Image Quality:

The Quiet Problem That Costs Millions

Fewer Exceptions Could Save Banks a Bundle

In the decade since the Check 21 Act took effect in the United States, image-based processing has emerged as the global standard for check clearing settlement. And while the operational benefits to financial institutions have been proven beyond a doubt, the digital clearing process has created new challenges of its own. Captured images must be consistently precise, high-quality, and most importantly, able to pass inspection without the original document available.

The great majority of scanned items pass through the system smoothly. However, the bulk of clearing expenses arise from 'exceptions' – those images that need manual intervention.

The following document is intended to help define the scope of image-quality issues and related exceptions that occur in the settlement process, as well as to identify major pain points.

The second section of this paper, *Reducing Exceptions Through Better Image Quality*, explores solutions and best practices for reducing the number of exception items that occur in check settlement, with the goal of eliminating a significant part of their operational expense.

What Causes an Exception?

At a typical financial institution today, about four out of every five checks and money orders are in good enough shape to make it through the scanning and clearing process without any human intervention. Most of the remaining 20 percent require a small manual correction – usually a few seconds of re-keying because of poor handwriting or other image-quality issues.

A very small proportion of problematic documents – amounting to a fraction of one percent – cause "critical errors" that rack up fees and second-day research and adjustment costs. These extraordinarily expensive mistakes can cost the bank, conservatively, $15-$25 per item.

Let's take a look at a few common processing and settlement problems, and how they occur:

Group #1: "Two-Cent Errors"

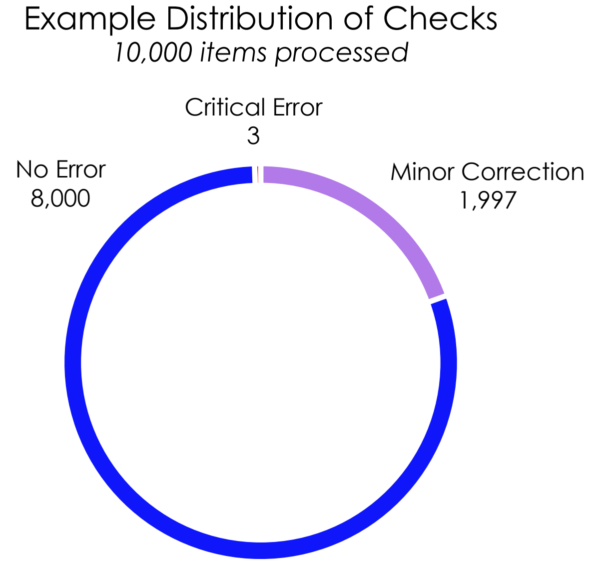
If a check clears without any manual intervention, it typically costs the bank between one-tenth of a cent and half a cent, depending on how many items a day it processes and how efficient its operations. If a simple correction is needed, the cost rises to between 1 and 10 cents, for the few seconds of time it takes an operator to re-key the relevant information.

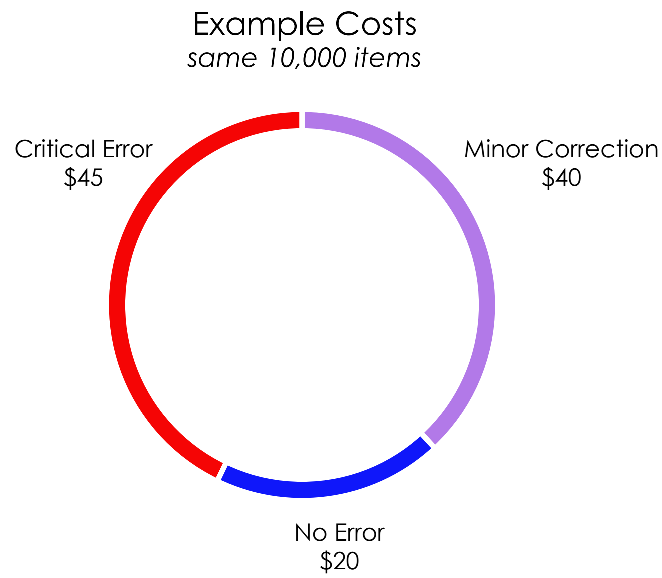
There are several different sub-types of errors that can cause a manual re-keying (see chart at end), but on average they tend to take about five seconds to correct, at a cost of about two cents. That may not sound like much – but with 18 billion checks processed annually in the U.S., correcting 20 percent of them for small errors consumes almost 5 million employee hours and over $70 million every year.

The practical implication for the bank is that, even though two cents is still a low cost per item, it represents up to a 20-fold increase over the cost of automated processing. The more severe errors, as we will see shortly, can cost thousands of times more still. *In other words, this minority of checks makes up the majority of all processing, clearing and settlement costs.*

It should be noted that, with minor errors, the "operator" who fixes the problem may vary from bank to bank. At a smaller institution, such corrections are almost invariably done at the teller window or at a branch back counter; larger banks may have operations centers or even entire departments dedicated to processing and clearing. This subtle but important difference in process has an impact on certain types of errors and their costs, as we will see later.

Another important consideration is that while these re-keying errors represent a vast cost increase over full automation, the converse is that automated image processing has itself reduced the cost of check clearing by 20 times over the past decade. Even with these errors, the system is more efficient than before, but removing the avoidable errors is what will help it reach its full potential.





Group #2: "Critical Errors"

The other major cost center in processing and clearing is derived from a very small percentage of checks and money orders – between 0.1% and 0.01% of the total, depending on the procedures being used by the bank. Typically, these "critical errors" involve items that make it through initial processing with only a minor correction or no correction at all, then cause problems later in the clearing cycle.

While only a tiny fraction of total items scanned, critical errors require extensive second-day research and adjustments, and can cost nearly $30 to correct. Some examples include:

- Manually corrected items that are rejected because they are still illegible to the recipient (Federal Reserve or On-Us bank)
- MICR line errors that produce incorrect account numbers
- Double-feeds resulting in missing items and incorrect balances
- Any error requiring the original paper document to be physically sent (to an internal operations center, or submitted for clearing via Paper Cash Letter)

Among banks surveyed*, the lowest estimate given for critical errors' cost was $15-$25 each, with a high of $29. What makes them so expensive? In addition to employee research time, major factors included: shipping and transit, customer communications, return item fees, low-value checks that were simply written off, and - if an item was cleared through the Federal Reserve - Paper Cash Letter fees of $10 per batch and $2 per item.

Why Size Matters: Efficiencies of Scale

The occurrence of minor errors remained fairly steady across all of the financial institutions studied; however, a notable trend was that, the smaller the bank, the more often critical exceptions tended to occur, and the more they cost per item. At a large bank, perhaps 1 in 10,000 checks and money orders might fall into this category, while smaller institutions would experience rates up to several times higher. The explanation for that discrepancy lies in the different procedures and safeguards that are employed.

Who Is the Operator?

A key difference between larger and smaller banks was the specialization within the operations process. At a local bank, the operator responsible for the initial processing and correction of checks is almost universally a teller, or perhaps a branch manager, either of whom has only basic training in image quality issues and clearing practices.

Among other things, this is the origin of many exceptions in which a corrected check passes the "eye test" when the

Exception Items: Example Costs

The following tables illustrate the projected costs of exception handling in various sized financial institutions. Examples use costs of $0.02 per minor correction and $15 per critical error.

Note the decreasing occurrence of critical errors in larger institutions, as advanced techniques catch and correct more items early in the processing path.

