Documentation: A Challenge in Making Aerospace Gears

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For years, Reliance Gear Corp. has manufactured gears for the aerospace industry. Located in Elmhurst, IL, Reliance has served as a Tier 2 or Tier 3 supplier. (Tier 1 suppliers work directly with the aerospace primes, the Boeings and Embraers of the world.) Like many gear shops, Reliance is certified under quality management standard ISO 9001. And its aerospace customers were satisfied with that certification. Until two years ago.

That was when Reliance learned it would have to become certified under another standard in order to keep making gears for its aerospace customers. The other standard: AS9100, the aerospace standard for quality management.

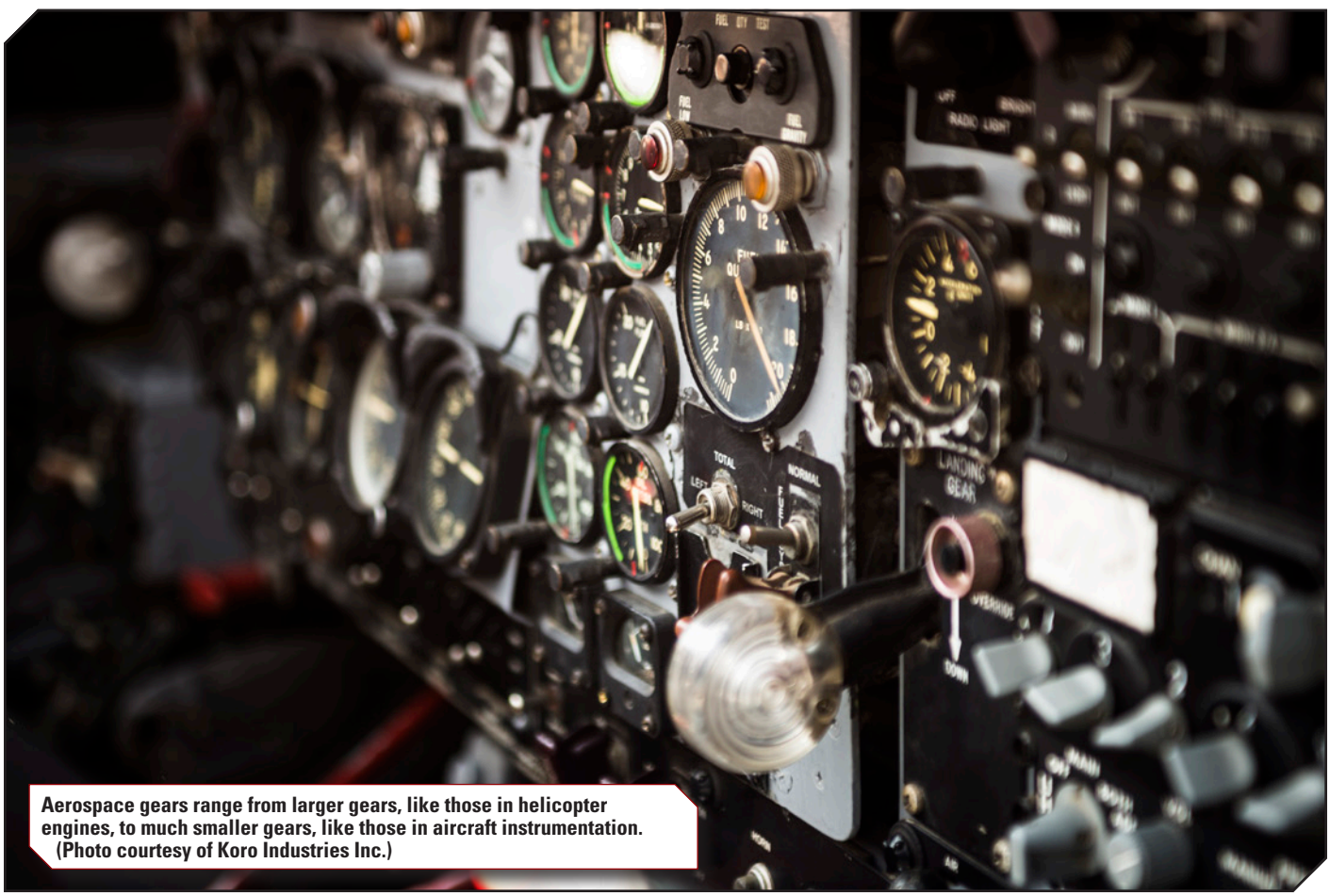
Increased Documentation

As it turned out, though, the process for AS certification was more involved in time and money than the process for ISO certification, according to Harshad Gujarathi, the former managing director of Reliance. (Editor's note: Since talking to Gear Technology for this article, Gujarathi accepted a position at another company, vice president of operations at IMS Global Gear & Machining, Downers Grove, IL.)

