

DEFENCE TURKEY

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AN INTERVIEW WITH
THE COMMANDER OF THE
TURKISH NAVAL FORCES ADMIRAL
BÜLENT BOSTANOĞLU

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The future is now with Axiam

“Computer Technology is Key to Building Competative Engine Cores: Penetration of technology in aircraft engines in the future increasing” Mr. Donald Lohin President & CEO, Axiam, Inc. enlightened us about advantages of Axiam Technologies for commercial and military aviation industry, ongoing programs in home and global markets, activities in Turkey and future development plans for Defence Turkey readers.

Defence Turkey: Thank you very much for this interview. Axiam is considered a significant technologies solution for the commercial and military aviation industry, for many years. Could you please inform us about your company profile, corporate abilities and product range?

Axiam is a private company. We have a number of shareholders. We are located in Gloucester, Massachusetts, in the USA, which is 20 miles north of Boston. Axiam was founded in 1983 as a measurement gauge company and we have evolved over time into a company that provides repeatable, integrated engine core assembly processes for turbine engines. They can be aero engines, industrial engines or power turbines for power plants.

Defence Turkey: What advantages does Axiam technology provide for manufacturing and cost effective solutions in the aviation and engine industry?

There are also benefits for engine shops or engine manufacturers. Axiam's software-driven assembly processes are able to reduce the total time it takes to assemble engine cores, and therefore we help obtain a smooth flow of work through an engine shop which has the effect of lowering their costs while improving shop efficiency. In addition, because we use computer technologies to build optimal engine cores engine shops will be able to deliver better quality and more reliable engines to their airline customers. Engine delivery dates become more predictable because problem engines that take a lot of unplanned time in the engine shop itself are largely eliminated. Instead you have a smooth flow of work and the many benefits that flow from that.

Defence Turkey: Why is this unique methodology important?

Because it brings optimization of the blade tip gaps of each rotor by

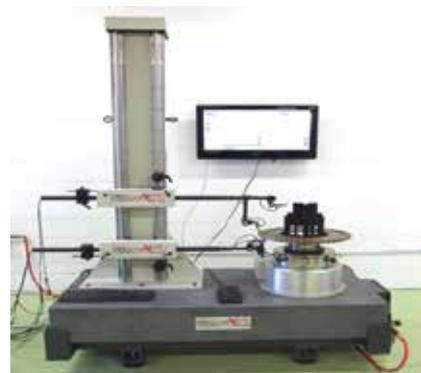
building the engine core from the actual centerline of rotation outwards to the casing. Thus, yielding improved engine performance and eliminating assembly and balance problems. These results are in contrast to the performance of engines built using the OEM's Engine Manual methodology or other alternatives.

Defence Turkey: How are the Engine Shop benefits achieved?

Total assembly time is about one-third of engine manual assembly time and is consistent for all engines. Rotors built using Engine Manual methodology typically require about 3 attempts to fit within the acceptable maximum allowable runout limits. In contrast, Axiam's builds are always optimal on the first pass which significantly reduces total assembly time, facilitates a smooth flow of work in the shop, and brings more reliability to delivery schedules. Test cell rejects due to vibration and rotor rebuilds are eliminated, saving significant cost. Often, there are often no specified build limits in the Engine Manual for the assembly of certain engine core modules besides the high pressure compressor, leaving the quality of the engine core builds up to each engine shop. In contrast, Axiam provides an optimal build model for each module assembly as well as its integration with other modules.

Defence Turkey: Can others deliver the benefits claimed by Axiam?

The simple answer is no, although some may claim they can. Only Axiam can build each part of the entire engine core to the actual centerline of rotation. Axiam holds a family of patents for computer-based engine core assembly about the actual centerline of rotation, not the OEMs. The secret sauce for Axiam is the mathematics in its predictive applications software, which predicts the best build based on the rotational center. Axiam estimates that