Single Branch

Correction	#/day	Cost/day	Cost/year
None	1,599	$1.60	$400
Minor	400	$8	$2,000
Critical	1	$15	$3,750
All	2,000	$24.60	$6,150

Regional Bank

Correction	#/day	Cost/day	Cost/year
None	160K	$160	$40,000
Minor	40K	$640	$160K
Critical	40	$600	$150K
All	~200K	$1,400	$350,000

Large Bank

Correction	#/day	Cost/day	Cost/year
None	1.6M	$1600	$400K
Minor	400K	$6,000	$1.5M
Critical	120	$1800	$450K
All	~2M	$9,400	$2.35M

original document is present, but is rejected by the recipient without the paper copy as a reference. At a larger institution, many of these (and other) potentially critical errors are caught by highly-trained specialists at an operations center before the image enters the clearing queue.

While such an arrangement cuts down on the percentage of critical errors – some banks are able to catch the majority of them before they reach clearing – it is simply not feasible for small institutions to dedicate staff to addressing the problem preemptively. In fact, many smaller banks outsource this part of their processing through their systems providers and see exceptions only as a line item in a larger bill, thereby remaining largely unaware of their true cost.

Transit Costs

A common arrangement among banks using teller capture is that when an item is returned in the clearing process, causing a critical error, the original paper document has to be sent to an operations center for second-level repair. This can raise the cost of handling an exception item dramatically; in one example case, a mid-size bank with two operations centers was spending $1,500 per business day, or up to $375,000 per year, on exception handling, much of it on couriers and express shipping. Among banks using operations centers this way, physical transportation tended to be near the top of the list of exception handling expenses.

The above is an example of the intricate balance between precision, cost, capital outlay, and process in successful management of exception items, which we will explore further in the next section.

Adding Up the Costs

We've gotten a general sense of how image-related problems can create expenses – but what does that mean to a typical bank's bottom line? Well, there's no such thing as a "typical" bank, but we've created a few example cases in the charts on the previous page.

What we hope you've noticed is not only the change in composition by size of the financial institution, but the overwhelming proportion of the expense that is incurred by a small minority of items. A major failure might occur only once per 5,000 or 10,000 items scanned – but at 15,000 to 30,000 times the cost of regular processing, they would account for the majority of clearing expenses.

Put in a different perspective, 18.3 billion checks are written annually, according to the 2013 Federal Reserve Payments Study. At a cost of $0.02 per item for manual keying, every 1 percent of checks that do not read correctly the first time represents $3.7 million in extra processing costs – and most banks reported that 15-20 percent of checks or more required this treatment. Assuming even the most conservative $15 apiece (based on our respondents' estimated costs) for the more difficult items, each one-tenth of 1 percent costs $275 million or more. Use a cost estimate in the middle of the range given by the banks we interviewed, and the price tag for each tenth of a percent quickly approaches half a billion dollars. Perhaps more unfortunately, since clearing is not a revenue-generating activity, banks must simply absorb these costs with little to show in return.

How much is the actual cost of image quality problems to the banking industry? It's impossible to say exactly because of the variations from bank to bank – but the cost within the United States alone could easily top $300 million. Add in the rest of the world, and the amount roughly doubles. It's not a billion dollars, but it's probably the quietest $600 million problem in banking.

A more important question for bankers to ask, though, is: What share of that $600 million is mine?

*To gather this data, Digital Check conducted interviews with various financial institutions and service providers in 2013-14. The results, while not scientific, are assumed to be representative of a typical sampling of banks and credit unions across the United States.

The Three Major Classes of Clearing Issues

In the image-based check clearing process, there are small nuisances and there are expensive mistakes. The great majority of both stem from three basic types of issues: image quality problems, MICR read problems, and mechanical problems with scanning the paper document . Those categories can be further subdivided into about 10 specific problems that account for most clearing expenses at a typical financial institution.

Error Type	Minor Correction	Critical Error
Image Quality	Poor Handwriting Faint Printing / Gel Pen CAR/LAR Mismatch Difficult Background Can't-Read	Manually Corrected Item is Rejected by Recipient
MICR	Can't-Read MICR Error MICR/OCR Mismatch	Transposed Digit
Mechanical	Streaks Obscure Printing (scanner needs cleaning)	Double-Feed ("Piggyback")

Generally speaking, the issues in the left-hand column are errors that take place at the point of transaction, and are immediately corrected by the operator with a few seconds of manual keying. These are the "Two-Cent Errors" that constitute a moderate but significant fraction of processing costs. The issues in the right-hand column – the "Critical Errors" – occur when a problem document actually makes it further down the clearing workflow. These errors, while comparatively rare, are the ones that require research, incur fees, and necessitate re-examining the original document – racking up major expenses all along the way.

Preventing a Small Problem From Becoming a Big Problem

Even though the critical errors account for the lion's share of processing costs, it's important to understand how a two-cent error can turn into one. Consider the following story, which will be familiar to many a bank operations manager:

> *A customer comes to the branch and drops off a check, which is scanned at the teller window. The dollar amount doesn't register, but the teller can easily read it on the original document – so he manually enters the correct amount, approves the deposit, and sends the customer on his way.*
>
> *Later, when an image of the same check is presented for clearing, the dollar amount still can't be detected automatically by the receiving bank. An operator is called to verify the correct amount, but – lacking the original document – she can't read it either. The item is rejected, incurring a fee, and the submitting bank must re-submit the image, or find the original paper document and re-scan it.*

This scenario plays out tens of thousands of times every day in branches and operations rooms around the country, whether the culprit is a bright background, a dirty scanner lens, or a gel pen whose ink isn't read well by machine.

Earlier, we mentioned that a teller capture environment and a branch capture environment would result in slightly different outcomes in handling the two-cent errors resulting from re-keying, and this is where we start to see those differences take effect. When tellers are scanning checks at the window, MICR and handwriting errors tend to be corrected right away by manual inspection of the physical document. This is fast and effective, but somewhat raises the chance that it will be rejected if there was something that was obvious on the paper check but not on the image.

When an operations center is involved, operators have only the image to go by when visually correcting mistakes, so the risk of this type of error is greatly reduced. However, without the original document handy, more time may have to be spent making manual requests for a re-scan, or transportation costs may come into play if the paper document does need to be pulled for processing. It's a bit of a "pick your poison" dilemma; however, as we will see in the second section, *Reducing Exceptions Through Better Image Quality,* the success rate of either method can be improved by applying the right technolgy.

Part 2

Reducing Exceptions Through Better Image Quality

Technology Cleans Up an Expensive Problem

In the previous section, titled *Image Quality: A Billion-Dollar Opportunity,* we examined the new technical considerations that have emerged since the U.S. switched from a paper-based to an image-based check clearing system. In several areas, including document design, legibility, and MICR strength and spacing, check images must conform to certain standards to avoid being rejected and incurring costly fees.

In the course of our research, we discovered that the bulk of the time and money banks spend on the clearing process results from the few items that cause errors.

Furthermore, a tiny minority of scanned items – – less than 0.1%, or one in a thousand – can account for half or more of total clearing costs by causing “critical errors” that take a proportionally huge amount of resources to correct.

Fortunately, advances in document imaging have made it possible to mitigate some of the most costly exceptions. Deploying the right technology and observing a few beneficial best practices can save a typical bank thousands or even millions of dollars in expenses.

