Figure 1 An operator at Quality Fabricators can retrieve a program that was sent to the control from offline bending software. *Photo courtesy of Quality Fabricators.*

Streamlining press brake setups help transform a business

Small batches change everything at Quality Fabricators

By Tim Heston, Senior Editor

It's been a long time since George Doucet spent his days turning a crank to adjust the backgauge of a press brake. That tedious act was just one reason that so many job shops followed traditional production methods. Setups were a bear; they put a black eye on productivity. So the fewer times operators had to set up their machines, the better.

How things have changed. Doucet is press brake department supervisor at Quality Fabricators Inc. (QFI), Addison Ill., a Chicago suburb. He has been bending sheet metal for three decades, and today he's doing something he couldn't imagine 30 years ago. For part of the day he works in the engineering department at a computer showing a 3-D simulation of a bending process. The available tools in the shop are all represented on the screen. If something can't be bent to spec with available tooling, he finds it before it hits the shop floor. If an issue with a blank size arises, Doucet doesn't worry. The software communicates with the nesting system upfront to take bend deductions into account. Blank sizes are changed on the nest before being sent to the punch press (see **Figures 1** and **2**).

And, oh yeah, this all may be for a batch of just 10 or 20 parts.

Falling lot sizes have driven innovation in bending, and lots have only gotten smaller during the past few years. No one wants inventory. Producing just in time isn't good enough anymore. Customers now want "just enough," just in time.

"Three years ago we were seeing lot sizes in the 100- to 200-piece-part range," said Rakesh Kumar, a division manager for Amada America based in Schaumburg, Ill. "Since then we've seen average lot sizes go down to 50 or so."

As the people of QFI discovered, smaller lot sizes change everything, not only in bending, but for the entire business of contract metal fabrication.

Small Batches and Bending

The very nature of turret punching and laser cutting seems tailor-made for high-mix work. The turret carries myriad tooling options, and the laser has no hard tooling at all. Most programming for blanking has moved off the shop floor. Want to reduce the batch size? No problem; just change the program. Modern nesting software helps shops mix jobs to maximize material utilization, optimize part flow, and manage remnants, all before being downloaded to the blanking center's controller.

Bending, though, hasn't been so straightforward. Welding aside, no other fabrication process requires so much operator intervention as the press brake. In the bending arena, a lot can happen on the floor before actual production. Operators must program the machine, make the bend program, find and set up tooling, run test bends, and only then run production bends. According to Kumar, a typical job shop's bending operator actually bent parts on average only 28 percent of the time in 2006. This year that average dropped to 15 percent (see **Figure 3**).

The culprit is smaller batches. In recent years lot sizes have continued falling, mainly because customers are ordering only so many parts. This makes for more setups, which in turn make the bending bottleneck even more apparent.

Bending Metrics

It was certainly apparent to Victor Camacho, QFI's vice president of operations. "Years ago it was all manual. We had manual backgauging," he said. "Then we brought in the modern press brakes with programmable backgauges, which allowed us to perform multiple bends within the same setup. But it was still all print-related. We supplied a print to the shop floor, and the machine sat idle as the operator spent time setting up the job."

Before changing anything further, QFI managers first had to know how operators spent their time. Their thinking: How can you know what you need until you know *exactly* what you have? Working with Amada America, they set up a video camera and timed bending operations.

For one part, they found that operators actually spent more time performing test bends (45 percent of the time, or almost two hours) than actually making parts for production (23 percent of the time, or just less than an hour). *And this was a repeat part, not new to the shop floor*. Operators spent a lot of time aligning tools and shimming punches, adjusting the backgauge, and tweaking other program elements at the controller.

For new parts, of course, on-the-floor brake programming also slowed things considerably. "We were doing a lot of on-the-floor programming," Camacho said.

Doucet chimed in. "With the old machines, you could still store previously run programs on the controls, but you'd have to recalibrate the machines and set up new tooling. They weren't precision-ground tooling, and their centers would be different. We'd have to loosen the die bed, put the new tooling in, tighten it, and center it, walking behind and in front of the machine to do it."

