AV&R Vision & Robotique, grand champion de la précision

Oeuvrant dans le domaine de l'automatisation industrielle depuis plus de 15 ans, AV&R Vision & Robotique est aujourd'hui reconnue comme un leader mondial en finition robotisée (ébavurage, profilage, polissage, rayonnage tridimensionnel) et en inspection visuelle automatisée (2D et 3D).

La majorité de ses systèmes sont utilisés sur des ailettes, aubes variables et disques aubagés monoblocs de turbines à gaz utilisées en aéronautique et en énergie.

« Au départ, nous étions simplement de bons généralistes capables de résoudre des problèmes d'automatisation en mariant vision et robotique. Et puis, il y a quelques années, nous avons choisi de nous concentrer sur l'aéronautique, en développant une expertise de pointe et en ciblant une niche unique, et nous avons commencé à exporter nos solutions partout, même en Allemagne et en Asie » raconte M. ÉRIC BEAUREGARD, président-directeur général.

AV&R Vision & Robotique compte 55 employés, dont environ 45 ingénieurs, réinvestit de 10 à 15 % de son chiffre d'affaires en R-D et exporte 80 % de sa production, ce qui lui vaut d'accroître ses résultats de 20 à 30 % chaque année. Permettant d'atteindre des niveaux de précision encore inégalés, son système de profilage d'aubes a été sélectionné en 2012 par la *Society of Manufacturing Engineers* (SME) parmi les innovations susceptibles de transformer les processus de fabrication actuels, entre autres distinctions.

« Nous avons des projets d'expansion dans la région, et par la suite en Europe, pour suivre nos clients, mais nous nous sentons très bien à Montréal, au confluent des cultures technologiques et des traditions commerciales européennes et américaines, ce qui constitue d'ailleurs un réel avantage pour notre grappe aérospatiale. Autre avantage, Montréal est une ville réputée agréable où nos clients ont toujours grand plaisir à venir nous rendre visite », assure M. Beauregard.

CONTENU RÉDACTIONNEL PRÉPARÉ PAR
L'actualité les affaires

AFFAIRES sans FRONTIÈRES

Par : Ulysse Bergeron | Date : le 14 novembre 2012

AV&R : des robots pour remplacer les Chinois

Certaines entreprises savent profiter des crises économiques. C'est le cas de la Montréalaise AV&R Vision et robotique, qui séduit l'Asie avec une technologie hyperspécialisée.

«Lorsqu'on va visiter une usine en Chine, on s'attend à voir plein de petits Chinois en train de travailler à la main. Mais si on arrive là et qu'on voit des équipements ultra-modernes qui permettent de fabriquer des produits au même prix, on a d'autres choix que d'être impressionné et de dire *Wow*! »

Éric Beauregard, président d'AV&R Vision & Robotique, contourne le robot installé au centre du laboratoire de sa jeune entreprise qui a pignon sur rue dans le Vieux-Montréal. Un bras s'étire et attrape, avec ses pinces, une petite pièce métallique. Sans technicien pour le manipuler, le robot positionne la pièce devant une caméra. À intervalle de quelques secondes, il la tourne et la retourne devant l'objectif pour finalement la déposer et en reprendre une autre, avec une extrême précision.

Souriant, le patron de l'entreprise de 60 employés explique comment sa technologie permet d'inspecter chacune des pièces qui composent les moteurs et les turbines d'avion. «Elle est programmée pour détecter les imperfections. Si elle en trouve, elle met la pièce de côté», dit-il.

C'est la crise économique qui a poussé cette entreprise créée en 2006 à lorgner les marchés asiatiques et du Moyen-Orient. «Pendant que ça ralentissait en Amérique du Nord et en Europe, on s'est intéressé à de nouveaux territoires qui n'étaient pas frappés aussi durement par la crise», indique Éric Beauregard. Aujourd'hui, l'Asie représente environ 18% de ses activités et ce marché ne cesse de croître, selon le président.

«Les fabricants se plaignent souvent de problèmes de qualité dans ces pays, où il est parfois difficile de trouver et de garder le personnel compétent. Un robot, lui, aura le même rendement qu'il se trouve en Chine, en Sibérie, en Oural... Il est objectif et neutre».

Les marchés en voie de développement ne s'intéressent pas seulement à la technologie pour son efficacité, mais aussi pour l'image qu'elle projette. «Pour eux, c'est une vitrine technologique», ajoute Éric Beauregard.

En quelques années seulement, AV&R s'est taillé une place enviable dans l'industrie de l'aéronautique. Seule entreprise au monde à se spécialiser dans la conception et la construction de tels équipements robotisés, elle compte parmi ses clients les géants Pratt & Whitney, Rolls Royce, GE et Honeywell. Chaque année, c'est une vingtaine de «robots» qui sortent des laboratoires d'AV&R après plus de deux mois de tests et de peaufinage.