No matter how efficiently a bank's clearing process runs, some level of manual intervention is unavoidable; there will always be a few documents that are simply so bad that they will never make it all the way through an automated image-clearing process without human intervention. But how an institution determines which items to pull, and how those items are handled, can have a tremendous impact on how it (and its customers) feel the pain from exceptions.

Changing the Things You Can; Accepting Those You Can't

You can think of exception items as belonging to one of two groups: issues that the bank can control; and issues that the bank cannot. Poor handwriting, for example, is by far the most common cause of two-cent image-quality issues, causing problems with up to 20% of all scanned checks according to the financial institutions we spoke with, but requiring little effort to resolve on the spot. However, unless customers' penmanship suddenly improves on its own, it will continue to pose the same difficulties, so it belongs to the latter category.

Speaking in broad terms, issues under the bank's control can be resolved with internal policy or by attempting to modify customer behavior, and most banks have gotten quite good at doing this. Problems outside the bank's control, though, can ordinarily only be mitigated with technology.

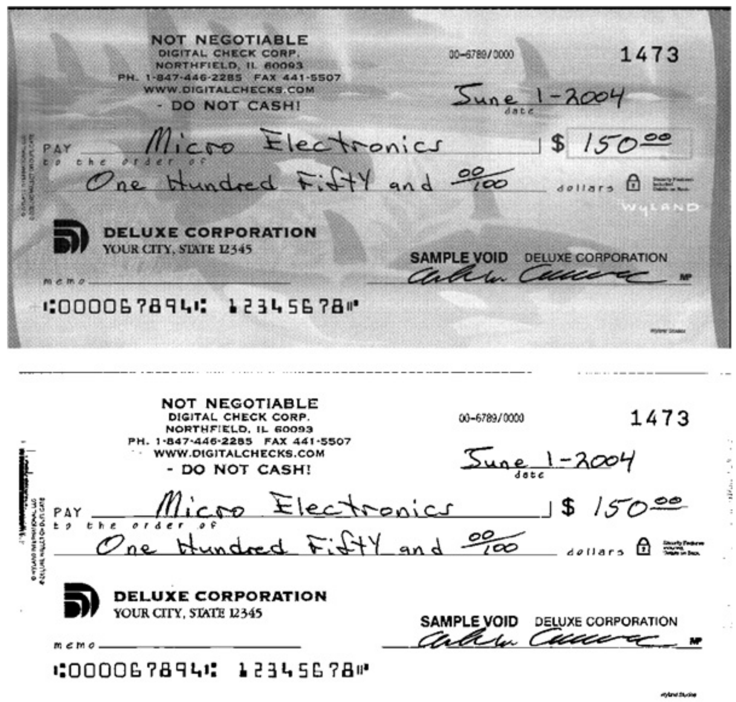
Dealing with Difficult Backgrounds

Most banks are aware by now that image-based clearing carries special requirements, and have adapted the designs of their own documents to avoid self-inflicted problems. This is evident, for example, in the declining number of optical security features and colorful backgrounds on checks ordered through financial institutions. (See our supplement titled Identifying Common Exception Items in Check Processing for more about image-friendly document design.)

On the other hand, most banks have no control at all over the designs of the documents they must accept from thousands of outside sources every day. Background interference was the leading cause of image-quality problems related to document design, causing OCR to fail in 1-2% of total documents processed by the banks who shared their data with us.

The three types of documents identified as highly problematic by every one of the banks we interviewed were money orders, custom-printed checks, and self-printed checks. Not surprisingly, all three are created outside the bank's sphere of influence.

Perhaps the most important development for image quality during the early years of Check 21 was the impact of adaptive thresholding, or in simpler terms, the ability of a scanner to automatically adjust brightness and contrast settings on the fly using software controls within the scanner. This technology was enough to filter out many light or moderately intrusive backgrounds, and proved a huge boon to banks, which were able to eliminate manual corrections on up to 3% of scanned documents.



TOP: A check with dark background printing obscures some of the key areas on a scanned check. **BOTTOM:** Adaptive threshholding creates a clear image by intelligently adjusting light levels in the image.

As helpful as adaptive thresholding is, it still has its limits: Documents designed for security can still confound a machine that's trying to apply a single set of parameters to the whole document. This is especially true of money orders and security checks, which often deliberately employ intense colors and varying background brightness to confuse any camera trying to read them.

In the example at the top of the next page, we see a money order with a dark background on one side, and a plain white background for the printing area. When such a document is scanned at uniform intensity using adaptive thresholding technology, the camera can only get one side "right" – either the dark portion is readable and the light portion is too faint, or the light side is visible while the dark parts are illegible. This is where we begin to reach the extent of basic thresholding technology's capability.

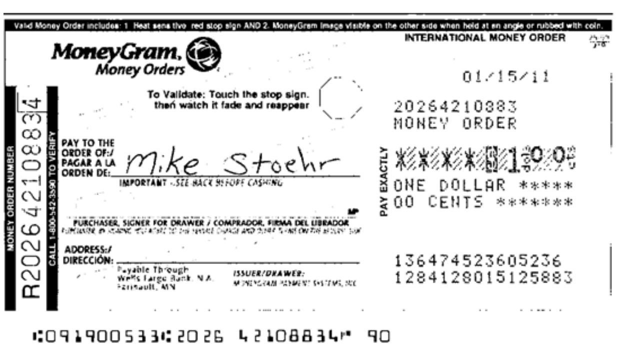
Solving the Money Order Problem

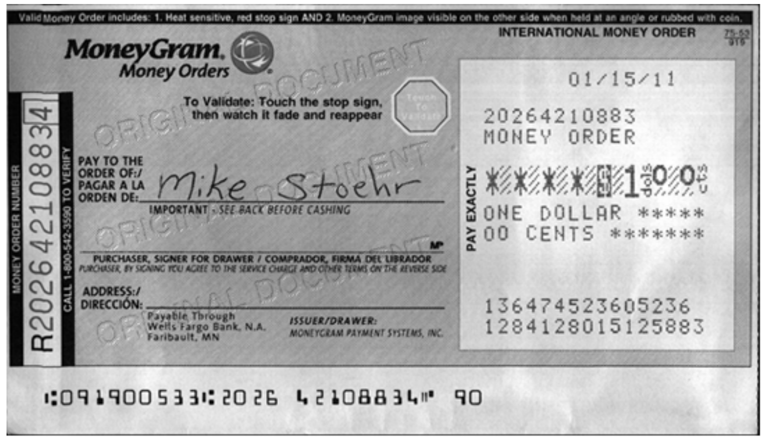
About 1-2% of documents are so poorly optimized for scanning that background interference still renders them illegible even after basic thresholding is applied. Many in the industry initially assumed technology was approaching its limits for improving read rates (for more about this, see the section titled "When It's Better Not to Force It" toward the end of the paper).

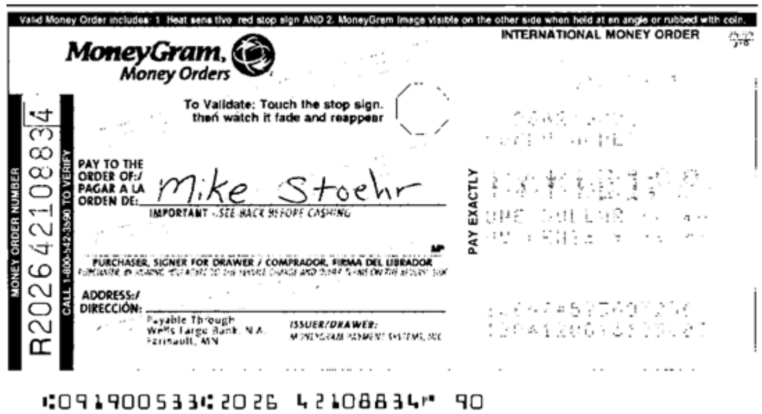
But with the overall number of problem documents pared down by basic thresholding, a new reality emerged: In keeping with the famous "80-20 rule," most banks were reporting that virtually all of their background problems were coming from the same handful of recurring document designs – as few as a dozen for some smaller banks, and perhaps 40 or 50 for larger regional and national operations. Some of these issues can be quite specific: One bank operations manager's biggest problem was the popularity of personal checks with a specific heavily-printed New England Patriots background; another told of an unhappy remote deposit customer who was being paid primarily with money orders and needed to manually enter thousands of them each month.