Camacho added, "From the engineering standpoint, we would process work and produce a DXF file for the turret, but that was the extent of programming upfront." This could cause serious headaches, especially for complex parts new to the floor. "The first time [brake] operators would see a complex job would be when the blanks were right in front of them," he said. They then had to determine if the part could run on one machine or multiple machines. The whole process sometimes took hours or even half a day to produce just one complete, correct part.

Hanging Fruit

Having bending metrics on hand has become more important because, as sources explained, shop managers have many options when it comes to improving the bending operation. Low-hanging fruit involves little or no investment, while middle- and high-hanging fruit requires serious analysis and ROI calculations.

Scott Ottens, bending product manager at Amada, explained some of the low-hanging fruit. "There's a lot you can do ergonomically to set up the station for bending. Make everything close and accessible. In fact, when we look at operator absence, half the time he's looking for material or tools."

This goes hand-in-hand with tool crib organization. Ideally, tool cribs should be adjacent to the brake. Tools should be clearly labeled, too, so that operators don't spend time measuring punches to ensure they have the

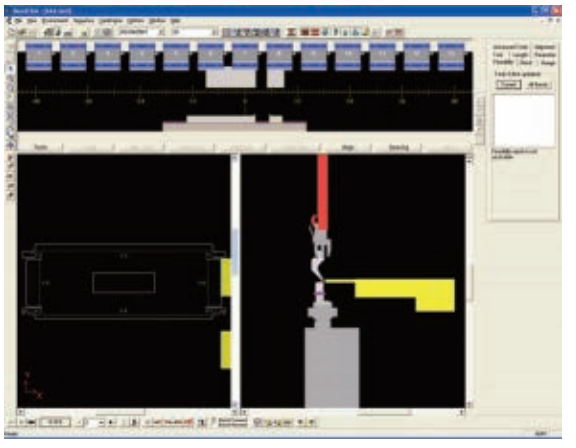
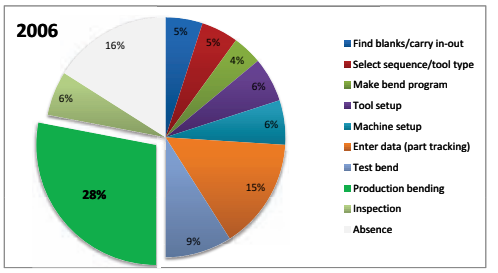


Figure 2 Offline bending and simulation software has eliminated on-machine programming at Quality Fabricators Inc. *Photo courtesy of Amada America.*

Task	2006	2010
Find blanks/carry in-out	5%	8%
Select sequence/tool type	5%	10%
Make bend program	4%	6%
Tool setup	6%	9%
Machine setup	6%	3%
Enter data (part tracking)	15%	14%
Test bend	9%	11%
Production bending	28%	15%
Inspection	6%	15%
Absence	16%	10%
	100%	100%



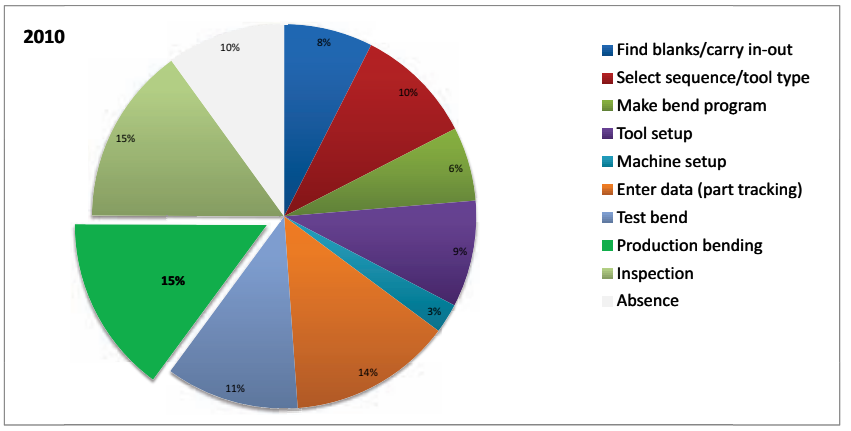


Figure 3 Production bending times have plummeted as lot sizes have decreased. According to data provided by Amada, operators on average spent 28 percent of their time bending parts in 2006; this year that number dropped to 15 percent.

right one for the job. Much of this is straightforward 5S. If the setup sheet has "Punch No. 3" on it, the punch should be clearly labeled as such in the tool crib.