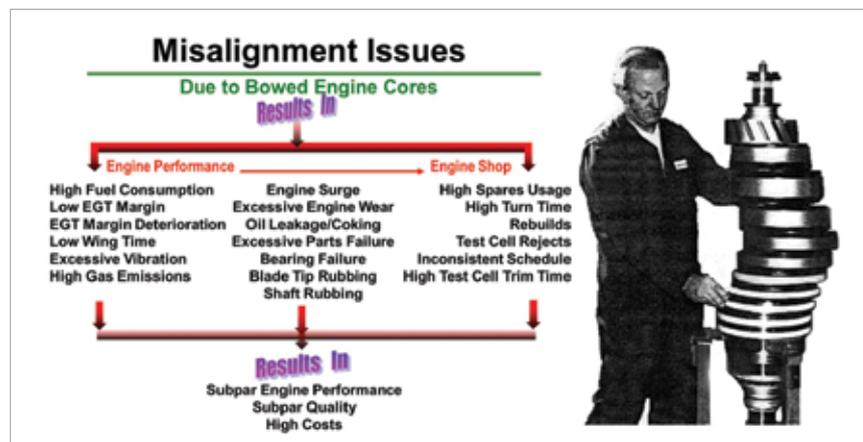
engine core builds are mostly bowed when using the Engine Manual process and then comparing to the maximum allowable runout after it is built. Some OEMs sell an electronic measurement gauge for use with their Engine Manual procedures and tooling, responding to Axiam. However, our testing of these "copy cat" offerings has indicated that their performance is no better than the traditional Engine Manual process because their assemblies are consistently bowed.

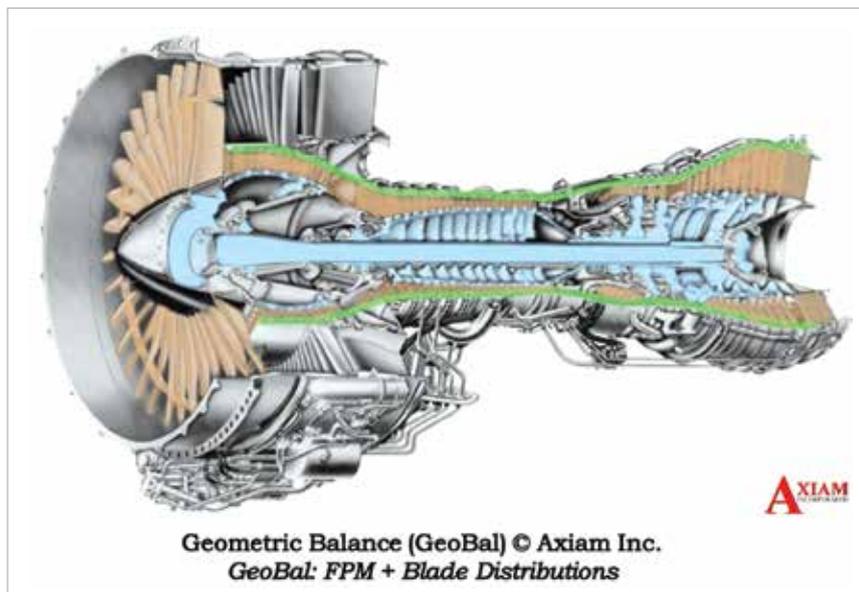
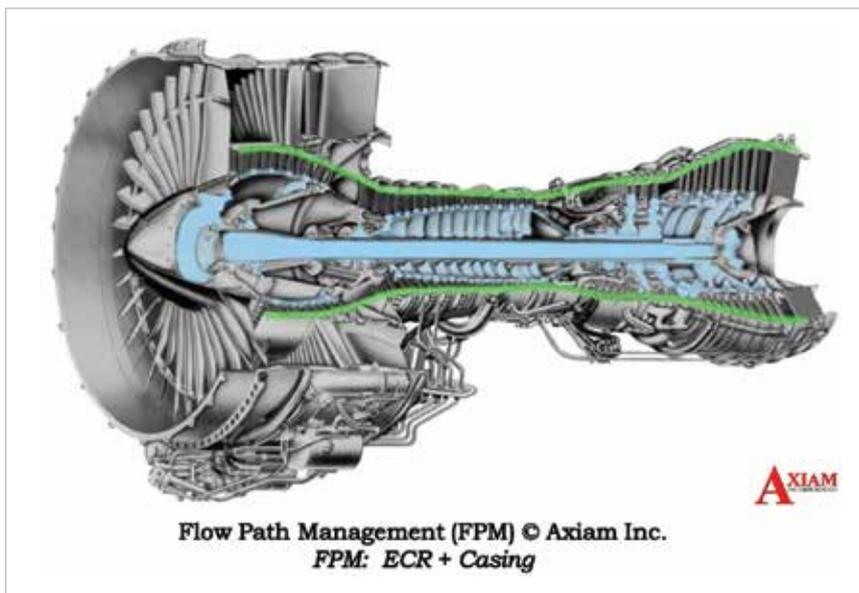
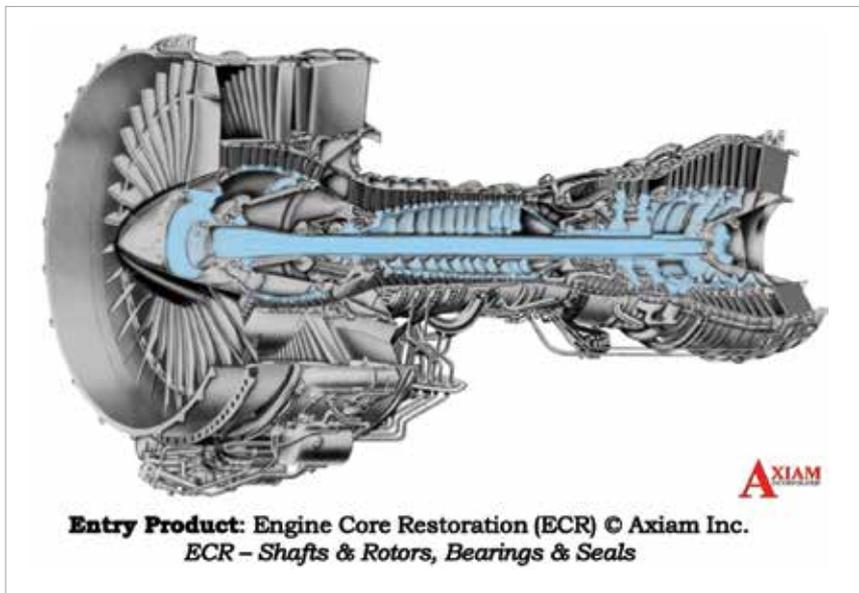
Defence Turkey: What kinds of problems appear when the engine core structure is bowed or misaligned?