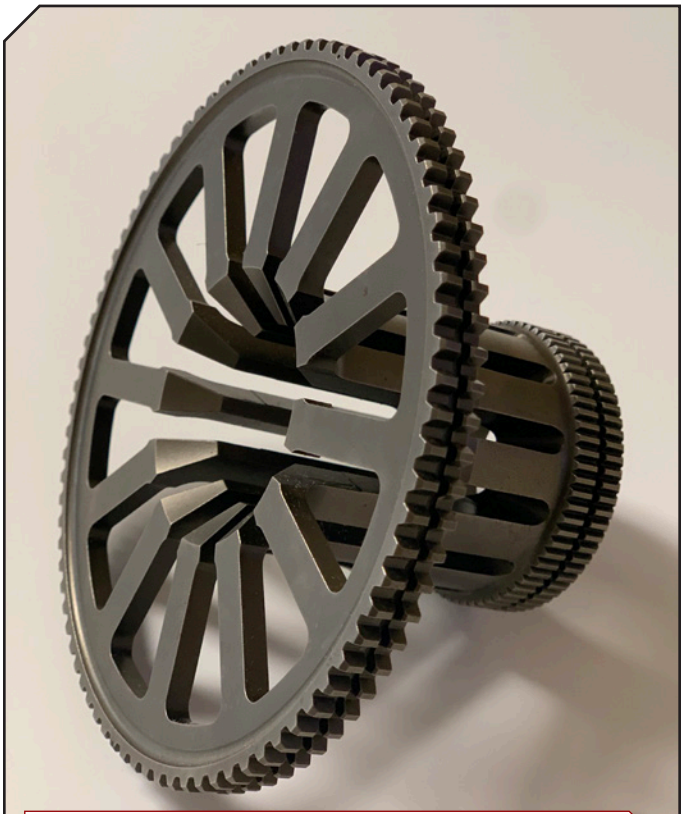
At first, Reliance Gear's experience with AS9100 didn't seem much different from its experience with the ISO standard. Gujarathi recalls the first and second AS audits. For the first, Reliance prepared its documents and an AS auditor reviewed them. He did give Reliance some advice about expanding its documentation, but he appeared satisfied with its paperwork.

When he returned for a second audit, though, there was a problem. Reliance hadn't expanded its documentation to the extent the auditor had expected. The gear shop had to document considerably more in order to meet AS9100. To do that, Reliance sent its quality control manager to a training program on the standard. It also hired a consultant, a person with 25 years of experience as an AS auditor.

Through this process, Reliance learned how much detail it needed to provide in its documents under AS9100. Gujarathi gives a brief example: the training matrix for a machine operator. Under ISO 9001, it may be enough for the matrix to say that an operator was trained on this machine, this second machine, and this third machine. Under AS9100, the matrix has to say that the operator was trained on this machine, by this person, for this many hours, and has to say it for each machine.



Aerospace gears range from larger gears, like those in helicopter engines, to much smaller gears, like those in aircraft instrumentation. (Photo courtesy of Koro Industries Inc.)



To make aerospace gears, some gear shops have to be certified not under ISO 9001, but under the aerospace standard for quality management, AS9100. (Photo courtesy of Reliance Gear Corp.)

Gujarathi describes AS9100 as a good standard and accepts that its requirements for aerospace work must be considerable: "It's for a really good reason." However, he adds that the necessary paperwork is also considerable.

The time and money spent to keep such detailed documents is one cost to a gear shop. Another is the AS audit itself. Gujarathi says an ISO audit can take a few days, an AS one can take a week. Also, during the audit, the quality control manager is preoccupied with the auditor every day. "He's not working on anything else," Gujarathi says.

He adds that the registration fees are different, saying that to register as ISO certified, it costs several thousand dollars; to register as AS certified, four to five times that.