Middle-hanging fruit includes a broad swath of technologies that, while not free, aren't like buying a new machine tool either. Consider press brake tooling. Ideally, each brake tool crib should have tools that aren't shared with other brakes. The operator doesn't add much value when he's waiting for someone on another brake to finish a batch, just to grab a tool.

Precision-ground tooling can make life easier; an incredibly repeatable press brake isn't very repeatable with cheap tooling, after all. And if brakes have CNC backgauges with enough axes, staged bending—with different tool sets placed next to each other on the bed—becomes a practical option. Here the operator bends multiple geometries using various tools set up next to each other, allowing all the bends for a product to be finished in one setup.

With staged air bending, it can be difficult to determine the exact shut height so that all tools overbend just the right amount to account for springback. This leads to those lengthy tryout times, with operators experimenting with shims and risers to get the tooling height just right. Common-shut-height tools have varying shoulder heights but (as their name implies) common shut heights, effectively eliminating the lengthy trial and error.

As Ottens explained, "Common shut height allows you to use all these tools at the same time on the brake bed, and it really reduces the complexity of your setups."

Another low- to medium-hanging fruit can improve bending efficiency—but, as sources explained, not necessarily overall efficiency. To reduce brake setup time, a shop can alter its blanking operation to produce parts that require the same or similar press brake tools.

"Shops often do this if it's possible, but we've seen many moving away from this," Ottens said, adding that the demand for ever-shorter lead-times has changed the game. Blanking some parts first, just because they require similar brake tooling, can prolong the manufacturing time for parts that require the odd punch and die set. Such a part may be moved to another run several hours or days later. But nowadays many contract fabricators just don't have that kind of leeway; the pressure to reduce lead-times is just too great.

This is one reason, Ottens said, shops sometimes take a look at the higher-hanging fruit, from modern CNC press brakes with programmable backgauges, on-the-fly thickness detection, and real-time bend-angle detection, to robotics. In fact, when it comes to brake cells, some of the latest designs cater to high-mix, short-run work.

"Years ago it was true that you weren't going to even look at robotics in the brake area unless you had long runs," Ottens explained. He added, however, that today some robotic cells have been redesigned "with the job shop in mind."

Specifically, certain cells use two tool-changing robotic manipulators, positioned on either side, in addition to the material handling robots that pick up blanks and perform bends (see **Figure 4**). This automatic tool changeout resembles some of the technology used in automated panel benders, which have manipulators that switch out hold-down tooling. Those manipulators are one reason automated panel bender setups can be measured in mere seconds, and these devices have been adapted to the automated press brake cell. Downtime for tool changeout can be just a minute or two.

Still, Kumar and Ottens cautioned that automation doesn't suit all parts or shop environments. Quality Fabricators, for instance, stopped short of purchasing a robotized press brake cell. Recent machine tool investments already have increased productivity in the blanking and forming area, so much so in fact that it revealed a bottleneck downstream, in the joining area. At the time of this writing, shop managers were looking at multistaking operations in the hardware insertion press to replace certain spot welding operations.

Continuous improvement, after all, never ends.

Upgrades at QFI

Ultimately, QFI went with a combination of technologies—some low-hanging fruit, others higher on the tree. In 2008 the shop invested in precision-ground tooling and two Amada press brakes, an 88-ton machine as well as a 143-ton system, both with ±0.00004-in. ram repeatability and a five-axis backgauge. The new brakes and tooling helped make staged setups much, much easier.

They also invested in offline bend programming and simulation, which eliminated the programming time on the newer press brakes. Doucet simply postprocesses the programs and, over companywide Ethernet, sends them directly to the machine controllers. Operators call up the program, and instructions appear right there on the screens. The machine controller shows a 3-D representation of the exact tool location, eliminating any significant manual calculation. For the older brakes, the software prints out a detailed setup sheet that goes with the job traveler. If it's a new job, or if first-article requirements call for it, punched blanks may be put in a flatbed laser scanner to ensure the cut part matches the DXF file. Then those blanks go to bending.

