FARMING

PRACTICAL PRODUCTION INFORMATION FOR PROFITABLE FARMING

WP photos / Michael Raine

Gerald Foster of Sunnybrook AB, whose welding shop is shown above, is experimenting with bolt-on wear edges to reduce combine expenses.

Replaceable concave wear edges

A $25 part that installs in one hour makes better economic sense than spending time and money to replace a concave valued at $1,300 to $2,600 ~ **Ron Lyseng**

LOW WHEAT PRICES are taking a bigger toll than many people comprehend, according to Gerald Foster, owner of Sunnybrook Welding and Machine in Sunnybrook AB. The poor economic return on wheat forces farmers to diversify into beans, peas, lentils and other specialty crops. That, in itself, is a good thing.

"But there's a down side," says Foster. "Operators are forced to run their cutterbar right down at ground level, and that plays havoc with your combine. Even if you don't have what would be considered really stony land, you're still putting a lot of small stones through the concave and back into the processors."

Foster, who makes his living rebuilding broken combine parts for farmers all over North America, says the common scenario is a stone gets into the concave and breaks off a piece of steel big enough to cause extensive, expensive damage in the delicate workings of the machine.

That may be good for his welding and machine shop business, but Foster says he would rather concentrate his efforts on engineering and fabricating combine parts that he never sees back in his shop again.

Longevity needed

"Chrome is passé. We cannot continue using it in combines," says Foster. "Chrome is no longer acceptable from an environmental point of view and it does not give your combine the performance and longevity farmers expect today. On top of that, it costs too much for what you get. From what we've found in our research, boron is the only product that gives us a significant improvement at an affordable price."

His first major step in putting boron into the combine was the development of a boron hardening treatment for rasps (see FARMING magazine November/December 2000.) When done properly, the boron treatment creates a super-hard surface that resists abuse.

But boronizing is an expensive process, so treating the entire concave is cost prohibitive. Boronizing certain parts and then welding them into place creates weak welds. The slightest trace of iron boride in the weld area can cause the weld to fail.

Foster's plan to bring boron into the concave is the combination of two techniques. Through their experience with boronizing rasp bars, the Sunnybrook people have a good grasp on the process of making iron boron penetrate into and adhere to various steel alloys. They concentrate on the hard alloys such as high carbon 1045 used to make wear parts in combines. The tricky part was figuring out how to apply the technology to a large item like a concave.

Bolt-on wear edges

Foster studied the lathes, drills and milling machines in his shop and decided that replaceable cutters could work on combine concaves just as well as they do on 3,000 rpm drills that wear out high carbon steel.

"We use replaceable carbide cutters all the time here in the machine shop. When a tip goes bad, you don't toss out the whole machine. You install a new cutting tool. The cutters are built so they fit snugly into their holder. There's no room for movement. They're held into place by tiny little Allan key screws about the size of the ones on your reading glasses. That's exactly what we're doing now with wear edges on concaves. The fit has to be perfect."

Before they are welded into the concave assembly, each of the front four bars has a groove fly cut into the top edge. The groove is 5/8-inch deep and 3/16-inch wide. The replaceable wear edge that bolts into this notch is slightly larger than the notch itself. It fits neatly into the groove but protrudes slightly up and forward, giving it a more aggressive profile.

Countersunk machine bolts every five inches hold the replaceable edges in their groove. The bolts thread into holes that are drilled and tapped into the basic support bar of the concave.
The thrust of the cylinder and crop push toward the edge, holding it in place in the groove. The machine screws serve more as locators than actual fasteners.