Engine issues caused by bow are often considered "balance" problems in the shop rather than assembly problems because the rotors were built to the runout limits. So technicians add weights to compensate for the bow or misalignment. Issues range from engine performance issues shown in the left column, such as fuel consumption or EGT Margin, to engine shop issues in the right column that adversely affect production activities, such as blade-tip rubbing. A common symptom of bowed assemblies is no consistency of builds, i.e. some builds are straighter and closer to the centerline than others, resulting in unacceptable performance variability among fleet engines. "Power-by-the-hour" agreements do not optimize engine performance because the shop still builds engine cores to the maximum allowable runout limits rather than building as close as possible to the actual centerline of rotation.

Defence Turkey: Why do OEMs often resist Axiam's solutions?

The business model of OEMs has changed due to competitive pressures to one with less reliance on new engine sales and instead a heavy reliance on the aftermarket for revenues and especially profits. Therefore, it is in their financial interest to resist solutions that would lessen engine performance issues, such as engine wear due to vibration, that drive spare parts sales





or lessen spare parts prices. OEMs now own about a third of the engine shops in the aftermarket. In order to promote this source of revenues and profits, it is in the OEM's interest to tightly control the aftermarket business. Airlines and engine shops have encountered such resistance from the engine manufacturers. Consequently, Axiam obtains approval for its engine core assembly processes from the FAA.

Defence Turkey: What are your on-going programs in your home market and global markets also?

In January we started a new airline initiative. Traditionally we have sold directly to engine manufacturers and engine shops that overhaul engines after they've been in the market place, but we concluded that airlines would be interested in the engine performance improvements (SFC, EGT Margins and Vibration) that are delivered using our assembly processes, so I started contacting and meeting with airlines in January, and my visit to Istanbul is a continuation of that effort. And while I'm here I hope to meet with about a half dozen airlines and inform them of the benefits that we can provide by using computer technology to build engine cores optimally. The response to date has been very positive. This is a new source of fuel savings which typically delivers savings in the range of 2-6 percent. Most airlines have not heard of our capability, so it is very gratifying to have them respond positively when they learn that there's yet another way to save on fuel and therefore help their bottom line for the airline.