To address these holdouts – the most difficult of the problem documents – Digital Check took the technology to the next level with the development of zoned thresholding, also known as custom thresholding. This technique uses special controls to identify the type of item based on R/T and/or account number, then divides the document up into several smaller areas, using different thresholding settings for each. The key difference from our standard adaptive thresholding is that it relies on pre-programmed instructions, rather than taking an "educated guess" on the spot. But with a finite number of problem documents, it is possible to build a database of instructions, with much better results.

Compare the images on the right, which show a money order scanned with basic thresholding, to the one below in which zoned thresholding was used on the same item.







Example: The Money Order Problem

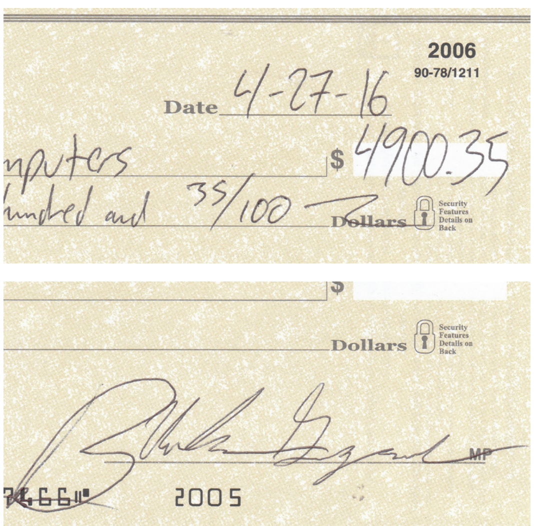
TOP: The raw image of a money order. While often of better quality, these images are not used for clearing; only plain black-and-white "bi-tonal" images are allowed. **MIDDLE:** If adjusted to clear up the left side of the image, the printed dollar amount on the right side becomes too faint to read. **BOTTOM:** If adjusted to make the printing on the right-hand side legible, the background makes the rest of the document unreadable.

Designs like this are good for document security, greatly increasing the difficulty of creating a fake image of passable quality. However, the contrasting tones make it impossible to apply a single setting for light levels to the whole document, as any change that improves one side will worsen the other.

MICR Read Rates, and How Image Quality Affects Them

Handwriting and colorful backgrounds account for the bulk of image-quality and can't-read rejects, but another small handful of exception items rack up a disproportionate amount of time and expense for how often they occur. MICR misreads or substitutions might occur in less than 0.1% of scanned documents, but can be among the most costly error types to a bank when they do happen.

MICR errors almost never occur under normal conditions, but certain problems with the document might result in an unreadable magnetic signal – see the supplement titled "Inside MICR Reading" at the end of this document if you are interested in a detailed explanation. The most common problem is a weak or missing MICR signal because the incorrect ink was used – usually on checks that were ordered from a discount third-party printer, or that businesses and individuals printed themselves. A check that was folded or otherwise damaged may also contain MICR digits with uneven signal strength.



TOP: THE DOLLAR AMOUNT goes outside the expected boundary area on this check, causing the OCR engine to misread the handwritten value. **BOTTOM:** The signature loops down and overlaps the MICR line. The magnetic signal will still be read accurately; however, it will likely produce a mismatch when verified with OCR.

When the scanner can't make out the magnetic signal, most banks will automatically trigger a manual inspection. But if there is a simple mismatch between the MICR and OCR and neither is obviously incorrect, then the bank has a decision to make. Does it stop the workflow for manual intervention every time there is a mismatch? Or does it trust the usually much more reliable MICR signal if there appears to be no error? As we're about to see, the answer depends varies.

The "Easy Button:" Image Quality's Give-and-Take With Workflow and the Customer Experience

When it comes to managing exceptions resulting from poor image quality, every financial institution must eventually answer the question, "How much imperfection will I tolerate in order to keep the process moving?" Operators want to prevent critical errors, but stopping every transaction for an inspection would itself be counterproductive. Customers want simplicity and rapid funds availability – so banks must walk a fine line between being diligent and being so careful that it's a nuisance. Let's take a look at our MICR example, as well as a few other processing situations in which the bank has a choice between speed and certainty.

Handling the MICR Line

As mentioned earlier, getting the MICR line right is one of the most important parts of processing a check, which is why most scanners use a magnetic read with an optical (OCR) verify. If both methods produce a match, the check passes automatically; if the MICR read or both methods fail, the obvious choice is to pull the paper document out for manual inspection and correction. But what happens when there is no "can't-read," but the two produce different results? The safest solution would be to inspect every mismatch manually, but the cost of this would be high.

What do the odds say? We know that the cost of manually entering account information stands at a few cents – $0.02 in the calculations we've used so far. Critical errors like wrong account numbers start at $15.00 and up. Therefore, if one scanning method fails, we would need to be confident that the backup method would produce an error less than 1 in 750 times – a success rate of 99.867% – in order to "break even" by relying on it as the sole method instead of manual inspecting every item. OCR does not have nearly that success rate. MICR attains that level of accuracy under ideal conditions, but its limiting factor in the real world is how many checks are printed within spec, as well as how many sustain damage.

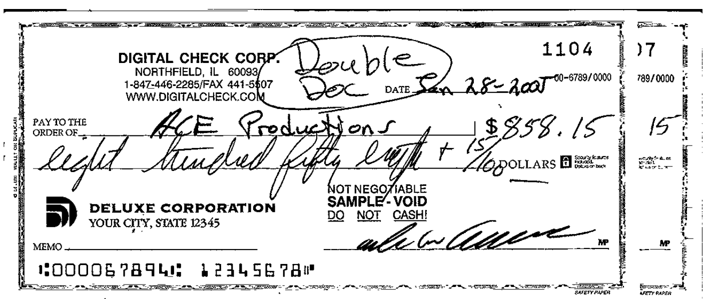
In this case, we see that physically inspecting each MICR-OCR mismatch is costly, but still probably better than the alternative.

Erasing the Paper Trail: The Removal of the Deposit Slip

For years, the deposit slip provided a valuable written record of each transaction at the teller window – a fact that remains true even in the image age. However, customers do not like to spend time filling them out, and, as mentioned in the last section, even though banks' own internal documents tend to be well-designed, poor handwriting is a leading cause of low-level image quality issues that require manual repair. As a result, many banks now skip deposit slips in favor of a card swipe, and use the teller window software to create an electronic replacement for the deposit slip. For checks deposited through RDC, deposit slips do not exist at all.

This move produced benefits on the front end – eliminating a source of image quality errors while nominally improving the customer experience – however, safeguards were given up as an important part of the paper trail was done away with. The practical implication of this is that certain errors, such as incorrect dollar amounts or missed items, are more likely to result in disputes if they make it into the processing queue.