"The cost differential and the requirements within the standard are so day and night that it becomes very difficult for a small company like ours to sustain that cost year after year," Gujarathi says. "It's not one time."

However, AS9100 certification isn't an across-the-board requirement of gear shops that serve the aerospace industry. For example, Koro Industries Inc. in Maple Grove, MN, also manufactures aerospace gears, specifically fine- and medium-pitch gears. Like Reliance, Koro is certified under ISO 9001, but Koro hasn't been required by its aerospace customers to implement AS9100.

Despite that difference, both companies have to deal with the additional documents that come with working in the aerospace industry.

Lists of Approved Suppliers

Once they cut teeth, gear shops often have to send their aerospace gears to subcontractors for additional processing, like heat treatment. However, some additional processes can be performed only by certain companies, companies specified by an aerospace customer.

These specified companies are on lists maintained by the customer. Each list tells a gear shop which companies are approved to supply a certain type of processing. Like the shop itself, these suppliers get on the customer's lists by doing the work to meet the customer's own certification requirements, which include audits conducted by the customer.

These approved suppliers can be a reassurance. A gear shop can relax a bit about sending a customer's aerospace gears to these suppliers. "They're approved for this customer," Gujarathi says. "They know exactly their requirements."

However, many companies may be unwilling to do the extra work to become certified, so an aerospace customer's lists may be limited. "We have to go to very few, a pool of very few subcontractors," Gujarathi says.

Steve Korosec echoes that comment. The president of Koro Industries, Korosec says the manufacture of aerospace gears: "It's a small industry."

Gujarathi adds that this situation wasn't always the case. In the past, Reliance could pick any subcontractor to do additional work on its aerospace gears, so long as that company could do the processing to the gears' specifications.

Moreover, Gujarathi notes: "The requirements around special processes—plating, coating, heat treatment—those are becoming more and more stringent."

More stringent requirements can mean looking at more documents.

Pre-Production Research

As Gujarathi explains, a gear shop needs an understanding of each outsourced process in order to work with the subcontractors that are performing the processes. "It puts a big intellectual drain on us," he says. "We are responsible for those products, even if the subcontractors are doing that [processing] for us."

The amount of paperwork is described by Korosec. For his example, he uses purchase orders from aerospace customers.

"You can have a purchase order now that is the thickness of a small-town phonebook: a quarter-inch thick," Korosec says. Once it has the order, a shop has to review it to figure out which clauses apply to in-house production and which apply to each of the subcontractors. Also, a clause may or may not apply to the part the shop is making.

Moreover, figuring out the clauses may not be the end of the work. For example, a clause about plating may not include the exact specification needed to meet the customer's requirement. The clause may only refer in general to the specification. As the contractor, the gear shop has to go onto the website of its aerospace customer and get the latest version of the actual specification.

With the specification in hand, a gear shop looks for subcontractors already certified by the aerospace customer. It's a

help then that a shop can refer to the customer's lists of already approved suppliers.

"So, you contact them when you get an order for such and such a part," Korosec says, "and you talk to them about the plating requirements, just to use plating as an example." If the talk goes well, the subcontractor will say it often runs that process for the aerospace customer.

However, checking with a subcontractor about its documentation can become more involved. Specifications may be superseded by other specifications. So, when talking with a subcontractor: "You always have to check to be sure that they have the most up-to-date spec for everything," Korosec says.

And an upshot of this effort? "You spend as much time on pre-production research, sometimes, as it takes to make the parts," Korosec says. "It's just incredibly different than it used to be."

"Years ago, 40 years ago, you'd get a purchase order to make parts for a flight instrument, and you got a one- or two-page purchase order, plus a drawing." Korosec says. "That is not the way it is anymore. And a lot of times back then, you just sent them a material cert—if that—and no cert was required for plating processes or anything like that."

Korosec knows about documentation from 40 years ago because he started working at Koro Industries, his parents' gear shop, in the mid-1960s, when he was still in grade school. "I saw all these changes happen," he says.

So, while documentation has increased, a gear shop may save time with an aerospace customer's lists of approved suppliers. When a list is short, though, it may become a problem.

Short Lists: Problematic Sometimes

Now, a short list can be a help when your gear shop is one of the few on the list. Clarke Gear Co. knows that feeling. Lee Mason, Clarke's chief operating officer, says there is a trend among aerospace companies to use fewer gear shops, but she adds: "Fortunately, we're one of two for our main customer."

