The Grinding Journal
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# The strange world of testing high value, big exposure components

## Walter consolidates production

## Knowing the source of grinding errors & how to fix them

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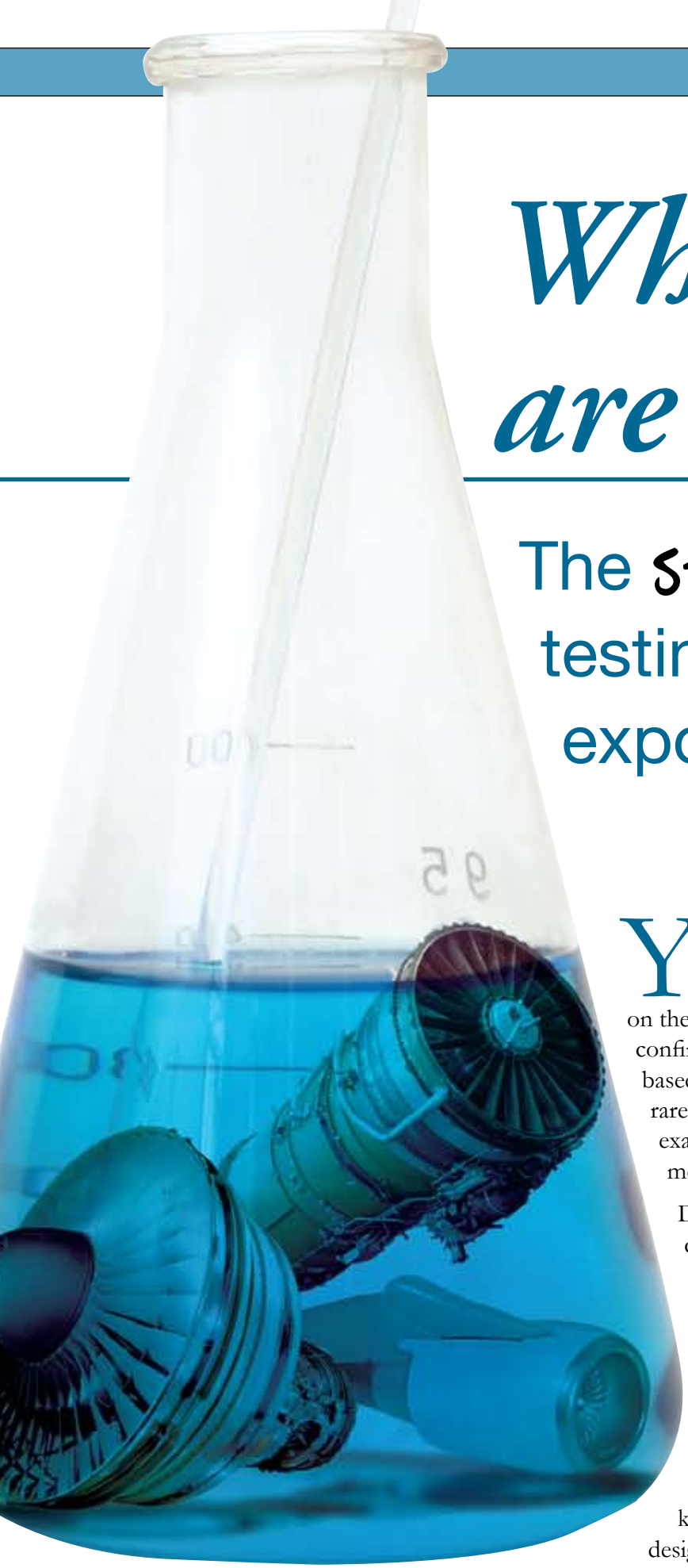