Another example of a problem that has become more difficult without deposit slips is the double-feed, or "piggyback" item, caused by two checks passing through the scanner at once. When a double-feed occurs, one of the items essentially disappears from the clearing process, which can cause mismatched totals at the branch and incorrect account balances for the customer. Deposit slips made these errors simpler to identify, either at the point of transaction, or after the fact if the customer challenged the results later. Double-feeds and balance errors are now among the more expensive of exception items to correct, in part because there often ends up being no record of the mistake.



THE DOUBLE-FEED, or 'Piggyback,' is among the most difficult errors to research and repair because there is often no paper trail to indicate where the problem occurred.

Strictness of Controls on Remote Deposit

According to the latest Federal Reserve Payments Study, approximately 17% of checks are deposited as images by the customer, up from 13% in 2009. However, it was not uncommon for 20-25% of certain errors to come from remote deposit among the banks we spoke with.

The double-feed was high on the list of problems magnified by RDC; if a customer makes a deposit and does not notice the missing check, the error will make it all the way into the processing queue and become a critical error resulting in an incorrect balance. There is, in fact, a way to prevent double-feed errors in remote deposit: requiring the customer to enter the total deposit amount and/or number of checks beforehand, and rejecting the transaction if the actual total does not match. However, the extra step – essentially the same thing as requiring a virtual deposit slip – slows down the user experience, and so is not in universal use.

The double-feed issue is itself only a part of the broader question on how tightly controls on scanned deposits should be enforced. It is possible to achieve similar confidence rates for RDC items as with teller-scanned items by using strict enough image quality rules, but only if more of the burden of re-scanning and re-keying items is foisted onto the customer. A few other instances in which a banking decision may affect image quality – and therefore clearing expenses – include:

- *How urgently the use of standardized checks and documents is encouraged*
- *Special relationships with large clients; e.g. relaxed controls, immediate funds availability, after-the-fact inspection*
- *Whether fees are charged for "repeat offenders" that produce disproportionate numbers of exception items*

Similar decisions exist in teller and certain branch capture situations, where the branch employees serve as the first line of defense against exception issues. For the most part, improvements to accuracy add time to either the customer or employee workflow, and therefore represent a tradeoff between precision and simplicity.

How Technology Can Help Win the Image Quality Battle

If the tug-of-war between clearing success and customer service operated in a vacuum, the issue would be settled: Financial institutions would eventually reach the maximum efficiency that could be achieved without driving away customers. The remaining problems would simply be accepted as a cost of doing business. This is, for the most part, the general goal that most banks have in handling image quality today.

However, improved technology, such as image cleanup and intelligent thresholding, is now making it possible to drive down error rates without affecting the customer experience.

For example, when applied correctly and given enough time to compile a full database of problem documents, adaptive thresholding can eliminate 90% or more of the manual inspections and image quality rejections that originate from document design.

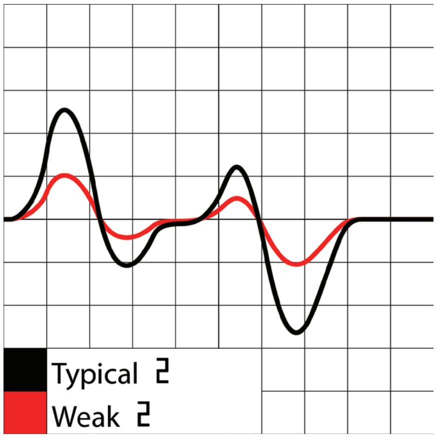
Thanks to more recent advances, operators can use click-and-drag filters to select and adjust parts of individual checks on the spot. This ability almost entirely does away with the remaining errors from backgrounds and document design, as well as faint printing, colored ink, and related problems.

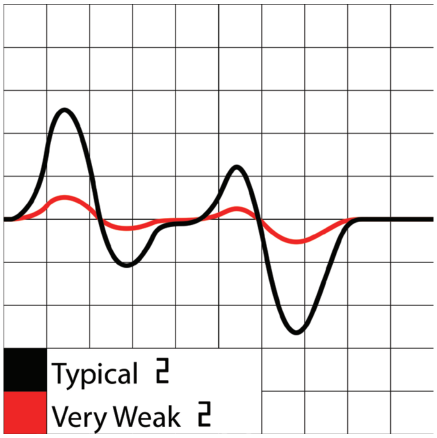
One goal we can hope to achieve with image enhancement technology in the near future is to intercept the great majority of items that currently need manual intervention and – unless the errors are related to MICR or poor handwriting – speed them through the system automatically. This alone would save the industry several million dollars.

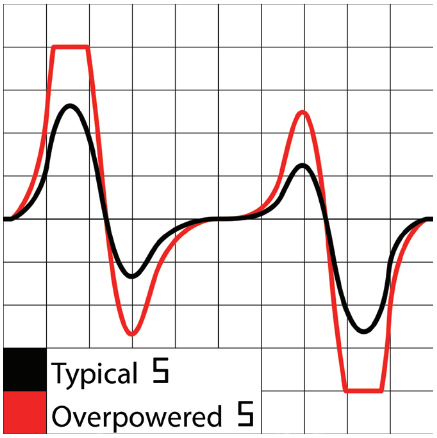
More importantly, once spot-cleanup technology is widespread, we should see a dramatic reduction in critical errors and paper clearing, which would be converted to simple manual interventions at a cost 500 to 1,000 times lower. The total operational savings from these activities would be in the hundreds of millions of dollars, with a further modest boost from low-dollar checks that were previously written off because their value was lower than the cost of submitting a paper cash letter.

We believe that the future holds a near-zero occurrence of these worst problem documents, and that every major institution will have an image cleanup and augmentation system in place. Please see the before-and-after images in our supplementary reports for examples and more best practices.

Addendum: The Limits of Today's Tech, and When It's Better Not to Force It







So far, we've talked about the problems that can thwart imaging equipment, and the ways to work around those problems with new, ever-improving technology. But sometimes, we reach a point at which it does more harm than good to push for the last little bit. For an example, let's look at how scanning equipment handles the erratic MICR levels that sometimes show up on checks today.

In a series of tests conducted by Digital Check over several years, read rates for a batch of checks with 40% MICR intensity improved from being barely readable with first-generation scanners to nearly 100% accuracy on those used today. Not coincidentally, industry OCR read rates have also improved by double digits in the same time period. But past a certain point, trying to engineer your way around a problem may not be the optimal answer: Given a check with 10% MICR strength, for example, one may be better off trying to read the item using a different method, or conducting a manual inspection instead of using brute-force technology.

Consider the 10-15% of documents that experience OCR problems because of scrawled handwriting. Typically, optical recognition engines assign a "confidence score" to each character, and accept it if over a certain percentage threshold. It's entirely possible to "force" lower-quality documents through the system by lowering the bar and telling the OCR engine to take its best guess – but is it a good idea? Let's look at the same idea with MICR, in which characters are identified by the wave patterns produced by their magnetic signatures. Contrast a typical MICR signal with one generated at 40% intensity, depicted in the top graph at left.