Eliminating on-machine programming is significant, to be sure, but calling up a previously programmed job, as in QFI's analysis in **Figure 5**, doesn't seem to be a big time hog. Pulling up the program and determining the tooling, sequence, and initial setup took only 14 minutes, or just 6 percent of the overall cycle time. Of course, that initial setup was just the beginning; operators spent *two hours* adjusting and tweaking.

And helping to reduce this tryout was, among other things, the offline software. Because Doucet simulates the bending operation upfront, he knows whether the original design file took into account bend deductions and the shop's available tooling. The software not only moves programming off the floor, but also reduces the number of tryout bends. The better-quality blank a press brake operator receives, the easier setup becomes.

"For good quality, it sometimes took 45 minutes to an hour for some setups," said Tony Mautone, QFI's vice president of manufacturing. "Now we do it within 10 to 15 minutes for the same setups."

Operators are shown tool locations, and the new brakes center tools automatically. They have thickness detection systems, too, and digital calipers that connect directly to

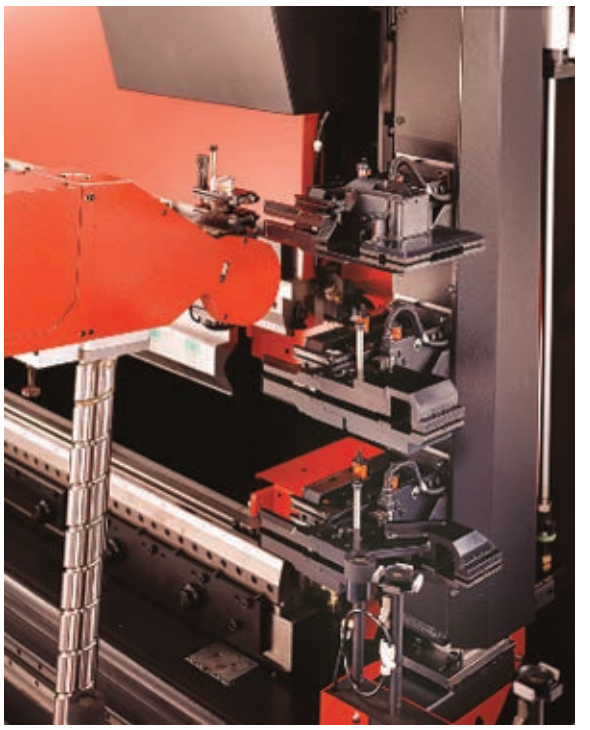
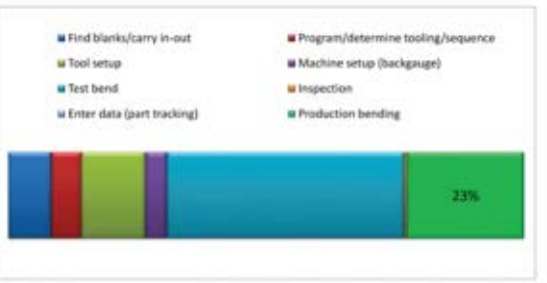


Figure 4 Robotic cells can be designed with the job shop in mind. In this cell, separate tool-changing manipulators on either side of the machine (shown above the bending robot on the left and in the picture on the right) change out punches and dies between jobs. *Photos courtesy of Amada America.*

Before	Time	%
Find blanks/carry in-out	0:19:51	8%
Program/determine tooling	0:13:54	6%
Tool setup	0:29:39	12%
Machine setup (backgauge)	0:10:01	4%
Test bend	1:50:04	46%
Inspection	0:01:20	1%
Enter data (part tracking)	0:00:00	0%
Production bending	0:54:01	23%
	3:58:50	