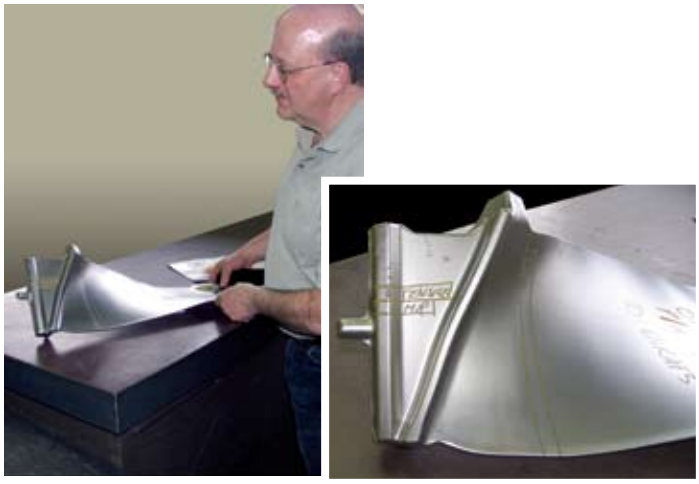
# When lives are at stake

## The strange world of testing high value, big exposure components

You've read the stories. A new airliner will be modeled down to the smallest bolt on a computer before it's built. Enormous production orders will go out based on the computer models, without any real-world checks to confirm that things will fit. Suppliers will produce the parts based strictly on computer programs, often on machines rarely touched by a human. And the airliner is just one example. We could be talking about any number of our modern conveniences.

Does it make you wonder how we can place so much confidence in a complex web of intangibles – or even *if* we should be so confident? As you're flying across the Atlantic, do you ever ask yourself how "they" know the turbine blade in that jet engine will withstand the heat and stress? Do you wonder, as they shave every pound off the design to save fuel, how they know the landing gear won't collapse on the tarmac? The answer is likely to include Dirats Laboratories – a respected testing facility hired to confirm that key components *do* in fact have the properties they are designed to have.

*Machining Supervisor Richard Irwin looks over a wide variety of parts and material samples awaiting testing. These "raw" samples require machining to create a testable specimen (note the markings on the part in the foreground). As the paperwork suggests, Dirats Laboratories tracks each part throughout the process of machining and testing.*



*(pictured to the left) Turbine components are probably the most commonly tested item at Dirats Laboratories. Here Richard checks-in a just arrived forged blade. The markings indicate which sections need to be cut out and tested.*

## How does testing work?

How does a full-service testing company like Dirats (pronounced dihr-ats) Laboratories work? In a typical sequence, a customer sends a high value part with a request for data about that part. For example, does the material meet a certain standard for high cycle fatigue? Or high-temperature tensile strength? Or any number of other properties. Dirats Laboratories creates a test specimen from that part, conducts the necessary tests on that specimen, and issues a certified report. That's the simple version. Let's explore some of the challenges.

## "Old timers" who took the tough courses in college

Dirats Laboratories stands out for the breadth of the testing they can perform. Not just mechanical testing, but also chemical and metallurgical analysis. They also handle the most difficult materials, which might mean using X-ray diffraction to characterize the phase composition of a ceramic coating powder. Or a plasma mass spectrometer to assess the trace element composition of an aerospace alloy. It's real egg-head work. So perhaps it's no surprise the *average* tenure of their testing professionals is an astonishing 18 years and growing. Why? Perhaps because Dirats Laboratories is a family-run business that has focused on testing from their foundation in 1939, nearly seventy years ago. Current president Eric Dirats (grandson of the founder) virtually grew up in the shop.

## When it absolutely, positively has to be there overnight

It's an intensely service oriented business. In a typical example from airframe manufacturing, a customer might forge and heat-treat a fifteen foot long landing gear leg, including a "prolongation" that he cuts off and sends to Dirats Laboratories for analysis. But he'll have to withhold the part from further manufacturing until Dirats Laboratories confirms that the prolongation passes the tests. So they will perform the testing overnight, even though the part is Rockwell 60 and even when they don't know it's coming until 4:00 in the afternoon. This helps explain why most Dirats Laboratories employees are in a Quality or Technical Support role, not machining or testing. (By the way, Eric Dirats tells us that "Every leg you see on a commercial airplane has had testing done on that specific piece of metal." Like he says, that's "nice to know!")

## Extreme levels of quality control

As Eric puts it "There's *nothing* here that isn't at *least* important, if not critical, and that's the way we have to behave. We have to give it our best." So the lab documents every specimen from the moment it (or the part it comes from) arrives. What's more, every specimen process has to be able to be duplicated precisely. Their collection of quality control certifications reads like alphabet soup. And their client list reads like a global "who's who" of the aircraft, power generation and medical prosthetics industries. Eric continues: "People use us because their part has high value and they have big exposure. We're like an insurance company…We reduce our clients' risk."