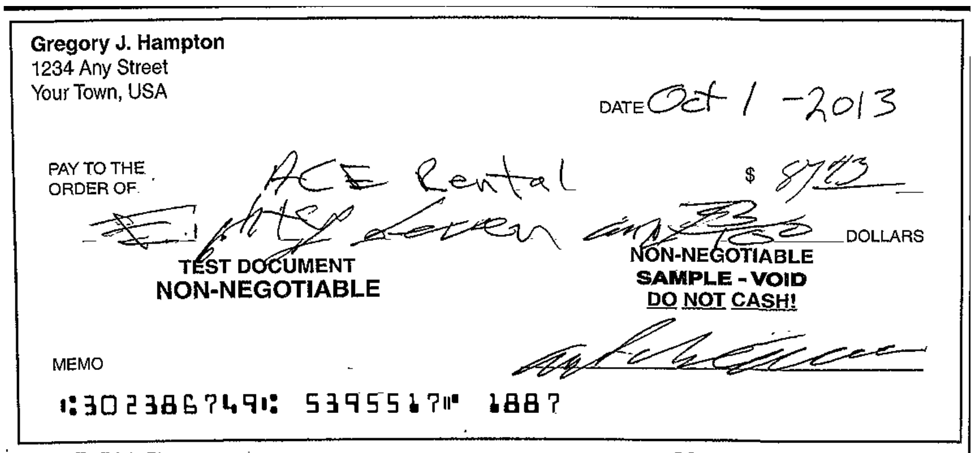
While the signal certainly reads differently, advances in technology have made it possible to ascertain the same pattern as a full-strength signal with increasing degrees of confidence. Now, compare that situation with the second graph, which shows a MICR signal of around 10%, or the third graph showing an overprinted signal of 200% that literally "jumps off the charts". For different reasons, both cause large gaps in which there's simply nothing to read; trying to read it anyway means you're just as likely to mistake the number for something else as you are to get it right.

Rather than trying to force-read a weak or exaggerated MICR signal, a better option is to verify with a backup system such as OCR, or to manually inspect the item. Remember, if even 1 in 750 checks of this type produces a substituted MICR character, even manual inspection of every item would be more cost-effective overall. In cases such as this, it's sometimes actually more cost-effective to back off of using advanced technology every time – at least, until the technology improves again.

A Supplemental Guide to Image Quality Issues

In the previous reports in this series, titled *Image Quality: A Billion-Dollar Opportunity*, and *Reducing Exceptions Through Better Image Quality*, we examined the extent of technological challenges that present problems in image-based settlement of checks and money orders, as well as best practices for correcting image quality errors. The following is intended to provide illustrative examples of common problems and their typical outcomes.

Poor Handwriting



Cause
Sloppy or unorthodox handwriting on a document filled out by the customer. Writing the dollar amount outside the standard area, or obscuring the dollar sign

Typically Found
On courtesy/legal amount fields of checks; on deposit slips.

Occurrence
Up to 20% of all scanned items.

Typical Outcomes
Optical Character Recognition (OCR) fails to identify a dollar amount. Manual correction is required.

OCR succeeds, but creates a mismatch between the courtesy and legal amount fields on a check.

Item reads successfully and enters clearing with wrong dollar amount, resulting in rejected item or account balance error (less common).

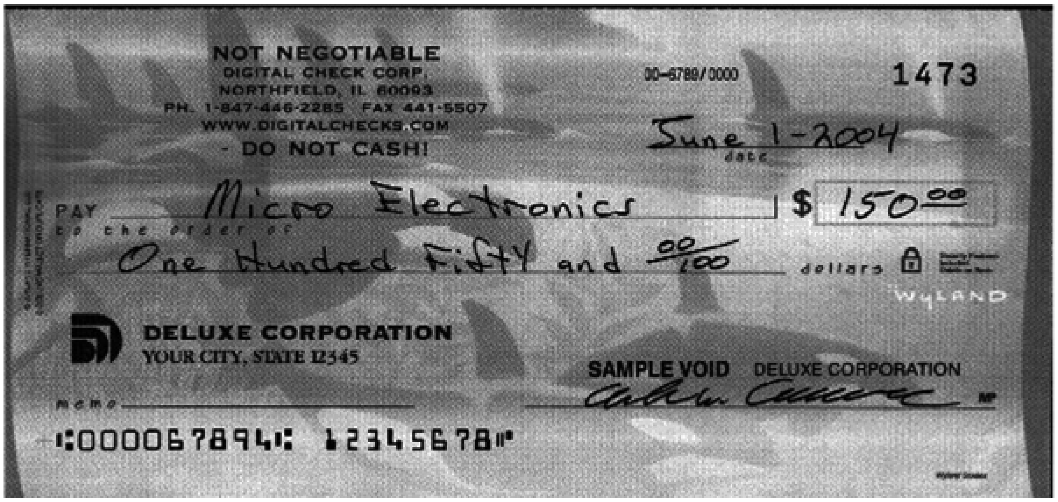
Comments
Sloppy handwriting is far and away the leading cause of image errors, but is usually simple to correct. The great majority of errors are fixed with a few seconds of manual inspection and re-keying. However, with about one in five checks failing the OCR image quality test, this stlill takes a huge amount of time overall. It is also a problem that's almost impossible to eradicate, as banks have no control over customers' penmanship.

Another handwriting issue that causes minor errors occurs when the written dollar amount goes outside the standard box where it is supposed to appear, or when the dollar sign on a check or money order is obscured or printed irregularly. CAR/LAR engines are programmed to look for dollar values in a specific area that is common to all checks, and to look for the dollar sign as the marker for the start of the value.

More serious and costly errors occur when one of these checks is corrected and sent, but rejected because the image cannot be read on the receiving end. This happens most frequently when the original operator, usually a teller, re-keys the amount from the original paper check – but the receiving bank, lacking the original document, still finds the image illegible.

In isolated cases, an item with the wrong dollar amount can enter the clearing process without being fixed, resulting in an incorrect account balance requiring costly research and repair.

Intrusive Background



Cause

Vivid background or other printing interferes with reading of important information on a check or money order.

Typically Found

On money orders, specialty checks, security documents, and custom-printed personal checks.

Occurrence

1-2% of scanned items; may vary by geographic location (see below).

Typical Outcomes

Optical Character Recognition (OCR) fails to identify a dollar amount. This can usually be fixed with manual re-keying.

MICR area is obscured, causing a mismatch if both MICR and OCR are used to verify account number.

Image makes a poor conversion from grayscale to bitonal; is corrected manually but rejected by recipient.

Comments

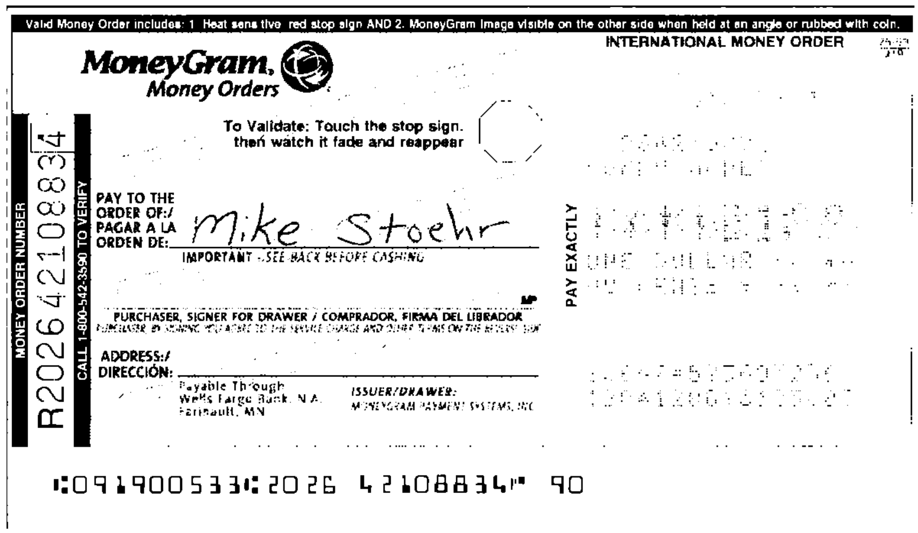
This problem occurs somewhat regularly, but is usually fixed with simple inspection and manual keying. Most often, it leads to a “can’t-read” error where the dollar amount or account number is simply typed in manually. Money orders are notorious for difficult backgrounds and patterns that interfere with scanning. As they are often issued by entities that are not involved in the clearing process, money orders are deliberately designed to be image-unfriendly for security purposes.

