 83 replaced by 92, resulting in sequence 81-87-92-84
• 81-87-92-84 replaced by 93-94-95-97
• 94 replaced by 98, resulting in sequence 93-98-95-97

These transitions occurred on the same face press, which is the reason Fig. 1 shows abrupt changes between color regions.

But sometimes two (or more) pairs of face and back presses will be in operation simultaneously. When that is the case, two sets of plate sequences will appear in the data, usually intermingled. This phenomenon is seen in Fig. 1 in the purple regions. About mid-way through production of the green sequences, a second pair of face and back presses was put into operation producing $10 FRNs while the first pair of presses continued to produce $10 FRNs. The second pair was loaded with face plates 88, 89, 90 and 91 (reflected in Fig. 1 by the purple regions), and the second press remained in operation partway through the pink sequences. It is not the case that the blue and pink regions of Fig. 1 (and to a lesser degree the green region) reflect ceased production of those sequences where the purple regions appear. Rather, the purple regions reflect concurrent production with the blue and pink regions as a result of two pairs of presses being in operation simultaneously. Indeed, notice how there is little overlap between the pink and blue regions. That's because those sequences were on the same press; that is, 93-98-95-97 (blue) was replaced by 99-100-101-102 (pink). But the purple regions are overlaid on top of both the blue and pink regions in an intermixed fashion because 88-89-90-91 was on a different face press.

Now look at the orange sequence, which mostly spans 7+ adjacent press runs (MFC10 through MAA8). Notice that an instance of orange also precedes that grouping by several press runs (MFC3), plus a few scatterings of orange show up many months and many press runs later (in MEB1, MGB7, and MGB8). This is an important point in the context of unserialed replacement sheet notes, because it isn't the case that just any sequence will turn up scattered throughout the data like the orange sequence does in this example. Only sequences from the supply or supplies of unserialed sheets set that were aside for replacement purposes will turn up scattered elsewhere in the data. Further, while the orange sequences have turned up as late as the pink/purple sequences, it is expected that a large enough sample of notes would reveal the orange sequences to be present within the yellow, green and blue sequences as well. The presence of the orange sequence 70-71-72-74 in multiple places elsewhere in the series is the third indicator that the MG-B note with face plate 70 came from an unserialed replacement sheet.

In summary, unserialed replacement sheet notes can sometimes be identified by their plate serial numbers because:

a) the note's face/back plate numbers may be atypical of the plate numbers of other notes from the same press run; and

b) the face/back plate numbers of the note appear in a press run that was serialed much later than most notes that bear those same face/back plates; and

c) the sequences to which the face/back plate numbers belong are found scattered throughout many press runs outside of the press runs where the sequences are otherwise typically found.

Other Unserialed Replacement Sheet Sequences

In Series 2013 $10 FRNs, four face plate/back plate sequences have been identified as having been used for unserialed replacement sheets:

<u>Face Plate Sequence / Back Plate Sequence</u>
1-2-3-4 / 1-2-3-4
22-23-24-25 / 19-20-21-22
70-71-72-74 / 40-42-43-44
106-111-108-109 / 59-61-62-63

In the prior Series 2009 $10 FRNs, three face plate/back plate sequences have been identified as having been used for unserialed replacement sheets:

<u>Face Plate Sequence / Back Plate Sequence</u>
1-2-3-4 / 1-2-3-4
42-43-45-46 / 34-35-37-38
64-61-57-60 / 46-55-56-57

Unserialed replacement sheet notes are found in other denominations as well. For example, three Series 2013 $5 FRNs are pictured below. The first note (MJ92800479A, face plate 85) is from an unserialed replacement sheet; the second note (MJ92804329A, face plate 131) is from the same run as the first note but is not from an unserialed replacement sheet; and the third note (ML14726430E, face plate 85) has the same face plate number as the first note but is not from an unserialed replacement sheet.

The three criteria for determining whether a note comes from an unserialed replacement sheet bear this out: a) the early portion of the ML-E block (much of run 1 plus runs 2 through 4) is composed of face plate sequence 85-90-92, so the note ML14726430E with face plate 85 is consistent with other notes in run 3; by contrast, the last portion of the MJ-A block (runs 12 through 15) plus the beginning of the MJ-B block (run 1) is composed of face plate sequence 124-130-131, so the note MJ92800479A with face plate 85 is atypical of other notes in the same run; b) notes from the early portion of the ML-E block were serialed in February and March 2015 while notes from the last portion of the MJ-A block and the beginning of the MJ-B block weren't serialed until June 2016; and c) face plate sequence 85-90-92 is found regularly in notes serialed between February 2015 and June 2015, but multiple individual instances of notes from that sequence have turned up much later (November 2015, June 2016).

Relative Scarcity

The quantity of sheets that the BEP sets aside for the unserialed replacement sheet supply isn't precisely known, but it is possible to estimate that quantity and ascertain whether that quantity is variable in the same way that it is with replacement star runs. A starting assumption would be that the supply amounts to a typical half-load (10,000 sheets) or whole load (20,000 sheets), which is the common quantity for many sheet-replacement star runs. Sequences identified in Series 2013 $10 FRNs and in other series show that the supply of unserialed replacement sheets was replenished either after approximately 60 to 70 press runs or after approximately 110 to 120 press runs. During the period April 1992 through February 2013, one partial (20,000-sheet) sheet-replacement star run was produced at the Western Currency Facility in Fort Worth for every 61.1 press runs of regular $1 FRNs (Farrenkopf 2017, 225). If that figure is comparable for $10 FRNs, that suggests that unserialed replacement sheet batches are set aside in quantities of one load (20,000 sheets) or two loads (40,000 sheets) at a time. In comparing the scarcity of unserialed replacement sheet notes found in circulation with the scarcity of star replacement notes found in circulation, those figures seem consistent; that is, unserialed replacement sheet notes aren't common, but they do seem to turn up slightly more often than the typical sheet-replacement star note.

So, if you've never paid much attention to the plate numbers on the notes in your collection or the notes you receive in change, take a look sometime and consider that your note might just have come from an unserialed replacement sheet!

Sources

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