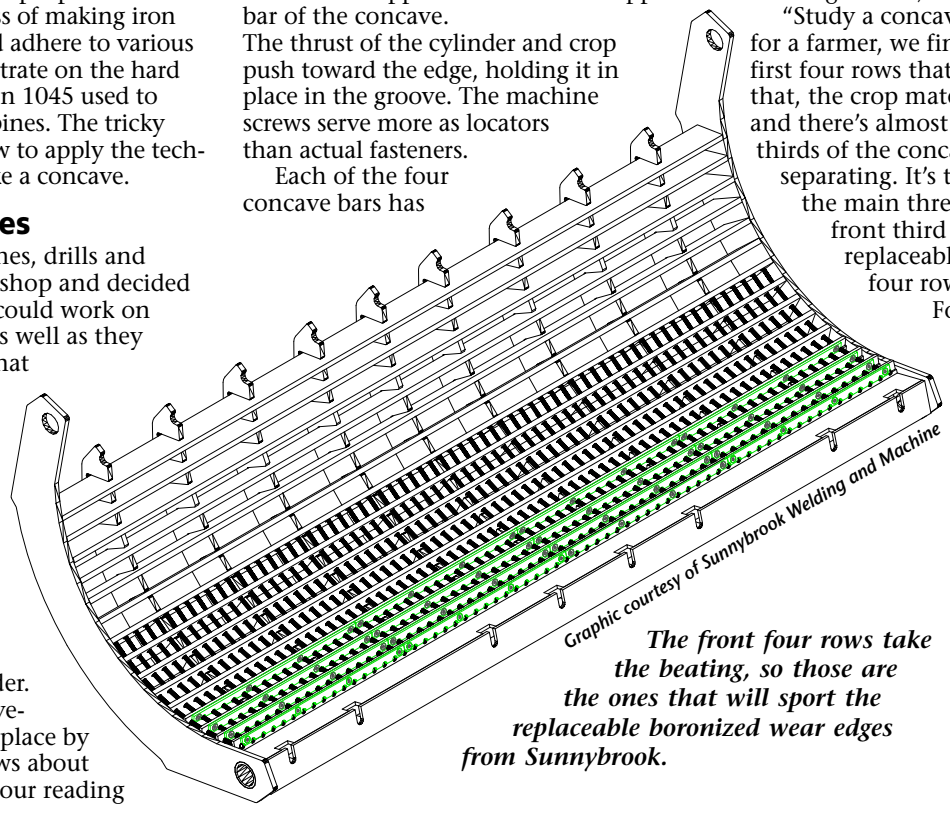
Each of the four concave bars has four individual replaceable wear edges. Depending on the combine, they range from 15 to 18 inches long and weigh about a pound. Once production is in full swing, each replaceable wear edge will cost about $25. That price includes the cost of machining the edge out of 1045 alloy, boronizing, quenching and tempering.

Replacement in the field is a simple procedure, requiring an Allan wrench to remove the damaged edge and install the new one. There is no need to remove the concave.

"If you never have a serious rock incident, your original concave could go on working forever," says Foster.

"Study a concave. When we rebuild one for a farmer, we find it's nearly always the first four rows that need the work. After that, the crop material is spread out evenly and there's almost no wear. The back two-thirds of the concave are really just for separating. It's the front third that does the main threshing. So, logically, the front third is where we put the replaceable edges. That's the first four rows."

Foster says Sunnybrook's patent lawyer has done a thorough search and found no similar technology in combines.



Graphic courtesy of Sunnybrook Welding and Machine

The front four rows take the beating, so those are the ones that will sport the replaceable boronized wear edges from Sunnybrook.

How hard is hard?

Fracture mechanics is a relatively new area of engineering that concentrates on structural integrity of materials. The internationally recognized standard for steel hardness is the

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WP photos / Ron Lyseng

The concave stays in the combine and a simple Allan key allows replacement of a damaged wear edge.

Steel is no steal today

THE ESCALATING COST of steel may force manufacturers to build implements that serve the farmer for more years.

"We're already seeing surcharges on steel," says Gerald Foster of Sunnybrook Welding and Machine. "The steel firms are charging agricultural implement manufacturers like us a surcharge when they gather scrap steel to melt down."

According to Gary Harris, owner of Westward Products in Red Deer AB and chair of the Prairie Implement Manufacturers Association, farmers can expect high steel prices to become permanent.

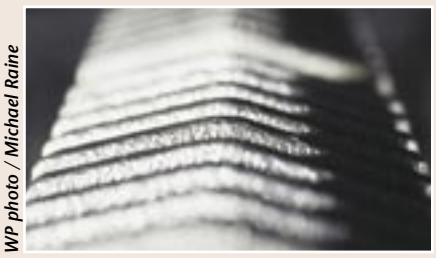
Harris says North American steel mills increased steel prices by $25 per ton in January, $55 per ton in February and $45 in March.

He says the increasing needs of China have triggered high global demand for iron ore, scrap steel, coke, alloy elements, oil and freight. Those higher prices are here to stay and will be reflected in prices farmers pay for machinery.

At least one major manufacturer is taking the boron challenge seriously. John Deere recently announced an optional large wire boronized concave for 9560, 9660, 9760 and 9860 STS combines working in small grains, soybeans, corn and rice.

In the same release, they announced the availability of stainless steel in clean grain elevators, loading augers, cross auger troughs and grain tanks.