In that case, Clarke Gear has a 50-50 chance of being contacted by the customer, a large aerospace company, when it needs more gears.

However, a short list can be a problem when your shop has to *use* that list. Clarke Gear knows about having to use a short list.

Recently, the shop was making gear shafts for an aerospace customer. The shafts had to be silver-plated. No problem. The customer had a list of approved plating companies, just two companies, but Clarke Gear had worked with one of them for years.

Then came a surprise: The customer changed the status of that plating company. "They suddenly disapproved them," Mason says. Clarke Gear had no choice. It had to use the one remaining company. Clarke had to ship the shafts from its location, North Hollywood, CA, to the plating company's location—across the country.

"We had to send these extremely high-risk parts to the East Coast," Mason says. "When I got the shipment bill, that took at least half of the revenue that was going to come from those parts." She says that similar surprises occur more often than they used to and adds that a few of those surprises do drive up the cost for Clarke Gear—but not the price to the customer.

Koro Industries made gears that were used in the mission to fix the out-of-focus lens in the Hubble Space Telescope, which hovers at the boundary of Earth and space. (Photo courtesy of NASA and the Space Telescope Science Institute)

Besides maybe having to use a "list" of one approved supplier, a gear shop may sometimes have to go off-list.

Going Off-List

Naturally, gear shops try not to go off-list. However, there are times when it's unavoidable. In those cases, a shop calls the customer to talk about going off-list. "If they have already got approved suppliers," Korosec says, "they're going to want to know: 'Why do you want to change it?' And so, you try and work with the approved list whenever possible."

And usually it is possible. "There are usually enough vendors that you can find someone that can handle your size part or toleranced part," Korosec says.

And that's another possible problem. For example, a list may have five approved suppliers, but some of them may not be able to process your gear shop's parts.

Korosec uses plating companies again as an example. With them, tank size isn't likely to be a problem when processing aerospace gears, especially small ones. However, some plating companies may not specialize in small parts. So, some effort may be needed to find the right fit in terms of capacity and handling.

Korosec adds that Koro Industries goes to a non-approved supplier: "Very seldom." He also adds that he can't recall going off-list in the last two or three years.

Some processes, though, don't need certification. An aerospace customer may not require it, so a gear shop won't need to look at a list of approved suppliers for this or that process.

Mason mentions several non-certified processes: grinding, honing, drilling, gundrilling. Other processes do need certification, like heat treating and plating. "Those can only be performed by approved suppliers," Mason says.

Naturally, additional documentation comes with a cost. But, it also comes with a challenge.

Dealing with the Documents

The cost is the time and people needed to create the documents and store them so they can be retrieved on demand. Korosec says the challenge is to handle all of this paperwork in ways so it's not crippling to the office.

And the documents have to be organized for on-demand retrieval in case of audits by aerospace customers. Korosec says that a couple of times a year, an aerospace customer will request the cert for this or that purchase order. So, the shop will go into its electronic files and send the documents to the customer, including the certifications for the gear material and for any special processes used to make the gears. Requests may be used to gauge the ability to meet audit requirements.

Finally, after the challenge of dealing with many documents, a gear shop has the work itself of making the gears on its factory floor. That work can be a challenge too, with its own trends. However, the work is the shop's core competency.

And manufacturing trends can be long established. One long-time trend is tighter tolerances, according to Jerry Bennett. He's the chief inspector/quality manager for Air Gear Industries International Inc., Phoenix, AZ. Air Gear serves the aerospace industry by refurbishing gears for aircraft, such as helicopters and turboprop planes.

The documentation to do aerospace work can be extensive, with gear shops having to meet standards to work for U.S. customers and other standards for European customers. (Photo courtesy of Air Gear Industries International Inc.)

The in-house processing to make an aerospace gear may be a small percentage, with other processes, like plating, done by subcontractors. (Photo courtesy of Air Gear Industries International Inc.)

Bennet himself has spent much of his career dealing with the trend of tighter tolerances among aerospace companies.

"It seems that all the companies are tightening up on involute lead, composite error, total runout a lot from back in the day. A lot of people have taken the AGMA 12, the AGMA 13 gears and even tightened them up more," Bennett says.

"All they're doing is just tightening them up."

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