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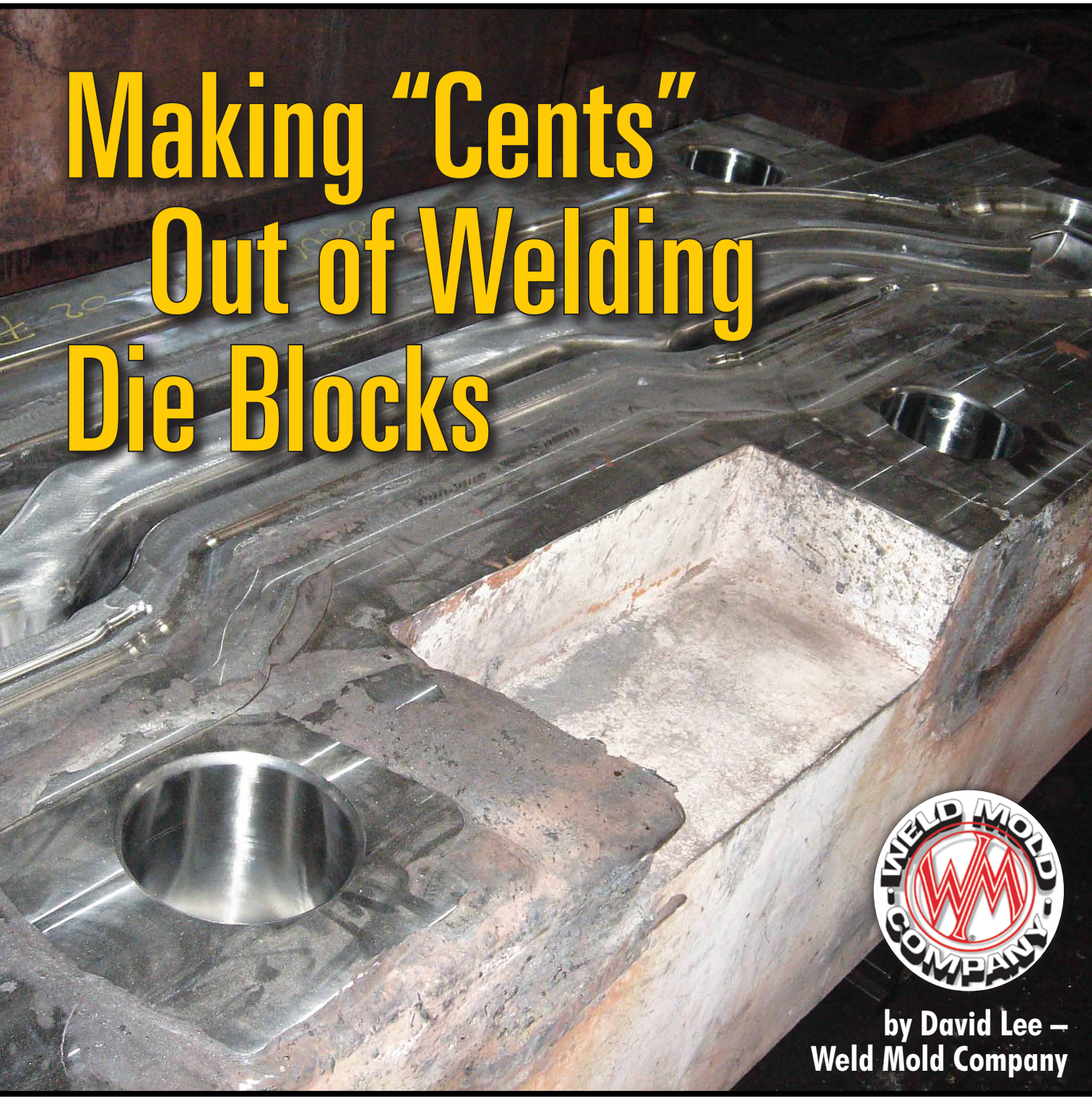

by David Lee – Weld Mold Company

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Making "Cents" Out of Welding Die Blocks

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The global economy isn't coming; it's already here! The competition is fierce, and every dime shaved from the cost of production can provide a competitive edge. Die welding is one way to cut costs from your production process.