## "All the disadvantages of a production company without the advantages"

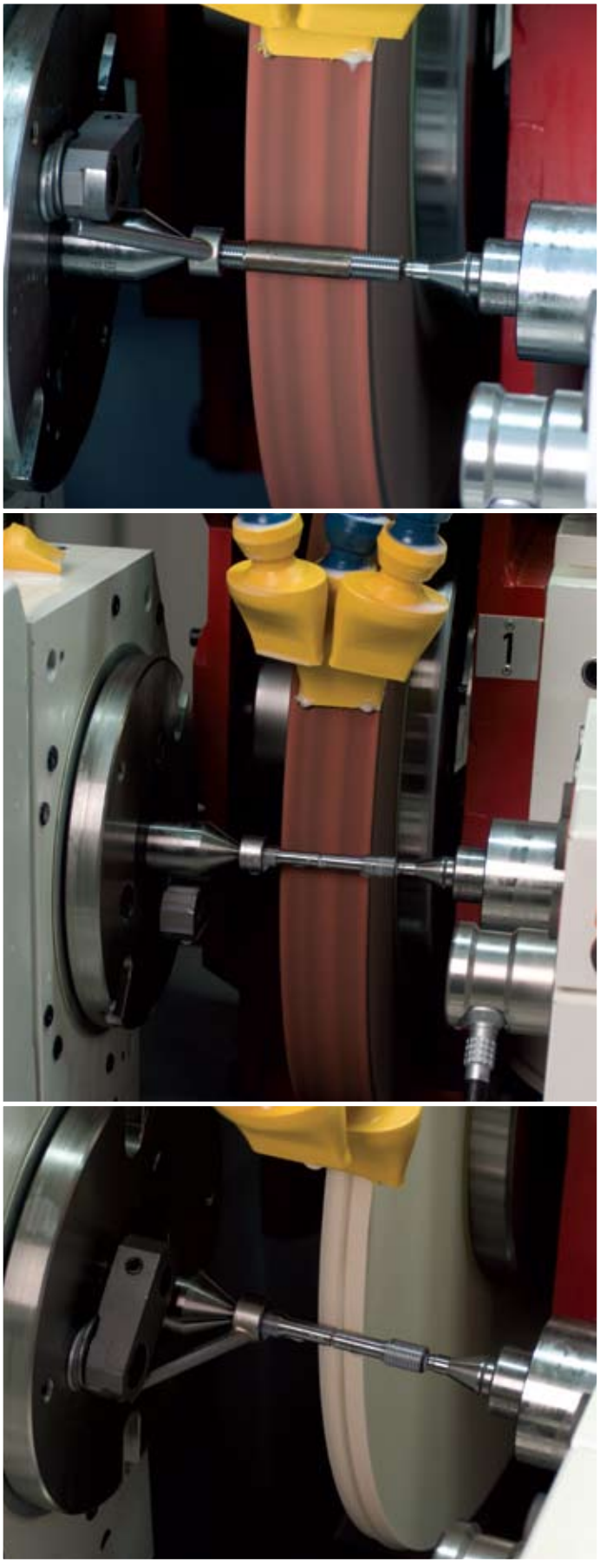
Testing is relatively labor intensive, yet it also requires a high capital investment. That's especially true at Dirats Laboratories, since they can machine an infinite range of specimen geometries in-house, in addition to their broad testing services. In fact, they greatly prefer to both prepare and test the specimen, because only then can they be *fully* confident in the validity of the test results. But unlike a manufacturing company, Dirats Laboratories can't produce parts for stock. If their machines are not producing specimens for immediate testing, they are idle. So Eric is ruefully accurate when he says they have "All the costs of manufacturing without the advantages." But this is where Studer helps…

*Operator Slawek Urbanek does most of his machine programming off-line on a PC with StuderGrind software. That maximizes productive time on the machine and speeds change-over-time - a critical factor because the lot sizes are tiny.*

*In this case, Dirats Laboratories uses EDM to cut rough test bars from a larger material sample. The final prep before testing is done on a Studer S31.*