— *RL*



WP photo / Michael Raine

Optional boronized combine parts may soon be available through some major manufacturers.

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Charpy Impact Test. Charpy is a precise measurement of how much energy can be absorbed by a piece of steel before it breaks. Higher energy absorption means a harder alloy.

Energy absorption is expressed in units called Joules. Energy absorption can also be expressed by converting Joules to foot-pounds of torque required to break the sample. Higher Joule numbers and higher foot-pound numbers indicate greater strength.

Shear force is a different strength factor, but is also measured by the Charpy test and expressed as a percentage. A higher percentage means greater shear strength.

Sunnybrook hired an independent engineering lab, Canspec Materials Engineering and Testing of Edmonton, to run Charpy tests on samples of three groups of concave edge material.

Specimen A was the control group, which was standard 1045 alloy with no surface hardening. Specimen B was standard 1045 alloy with a chrome overlay applied according to industry standards. Specimen C was the same 1045 alloy, but with a boronizing treatment plus the necessary heat quenching and tempering to support the iron boride process. (See chart on impact test and specimen photos.)

Specimen A, the control samples, averaged 14 Joules, 10 foot-pounds of torque and 13 percent shear strength.

Specimen B, the chrome plated samples, did slightly better on energy absorption but worse on shear rating, something that many farmers suspect of their chrome surfaced concaves. The chrome averaged 16 Joules, 12 foot-pounds of torque and 10 percent shear strength.

Specimen C, the boronized samples, averaged higher with 39 Joules, 29 foot-pounds and 47 percent shear.

The test is done by locking each sample into a frame and then striking it with a swinging pendulum with a spike point dropped from a given height. The pendulum is precisely aimed at a small notch machine cut into the specimen to ensure that it will always snap when struck.

The distance the pendulum travels after it breaks through the specimen is carefully measured. With a weak specimen, the pendulum will swing a long way after breakthrough and ratings will be low. With a stronger specimen, the pendulum travels only a short distance after breakthrough, because it required more energy to break the sample, so ratings will be higher.

According to Foster, "shear is not as important on replaceable edges because they are physically backed by the main support bar. Energy absorbed before breaking is really the most critical factor. If you look at the numbers, you can see why we think boron will shortly make chrome obsolete."

Field testing

Sunnybrook's controlled field testing will begin early this summer on eight combines running in some of the worlds grittiest harvest conditions – Idaho, Oregon and Washington state.

The Sunnybrook test will include conventional concave materials, bolt-on boronized wear edges and bolt-on stainless steel wear edges.

"From everything we've learned to date, boron is the way to go," says Foster. "But we're not close minded about this. We think stainless steel might also be a good candidate for this kind of work. Stainless steel is expensive, just like boron, but if it can be made to work as a small, replaceable piece that we bolt into place, it might be economically viable.

"It's not viable to try to do these high tech sort of treatments on a scale as large as the whole concave. All you need to do when you do this kind of engineering is to isolate and deal with the high wear areas."

Gleaner is up first

Foster says the Sunnybrook replaceable wear edges will eventually be available for all combines, but Gleaner is first on the list. The replaceable boronized edges are expected to be available for rotary Gleaners by this time next year.

"We're going to start with the Gleaner R62, 72 and 75. The most abuse you'll ever see on a concave is on these combines because of that natural flow process. They have a conventional type feeding system up front, and then immediately behind the concave they convert to a rotary.

"As you're looking into the combine, the material that comes in on the far left comes up and over the cage and actually passes over the concave twice. There's a little area there about six inches wide where we always see an extra eighth inch of wear. That's the highest wear spot on any combine. That will be our biggest challenge, so that's where we want to start."

Dollars

Foster says the economics of the replaceable edge are simple. A replacement concave made of conventional hard steel typically sells for about $1,300. A chrome plated concave sells for about $2,600.

A complete Sunnybrook concave with replaceable wear edges will sell for about $1,600. That will be a new concave, manufactured from new steel, with fly cut bars and equipped with a set of boronized wear edges. Sunnybrook will not be able to retrofit existing concaves because the fly cut machine work must be done before the unit is assembled.

"On every concave, we start with 1045 hard steel. That's pretty well standard in the industry now. Adding these wear bars increases our cost by about 20 percent. So the farmer buys a concave that's $1,000 cheaper than chrome and will last many times longer than chrome.