Every company has a goal to make money, and forges are no different. Profitability keeps us all in business and, as a manufacturer, Weld Mold Company understands there are fixed costs that must be met – from labor and energy to raw materials and facilities. There are, however, costs in forging that can be controlled and from which profitability can be found. Among these costs are tooling inventory, parts per re-sink, re-sinks per block and reliability of cavity performance, which can determine whether a forged part is just a place-keeper in the production schedule or a real moneymaker.

The forging industry worldwide can be broken down into two groups: those that believe in die welding and those that don't. It is a common practice among forges that don't have a die welding program to think of the tooling they use as expendable. That means at the end of a predetermined period of usefulness it must be replaced. This thought process also means that there must be replacement blocks available.

"We're not in the die manufacturing business."

With few exceptions, a forging company will tell the casual observer that they are not in the die production business even though they have a fully equipped and staffed die room that is usually in full operation (even when the forge is not running). In a high-production shop that doesn't have a welding program, the casual observer will note that there are always

The die repair process begins by scarfing (top), during which the existing die is ground or torched, readied for the deposit of replacement material by flood welding (above left) and eventually machined into a new die (above right).

Table 1. Hammer-die process (connecting rod; 4,000-pound hammer; 4340/Weld Mold 9650)	
Original die costs	$1,600
Original die life	3,000 units
Original die cost per forging	$0.53
Cost of repairs	$1,600
Die life after repairs	7,958 units
Die life increase	250%
Cost reduction per forging	$0.33

new die blocks being roughed to receive the final configuration for production. The casual observer would conclude that, indeed, the forge is in the die production business. In a high-production forge, a die block rarely lasts 12 months (and typically much less in some shops) before a new one is needed to replace it.

Over a period of time, these forges spend money to purchase new die steel, to machine the block to fit the forging process and to create and machine the impression and any features (like locks) that may be necessary. As the impression is reworked, the productivity may drop with every re-sink. An impression that produced 5,000 pieces on its initial sink may yield 4,500 on its second sink. By the time the die has reached the last re-sink, it may be down by one-third of what it produced when new. The irony is that each re-sink costs the same. In the end, each forging sold bears a higher tooling cost. The last forging produced costs more to make in dies that will be scrapped than the first forging produced in new die blocks.

This Cycle Repeats for Each Die Block Used

Another issue more significant than cost fluctuation, the non-welding forge faces in die steel, is the lead time. This is particularly important when a new program is being discussed that would require additional die steel. Because there can be a prohibitively long lead time (at one time, six months), most non-welding forge shops maintain a stock of die steel. In 2014, a busy, mid-size hammer shop reported that they spent $100,000 annually on die steel to maintain production. This is just for the material and doesn't account for the cost and time to put that die steel into a condition to make forgings.

Many forges and forge operators today acknowledge the fact that, in most cases, a welded die will outperform an unwelded die in many critical aspects, most notably in cavity performance and die-block life.

What can I expect from a welding program?

Weld Mold has many longtime customers in the forging industry, all of which consider the tooling they use as a long-term investment rather than a replaceable commodity. Except for catastrophic tooling failure, new die steel is rarely even a budgetary consideration for them.

Table 2. Press-die process (connecting rod; 2,500-ton press; Finkl FX Die Steel)

	Virgin block 4 runs with machining	**535**	**9580**	**988**	**5551**
Die cost/repairs	$6,228	$3,769	$4,122	$4,850	$7,032
Die life (units)	6,000	8,580	10,740	16,260	46,866
Die cost/forging	$1.04	$0.44	$0.38	$0.30	$0.15
Die life increase (%)		43	79	171	681
Savings per forging		$0.60	$0.66	$0.74	$0.89
Savings (%)		58	63	71	86

For those forges, the savings are many, including:

- **Reduced spending for die-steel inventory.** Because welded dies have an almost indefinite life span, the purchase of new die steel is not a regular budget consideration.
- **Increased cavity performance** means more parts between repair cycles. The right selection of welding materials can increase output in a given cavity by 50%, 100% or even 300%.
- **Improved reliability** that each re-sink will produce the same number of parts. The consistency of the welding alloy and the ability to place specific wear-resistant materials at critical wear points can increase the amount of time a die spends in production.
- **Fewer production variables** because only the cavity is welded and machined. The die height and mass remain the same. Reliance on shims is sharply reduced.
- **Flexibility** to respond to a customer's need to implement changes in a part design (for model-year changes or new engineering considerations).