## Grinding handles tough materials with low stress

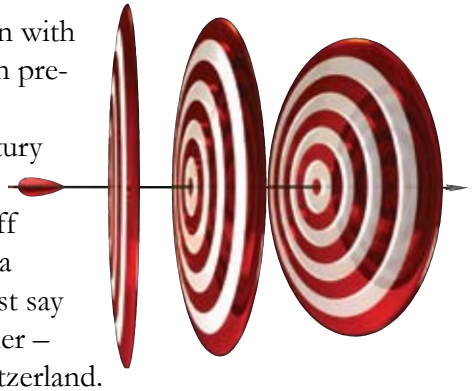
Being able to prepare a wide variety of test specimens requires a variety of machine tools. Given the materials involved and the geometries required, grinding is a key technique. For example, testing the tensile strength of a refractory aerospace alloy calls for a test bar about three inches long with a ¼ inch gage



diameter (commonly called a "dog bone" outside Dirats Laboratories). The blank may be cut from the sample material with wire EDM or abrasive waterjet. But to create the final form the blank must be ground, and with a minimum of residual stress, which would affect the test results.

Minimizing stress is also critical because Dirats Laboratories must be able to duplicate the specimen *exactly,* even if the subsequent job is *months* later. Otherwise the test results can not be compared. Geometric tolerances are not particularly tight and the specimen only has to fit the testing stand. But it's a challenge to duplicate the *metallurgical* properties of a series of parts, especially when they are hard to machine. That's a major reason Dirats Laboratories has its own machine shop in the first place. And it's a major reason a Studer S31 cylindrical grinder is at its heart.

## As stable as a Swiss mountain and as accurate as William Tell



The Swiss obsession with accuracy might even pre-date William Tell's legendary 14th century marksmanship (he shot an apple off his son's head with a crossbow). Let's just say it runs deep at Studer – based in Thun, Switzerland. The Studer S31's unique GRANITAN base dampens any vibration. Its proven knobbed guideway system virtually eliminates "slip-stick." The FANUC 21i control and glass scales on the X & Y axes assure precise positioning. Every aspect of the grinding process can be monitored and controlled, like achieving a constant wheel speed through a grind. Coolant delivery is excellent. And key components are manufactured to the highest tolerances. For example, the roundness of the workhead spindle is accurate within 0.000,004 inches (0.0001 mm) and the conical tolerance over 10 inches of taper is 0.000,08 inches

***(pictured to the left) The Studer S31 grinds the midsection of a test bar and then the groove in one setup, thanks to a rotating head with twin spindles. Besides flexibility, it's the rock-solid repeatability of the machine that gets top billing.***

(0.002 mm over 250 mm). These features combine to deliver peerless accuracy and stability on even the toughest material.

Once Dirats Laboratories has established a machining process that produces a specimen without residual stress (and such qualification typically requires destructive testing), they know the S31 will duplicate that process no matter when it's repeated. Or as Eric puts it: "It's a Six Sigma machine. It does everything you need to get the process to the next step."

## Relying on Studer's fast-changeover capabilities

Cutting the "time to get the first part" is critical to Dirats' Laboratories profitability because their batch sizes are so small. Ten specimens would be a big batch. But as Machining Supervisor Richard Irwin explains "Even if we need a run of ten bars, we may *not* make them as a set. We may have to get one to test, interrupt the setup for another job, and then return to the original bar for another specimen." So while the grinding itself may then return to the original bar for another specimen." So while the grinding itself may actually be a little slow (so as not to introduce stress), changeover has to be very fast. "It's the one place where we can save time. We can't change the machining parameters, but we can cut the setup." Thankfully, this is another area in which Studer technology excels.

Operator Slawek Urbanek reports that "The machine is easy to setup. And the software is very easy to use. Changeover takes about 10 minutes, unless the wheel must be dressed to a new form. If the part requires a different wheel form it can take a while to dress that form into the wheel." But Slawek also demonstrated that *StuderGrind* software allows him to program these changes offline on a PC, so he's not using machine time. With any advance notice about what part he needs to grind next, he can go from part to part in minutes. And the S31's rotating grinding head turret with twin spindles gives Slawek the ability to combine different wheels to complete a complex grind in one setup. For example, the typical test bar requires an OD grind along a central gage section, a "V" notch with a small radius at its base in that gage section, and a thread at each end. That's one setup on the S31.