Defence Turkey: What's the percentage of utilization of these new technologies currently. In the next decade, what is your forecasting for the utilization of Axiam technologies in the commercial industry?

Axiam to date has 48 customers globally for 52 different engine models. These customers include commercial aero, military, space, industrial, power and marine. I believe the use of computer technologies to bring efficiencies to engine manufacture and overhaul is just now gaining a foothold and will further penetrate these markets in the future. I would expect that at some point in the future all engine shops will be using some form of computer technology to build their engine cores.

Defence Turkey: Could you please inform us about your activities in Turkey and your cooperation with Turkish defence industry companies and Turkish authorities?

We recently met with representatives of the Turkish Air force. For decades, we have worked with the American Airforce and Navy and we hope that we can do the same with the Turkish defence organizations. We can help them become more mission ready by having more reliable engines, improving the thrust of engines for fighters, and saving cost on maintenance. These are major objectives that the military tends to have. We have an existing Turkish customer for components of the F-135 engine which goes on the F-35 aircraft, the new joint strike fighter. Alp Aviation, in Eskişehir, uses Axiam to measure the compressor parts that they manufacture and send to Pratt & Whitney in the United States. Pratt & Whitney has requested them to use Axiam because they want to make sure that all the parts that are received at Pratt & Whitney meet geometric specifications. Pratt & Whitney's experience with Axiam, on other military engine lines, tells them that this is an effective way to ensure that they get parts that meet specifications.

Defence Turkey: How do you assess your strategy and plans for Turkey in the coming period?

I would like to meet with as many airlines, commercial engine shops, military engine shops, and industrial turbine shops to explain how we can help them achieve their objectives by assembling their turbine engines using Axiam. So, I would like to explain to them the benefits that are available and hopefully form some kind of relationship with them in the future.

Defence Turkey: What are your future development plans?

We currently have a product under development which we expect to finish in two or three months and then will begin a beta test at an engine shop. We expect to introduce that product by spring or early summer. This product will enable us to use our



Target Build Models Software © Axiam Inc.

computer technology, procedures and tooling to build optimally the entire engine core which includes the rotors, shafts, bearings, casing and blade distribution all about a common center line of rotation. No other products are available in the marketplace that can do this. Axiam holds the patents for this product and it promises to improve engine performance and shop efficiencies beyond our current product offering.

Defence Turkey: Do you have any plan to develop a new product with Turkish companies to support export with Turkish companies?

We would like to develop a product for helicopters that would build the engine, shaft, gear assembly and the propeller all to a common centerline or rotation. This would have a very significant beneficial impact on helicopter vibration. This is my first trip to Turkey to talk with airlines and the military. I've had this idea for years and I am looking for the right opportunity to find a partner to work with us. I think this would be an opportunity to work

with a Turkish company to develop a product that could be exported.

Defence Turkey: Would you like to add some remarks for our Defence Turkey readers?

Yes, from my many years in business, I have learned that companies, whether they are airlines or engines shops or engine manufacturers, cannot 'rest on their laurels', as we say, they cannot stand still. They have to continually evolve over time in order to remain competitive and remain profitable, because if you are doing something that's successful today, your competitor will notice and try to do the same thing and therefore you will end up making less money unless you continually improve. This is why I think the penetration of technology in aircraft engines in the future will increase. Airlines are now starting to monitor performance of engines on wing. Engine shops are now using technology to build engines. MRP systems in engine shops can track the costs of an overhaul much more accurately than we used to do, and that will help generate the most efficient pricing to overhaul a jet engine. I think this use of technology will only accelerate in the future as competition increases and as global communication improves. You have to understand that the aviation business will have to compete globally. So I think the market pressures will force the increased use of technologies in the future. We are just in the beginning stages of the use of technology in the aviation business to remain competitive and achieve our objectives.

Defence Turkey: Thank you very much for the interview.

You're welcome. Thank you very much. ■