After	Time	%
Find blanks/carry in-out	0:19:51	16.5%
Program/determine tooling/sequence	0:00:30	0.4%
Tool setup	0:15:00	12.5%
Machine setup (backgauge)	0:02:00	1.7%
Test bend	0:01:30	1.2%
Inspection	0:00:30	0.4%
Enter data (part tracking)	0:00:00	0.0%
Production bending	1:21:00	67.3%
	2:00:21	

Figure 5 Quality Fabricators reduced test bend times dramatically with new technology. For this six-bend part, test bend time dropped from nearly two hours—just for the final two bends—to a minute and a half for all six bends. *Images courtesy of Amada America.*

the machine control. This overcomes that all-too-familiar issue of thickness variation. Say a program is written offline for 16-gauge material. Of course, mill tolerances aren't that tight, so the metal could be anywhere between 0.055 and 0.060 in. So now the operator receives his batch of blanks and, using the digital caliper, measures the first one to find it's really 0.057 in. thick. That information feeds back to the press brake control, which then makes all the necessary program changes to account for the new material thickness.

In other words, say goodbye to those hours of test bends.

A few test bends remain, but just a few. And they now take minutes instead of hours. For that batch of 66 parts requiring six bends each, operators perform test bends for only a minute and a half; and this is for a complete six-bend part, thanks to the staged setup. Previously the part required two separate brake operations.

Before, this same batch required 12 test parts, and to form just the two final bends took an operator almost four hours. With the technology upgrades, the operator can bend 66 parts, complete in one setup, in two hours (see Figure 5.)

What Really Matters

Let's be frank. Customers really don't care that Quality Fabricators Inc. slashed its press brake setup times dramatically. What they care about boils down to one question: *Can you deliver a quality product for the right price—just enough, just in time*?

This is what QFI's managers care about too. They have to care, because competition is fierce.

"We've learned to change with the economy," Camacho explained. "We no longer can depend on those longer-run quantities and large orders. Being a 100-person shop, it's not always easier to be cheaper than the next guy. When you are dealing with 10-person shops, you're dealing with competitors with less overhead," and partially because of this, small shops have always been able to handle those small jobs. To grow today, he said, QFI must compete in that space too. After all, there's not enough large-volume work to go around anymore.

From a manufacturing efficiency perspective, small jobs aren't a bad thing. In fact, QFI now avoids running huge lot quantities. The job shop even takes a cellular approach for some of its work. One area of the shop has turrets placed next to bending cells and hardware insertion presses dedicated to certain products that are part of a long-term contract.

QFI also has implemented a demand-pull, kanban part-flow system throughout the shop. For instance, assembly and welding areas pull parts from upstream processes. The schedule may show that they need to produce 200 units of a certain product. The assemblers pull from upstream departments only what they need, when they need it. They don't need a batch of 200 all at once. That would take far too long to punch and bend. Instead, they may pull 50 into their kanban bin (the level depends on the job and the timing of the job). Once the kanban bin gets down to a certain level, it triggers upstream processes to fill the kanban again to 50—but never more. And if a rush job comes in, no worries. The scheduler simply adds it in between two small batches.

"We can expedite jobs with little or no interference to production, and customers are not always required to pay a premium," Camacho said.

Most important, such lean manufacturing initiatives shorten the cash cycle, which undoubtedly helped the company through tough times. Last summer QFI's business declined by 20 percent. "We had a few layoffs, but we never really faltered in a significant way," Camacho said.

QFI managers have been able to negotiate with suppliers to deliver material within a day. "With larger batches, we ordered material in larger quantities. Now we have been able to get the supplier to drop material required for, say, only 30 components. We get that metal the next day, and within two days we've shipped that product. So now we've been able to pay the bill for the material at the same time that we're getting paid for the product we shipped."

This couldn't have happened if long setup times forced QFI to run large batches, flooding the floor with work-in-process. Cash is king, and that is why streamlining setups, on the press brake or anywhere else, really matters. FAB

Senior Editor Tim Heston can be reached at timh@thefabricator.com.

Quality Fabricators Inc., 1035 W. Fullerton Ave., Addison, IL 60101, 630-543-0540, www.qfi-usa.com

Amada America Inc., 7025 Firestone Blvd., Buena Park, CA 90621, 714-739-2111, www.amada.com