The savings not only apply to the dies themselves, but they extend to the support equipment. Sow blocks that crack in the die pocket, rams that wobble in the guides, broken or bellied die sets and loose guide-pin pockets can all be corrected and improved with the right selection of products and the appropriate welding process.

Prove It

Data from our customers can more clearly illustrate savings that are experienced by successful welding programs.

One shop making Inconel forgings reported that an unwelded die cavity could produce less than 50 pieces before the cavity was destroyed. Welding an FX-type die block with Weld Mold 9580, using the proper procedure from start to finish, the same cavity now reliably produces 700-800 pieces before rework is necessary. That is an astounding 1,500% increase in productivity!

How long can die steel reasonably remain in service before the accumulated stresses from forging and welding take their toll, cause failure and necessitate its replacement? Let's look at one

Table 3. Open-die process (3,500-ton press; open-die forge of billets to round bar; H-13/Weld Mold 4638 & Weld Mold 4637)	
Original die raw material	$11,898
Original die life	50 hours
Original dies cost/hour	$238
Cost of welding repairs	$31,934
Die life after repair	370 hours
Die life increase	640%
Welded die cost/hour	$86.30

forge that no longer budgets for die-steel replacement.

The savings are dramatic, and they are not exclusive to closed-die impressions, as the breakdown in Table 3 shows. It is important to note that while closed-die cost/production data is often based on the number of parts per re-sink, open-die cost/production data is almost exclusively determined by time in service, creating an analysis that results in cost per hour instead of cost per part.

The author's personal experience has seen the number of parts per re-sink increase from 4,800 to over 11,000 on a consistent basis, with most dies in service up to 12,000 parts. The age of the die blocks was measured in years. Because the welding program was so well integrated into the overall flow of forge production, if a set of dies made "only" 10,500 parts, somebody had some explaining to do!

Die-Block Reassignment

Let's say we have a production program that has ended and that the associated tooling has become surplus, though mostly in good condition. Traditionally, some of this tooling would be turned into components that will serve other purposes. For the most part, the dies may be viewed as non-usable and scrapped.

A huge benefit of a welding program, beside an increase in block life and cavity production, is the ability to reassign tooling once a program has ended. Since the tooling already fits your forging process, be it press or hammer, the need to buy new die steel can be greatly reduced or eliminated. The ability to blank out obsolete cavities with the appropriate welding material in anticipation of a new production program will save money and time, as well as provide flexibility when responding to a customer's RFQ.

With new production-program lead times shrinking, what used to be months in development has been shortened to weeks. This is due to the advent of global competition, the use of CNC machining, predictive-flow tools and other time-saving techniques. Waiting a week to receive the required die steel isn't an option. An in-house welding program can provide an immediate response to problems that may arise based on a customer requirement that a program use specific tooling materials like H-13.

Most forges use a Finkl FX®-type die steel. This provides the machinability, toughness and overall economy that many forge operators find favorable. When production requirements arise for tool steel other than FX types, Weld Mold can provide the material that will allow a common die steel to meet those needs. From our industry-standard 500 series (525, 535, 540, 545 and 5550) to our selection of standard and proprietary tool steels (e.g., 954, 9650, 9652 and 9580, H series and high-speed steel), Weld Mold products have been proven to increase cavity production and wear resistance of standard die steels like FX or even 4340. This allows the use of the less crack-sensitive base block to perform to the much higher production standards of H-13 or even M-2, which saves you money.

What are the requirements for a welding program?

Whether you want to establish a welding program in your facility or prefer to send it out, a successful welding program requires:

- A top-down commitment to success
- The correct material and equipment
- Skilled personnel and supervision
- The correct primary and support equipment
- A documented welding procedure

These requirements apply not only to the forge that has or wants to incorporate die welding into their tooling management program but to those outside sources chosen to provide this service. Traceability of the process must be available for the benefit of all involved should problems arise.

The decision to establish a welding program must take many things into consideration. This is where die-repair professionals can help. A common mistake is thinking that the equipment on hand, used primarily for maintenance and fabrication purposes, is suitable to the task of die and forging component repair and rebuilding.

Since 1945, our welding professionals have served the forging industry, developing welding filler materials, technology and equipment that can ensure the success of your welding program. We can provide an analysis of the requirements of a welding program that serves your forge's needs.

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