A common cause of exceptions is when an operator – usually a teller – makes a spot correction with the paper check in front of him and sends it on for processing, only to have the item rejected on the receiving end because the image is illegible without the original document as a reference. The operator must therefore be careful that the final image will be legible *even without the original available*.

Individual branches may experience extreme concentrations of these documents, for instance, if a specific employer in the area uses non-conforming payroll check, or particular business customers receive many money orders. This can lead to a poor customer experience.

Modern scanning technology has gotten better at dealing with intrusive backgrounds, automatically searching for the best light levels to produce a readable image. However, in extreme cases, more advanced techniques may be necessary.

Faint Printing



Cause

Payment document is printed on an old-style dot matrix printer, and the ink ribbon is overdue for a change.

Typically Found

On money orders and some self-printed business checks.

Occurrence

Less than 1% of scanned items; may vary by location.

Typical Outcomes

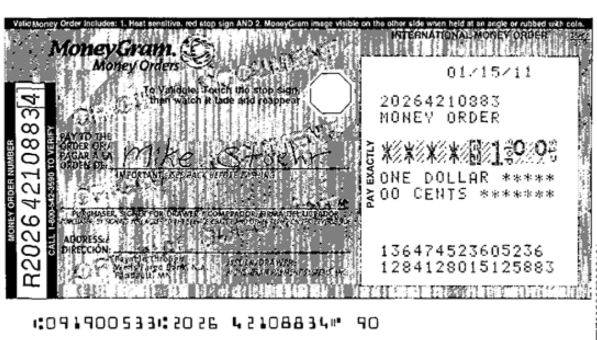
Optical Character Recognition (OCR) fails to identify a dollar amount. This can usually be fixed with manual re-keying.

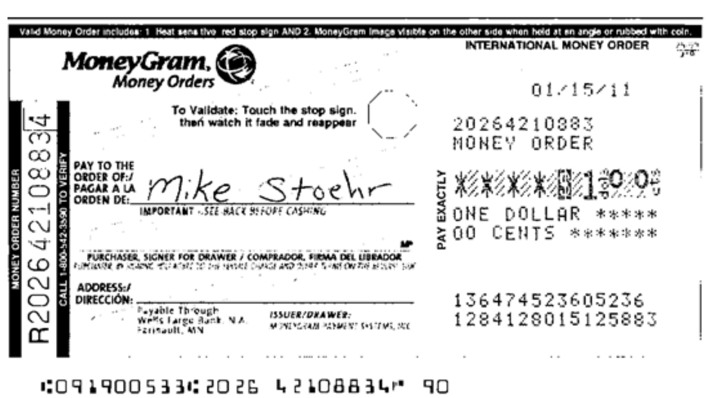
However, in some cases it can still be impossible to get a useable image from the original document. If, after multiple attempts, the image is illegible, the money order may have to be submitted as a paper item – or, if low-value, simply discarded and written off.

Comments

In the image world, these types of documents can present a "hard stop" that makes it impossible to use electronic clearing. However, recent technology can be used to solve this problem.

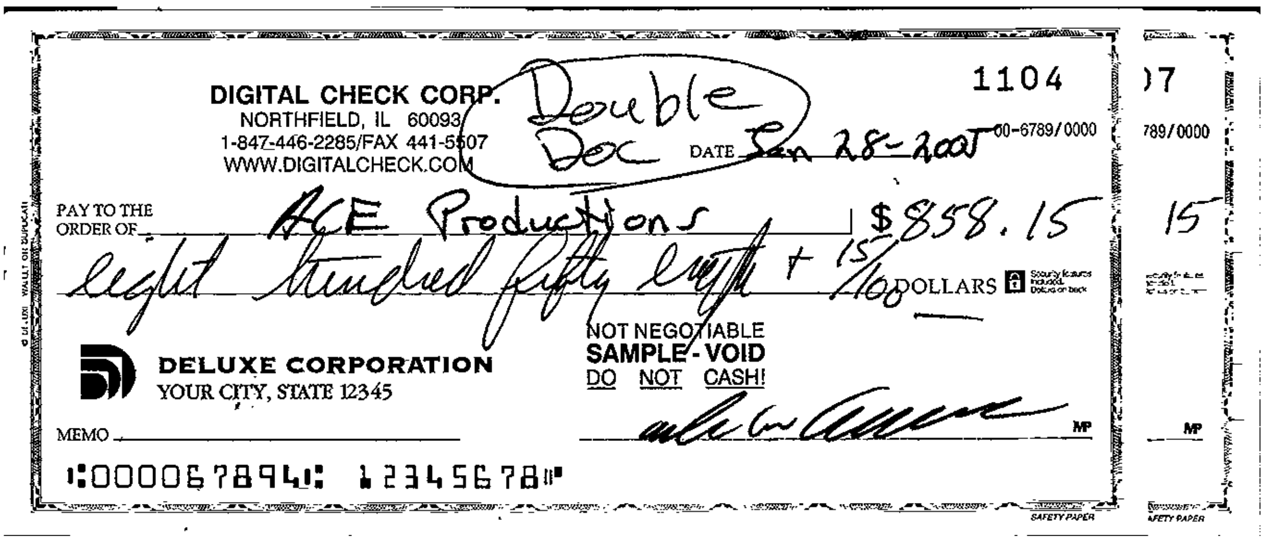
If the scanner captures the entire check or money order at the setting that ordinarily produces the best clarity, it fails to pick up the dollar amount no matter how many times it is re-scanned. This is the default for most scanners. If it captures the image at the setting that makes the dollar amount clear, the rest of the document becomes obscured. However, special zoned settings, like those in Digital Check's Special Document Handling module, can be used to create different light thresholds for different parts of the same document. The result is closer to the image at right below.





DIGITAL CHECK

Double-Feed ("Piggyback")



Cause

Two checks pass through the track at once. This may occur because of moisture or a foreign substance, or due to rare mechanical misfeeds.

Typically Found

At random, in possibly any batch of documents. Can happen either in teller/branch capture or with RDC.

Occurrence

Very rare; perhaps 1 in 10,000 items scanned.

Typical Outcomes

The check in front obscures the one behind it, so the second check disappears from the batch as if it was never scanned at all. It is not submitted for settlement, and the depositor is not credited with the funds.

If not detected immediately, a double-feed almost always results in an incorrect account balance, which can incur a lengthy and expensive research/repair process.

Comments

Double-feeds actually happen much more often than listed above, but most of them are caught right away by automatic detection systems in the scanner; these are designed to measure properties such as document size and paper thickness, and stop the batch if a problem occurs. But very rarely, a double-feed may actually pass the technical inspection and slip through.

Two special properties make the double-feed a particular nuisance. First, just like poor handwriting, there is no way of completely preventing it; there will just always be some items that temporarily become stuck together. Yes, technology can be used to catch most double-feed problems, but only to a point. Tighten the safeguards too much, and you begin creating false positives that repeatedly bring the batch to a stop.