"As long as you don't wreck the concave, you can go on replacing wear edges forever. Every couple years you do the first two rows. Then do rows three and four later when it's needed. And, if you're really interested in getting creative and stretching your dollar, it only takes a couple hours each year to measure all the edges and move the best ones to the front and the shorter ones to the back."

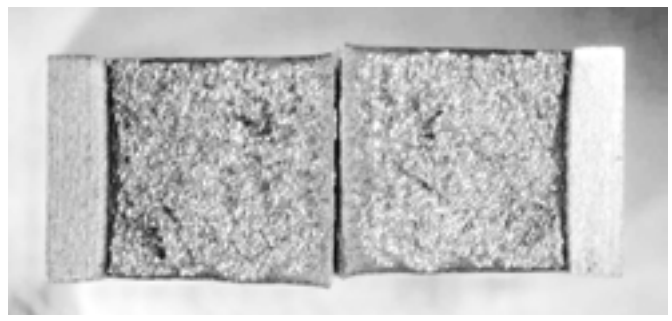
Foster says there's more to the picture than saving money. If the concave can last the life of the combine, there's more incentive to build it better in the first place. He says that until now, concaves have been thought of as throw-away items, almost like belts and bearings.

"Farmers are reluctant to spend more money than they absolutely have to on a concave because they know it only takes one second and one stone to send a brand new concave to the scrap metal pile. If manufacturers and farmers know the thing can last a long time, there will be more reason to justify the investment in stronger and better concaves.

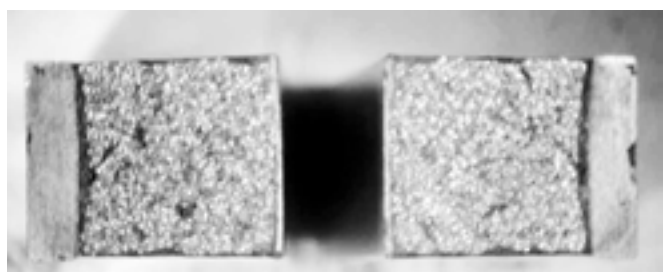
"Another thing we're looking at is the cost of running the whole combine. Lab tests tell us that boron concave edges greatly reduce the likelihood of a large piece of steel flying back into the combine. If we get any problem at all, it will be a small chip of steel, not a chunk of steel. It might knick up a couple of straw chopper blades, but that's about the worst that can happen under most circumstances." ■

Contact: Gerald Foster, Sunnybrook 780-789-3855

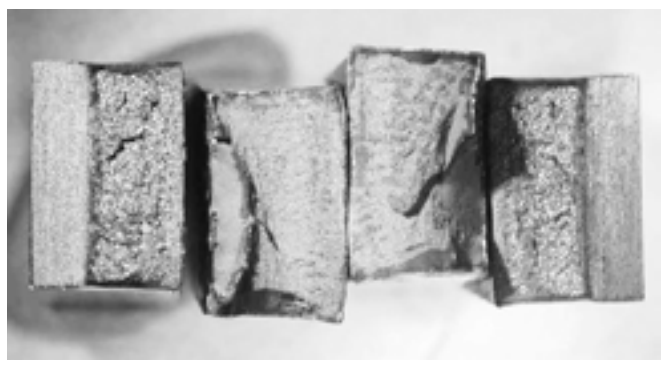
Impact Test



Specimen A Control	Test Results		
	Energy Absorbed		Shear
	(J)	(ft. lbs.)	(%)
A1	16	12	20
A2	14	10	10
A3	12	9	10
Average	14	10	13



Specimen B Cr Plate	Test Results		
	Energy Absorbed		Shear
	(J)	(ft. lbs.)	(%)
B1	14	10	10
B2	18	13	10
B3	16	12	10
Average	16	12	10



Specimen C Wear Strip	Test Results		
	Energy Absorbed		Shear
	(J)	(ft. lbs.)	(%)
C1	43	32	50
C2	23	17	30
C3	50	37	50
Average	39	29	47

Source / Canspec Group Inc. *WP graphic / Shelley Zipchen*

FARMING CONTACTS

Toll free 1-877-379-4414

William Strautman, PAg
(306) 776-2337 fax 776-2326
bill.strautman@producer.com

Ron Lyseng
(204) 654-1889 fax 654-2032
ron.lyseng@producer.com

COMMENTS WELCOME

We welcome comments and suggestions. Send to **FARMING**, The Western Producer, Box 2500, Saskatoon, Sask. S7K 2C4.
Fax: (306) 776-2326
e-mail: *farming@producer.com*

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