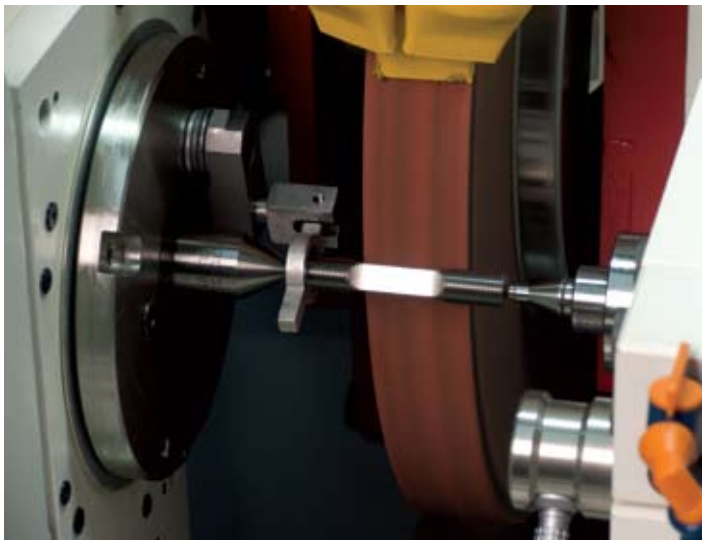

*After programming on a PC, Slawek spends only a few minutes on the machine itself. On the machine or off, he says the Studer software makes it easy.*

## Out-of-round grinding too

Although it wasn't part of Eric's original thinking, the S31's ability to handle non-round grinding has opened new possibilities, because some customers now demand a test bar with a non-round gage section. "Sometimes it's a rectangle, sometimes an oval, sometimes a rectangle with radii. From their traditional sources, customers found this to be a very expensive specimen to make because it required 25 operations and a lot of hand work. Now we have a way to make these parts easily." That's because Slawek can program the forms with *StuderGrind* software in seconds and the S31 grinds them in one setup. Eric summarized the S31 by observing that the machine "does everything a production grinder does excellently, but it's much more flexible. That's new to the industry."

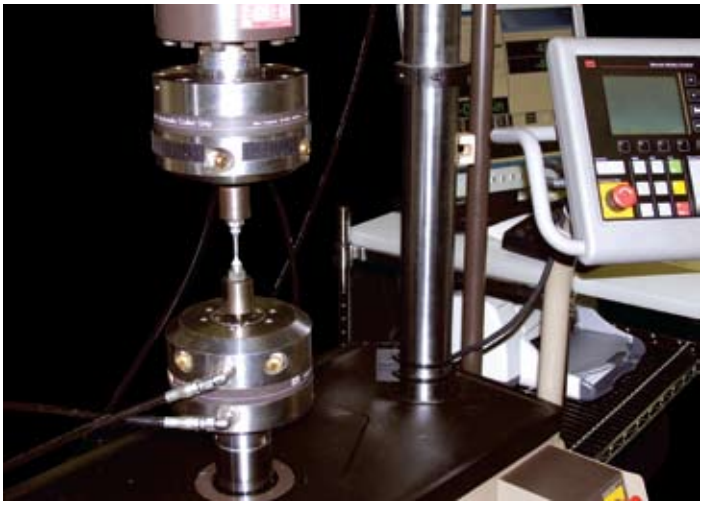
## Excellent support cinched the decision

If repeatability, fast setup, and flexibility filled the bases, support scored the run. Eric says every member of the United Grinding support team "from the engineer to the field technician …has been very capable. They know everything inside out and they work efficiently. It was a major factor in choosing the Studer." And he emphasized that he wasn't just talking about service or training, both of which were excellent, but the ability



*The Studer S31 has made out-of-round grinding an easy addition to Dirats Laboratories' capabilities, and the forms can be programmed off-line with StuderGrind*

call and get applications advice on new projects. In his opinion, a typical customer can't become an expert at every aspect of grinding, especially given the capabilities of the machine. So getting quick answers requires a direct link to the manufacturer. That's what he gets with Studer and United Grinding. Richard went even farther: "In the end the final the question came down to 'Where are you going to get support for this piece of equipment?' There are some others around that have pretty good machines, but you guys have <chuckling> a *really* big support network!" ■



*Now we get to destroy the part! After all the machining, the bar is mounted in a tensile strength testing stand and pulled apart (while measuring of course!)*

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