Just as importantly, once a double-feed makes it past the initial safeguards, it leaves behind no sign that a problem ever occurred. The error is usually discovered on Day 2 or later, when a balance discrepancy is reported (if it is noticed at all.) This means that virtually all double-feeds that make it through end up causing major errors. Moreover, in deposits submitted via remote deposit capture, the bank is not even in possession of the orginal documents, so even though the majority of cases are resolved by eventually locating the missing item, tracking it down can be a painstaking process and frustrating for the customer.

There is one way to prevent double-feeds, which is to require the operator to enter the total number of checks expected before scanning begins; if there is a discrepency, the system will prompt a manual inspection before the batch is sent. The main issue there is with high-volume batches: Not only does it take time to count a large stack of checks, but the operator is just as likely to have the wrong count as the machine is. For low- and medium-volume environments, though – and especially with RDC – this practice can cut down on costly errors.

MICR Misread

Causes
Low-quality printing with weak or no magnetic ink.

MICR characters that have been physically worn, scuffed, creased, written over, or otherwise damaged.

Typically Found
Weak or missing MICR signals on self-printed checks, or checks ordered from online discounters.

Physical damage randomly among checks and money orders in general.

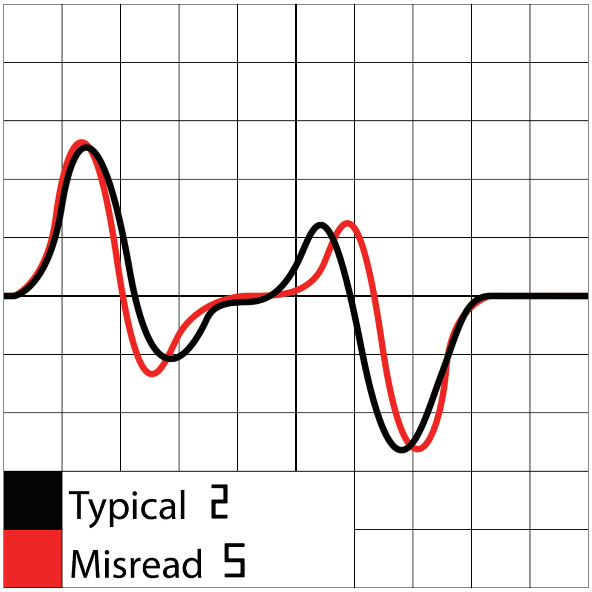
Occurrence
Up to 2% of items scanned

Typical Outcomes
Most often generates a simple "can't read," or a mismatched digit if being simultaneously checked with optical character recognition (OCR). These require a few seconds of re-keying by the operator.

Occasionally, a poor magnetic signal can be interpreted as a valid but incorrect digit, leading to severe problems such as incorrect account numbers (see below).

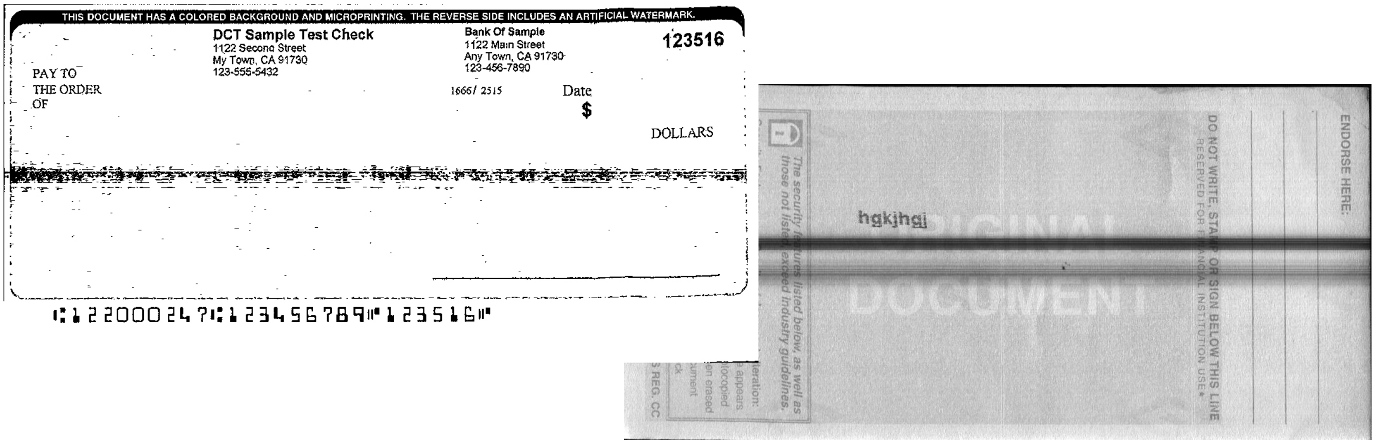
Comments
The most common, and fastest-growing, cause of MICR issues are checks that are printed out-of-spec – usually with weak magnetic ink, although it is possible for it to be too strong as well. Most of the time, either the magnetic signal can be interpreted anyway if it's close enough (Digital Check routinely tests our equipment at low signal strengths), or it simply doesn't look like anything and generates a can't-read error, which is fixed with a few seconds of re-keying. These issues can be tedious, but not dangerous.

The real problem occurs when one MICR character reads like another, as shown in the magnetic signal graph at right. This can happen for a number of reasons: incorrect signal at just the wrong strength; incorrect spacing between MICR line characters; or physical damage to the check, which can cause unpredictable results. These tend to product the types of errors that can be severe.



The best defense against MICR errors is to employ dual validation, using OCR to double-check the MICR line. It will cause marginally more small "mismatch" errors that require manual inspection, but it takes hundreds of these minor pauses to equal the cost of a single item sent with incorrect MICR data.

Streaks & General Poor Quality



Cause
Lens is obscured; scanner requires cleaning.

Typically Found
On scanners with heavy use, or which have not been cleaned in several weeks.

Occurrence
Depends on maintenance habits.

Typical Outcome
The scanner stops repeatedly due to apparent jams or can't-read image quality problems. Many other images contain streaks or lines that obscure parts of the check. This causes a continuous string of manual-entry and possibly more severe errors until the problem is fixed.

Comments
Regular cleaning is one of the simplest, but most important, maintenance items needed to maintain image quality. Because scanning checks involves paper coming in contact with the rollers and read heads, that means that dirt, dust, and even paper rub-off from the checks themselves will eventually make their way into the track and cause problems.

In cases where a scanner is long overdue for cleaning, some users have reported that the device seems to stop for a paper jam as often as every two or three documents, leading them to think the machine is broken! What's actually happening is that accumulated dirt is obscuring numbers and writing, causing OCR to fail and the device to stop for a can't-read error. Obviously, the operator experience in such a case is terrible, and doing a re-scan once every few documents can make a stack of a few hundred checks take an hour.

As with other types of errors, the worst case with an occluded lens is not that it fails to read a check (producing an error that costs a few seconds and some frustration), but that it turns one number into another and thinks it has successfully read the check. While rare, these items are among the most costly and time-consuming to fix.

Depending on the model, it's recommended that a cleaning be done once every few thousand to 10,000-15,000 scanned items. In tems of cost, it takes a few minutes and about $2 worth of supplies to clean a Digital Check scanner; each stop for a misread costs about $0.02 worth of time, and a major error $20-$30 to fix. Cleaning is an activity that quickly pays for itself.