Les robots d'AV&R sont hyperspécialisés dans la finition et l'inspection de turbines à gaz. Un choix réfléchi et stratégique, dit Éric Beauregard. «Nous nous sommes questionnés. Est-ce que nous voulions être des *Jack of all trade* de la robotique et accéder à un très gros marché sans réellement sortir du lot, ou voulions-nous devenir hyperspécialisés et étendre nos activités à l'ensemble de la planète?» AV&R a

choisi sa niche. Aujourd'hui, 75% de son chiffre d'affaires – évalué à plus ou moins huit millions de dollars – provient de l'étranger.

La technologie d'AV&R sert également à la finition du millier de pièces des systèmes rotatifs qu'on retrouve dans les moteurs d'avion. Elle en effectue le polissage, l'ébavurage et le profilage. D'ailleurs, dans une autre pièce du laboratoire, un jeune ingénieur programme un bras robotisé qui saura prendre les pièces des moteurs afin de les polir sur une brosse rotative.

Dans l'aérospatial, les machines robotisées d'AV&R sont rapidement synonymes de petite révolution, indique Éric Beauregard. Jusqu'à très récemment, les employés inspectaient les milliers de pièces qui composent les moteurs d'avion. L'entreprise de Montréal souhaite remplacer l'humain par la machine. «Contrairement à l'industrie automobile, l'aéronautique est encore assez conservatrice dans l'utilisation de robots», dit-il néanmoins.


Éric Beauregard, président, AV&R Vision & Robotique

Il lui faut tout d'abord convaincre les grands fabricants des avantages de la machine comparativement à l'humain. «Souvent je me suis fait dire: "Nous faisons de bons moteurs depuis des décennies, pourquoi changer notre façon de faire?"» Sa réponse : les robots offrent une constance inégalée et une rapidité que l'humain ne peut pas offrir. «Le robot fait sa tâche toujours de la même façon. Il n'est jamais sur un lendemain de veille, n'est jamais fatigué ou déconcentré par des pensées personnelles», dit-il.

À lui seul, le secteur des turbines à gaz génère 95% des revenus d'AV&R. Et l'aéronautique représente 85% des activités liées aux moteurs. «Le 15% restant, ce sont des turbines à gaz utilisé à des fins énergétiques », explique-t-il, soulignant que les pièces et les tâches à effectuer sont similaires.

AV&R privilégie un développement par étape. «Il n'est pas question de s'éparpiller, aussi bien sur le plan de nos activités que de notre expansion géographique. Nous voulons avoir des bonnes assises à un endroit avant d'en développer un autre», explique-t-il. L'Europe représente 30% de ses activités, alors que les États-Unis 28% et le Canada 24%.

«On s'intéresse au marché parallèle, soit des marchés qui s'inscrivent dans la continuité de ce que nous faisons déjà», dit toutefois Éric Beauregard, comme la remise à neuf de pièces de moteur d'avion, un secteur qui représente déjà 10% de des activités en aéronautique d'AVR&R.

AV&R lorgne également le secteur de la santé, dont le marché des implants orthopédiques pour les genoux et les hanches. «Il y a une grande ressemblance avec l'aéronautique. Les pièces et les alliages sont complexes et les méthodes de fabrication des composantes sont semblables», dit-il. L'entreprise teste actuellement sa technologie en travaillant avec Stryker, un géant américain des technologies médicales. Mais prudent, Éric Beauregard compte développer cette nouvelle avenue avec autant de tact qu'un chirurgien lors d'une opération. Son objectif principal: assurer la bonne santé de l'entreprise qu'il dirige.

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http://affairessansfrontieres.bwob.ca/secteurs-d-activite/haute-technologie/avr-des-robots-pour-remplacer-les-chinois

AVIATIONWEEK
& SPACE TECHNOLOGY

Downtown Motion

Robotics innovation thrives in the heart of Montreal

Michael Mecham

It is unusual for aerospace workers to take the subway or bicycle to work. But not when your average staff age hovers around 30 and your offices are in the heart of Montreal.

Is this the face of a generation that will define aerospace's cutting edge? What AV&R Vision & Robotics does and how it does it may offer some clues. Formed 17 years ago, the company's identity comes from solving what CEO and President Eric Beauregard calls "automated projects that are unsolvable." Ninety-five percent of its customers are in aerospace, nearly all in gas turbine engines. The rest are in industrial engines. Medical systems are on the horizon.

"They eat technology when they wake up, when they have lunch and when they go to sleep"

AV&R's customer base includes all major engine makers—GE Aviation, Pratt & Whitney, Rolls-Royce—and their industrial partners. Traditionally, 25% of its sales were within Canada, another quarter in the U.S. and the rest split between Europe and Asia. But the big Airbus and Boeing single-aisle reengining projects have prompted a shift to 50% in the U.S., with Pratt already ordering for its geared turbofan and GE Aviation doing the same for Leap.

Most of the automation and visual inspection work concerns original equipment manufacturing of rotating parts—blisks, blades and vanes. AV&R also supports overhauls with customers such as Delta TechOps and Chromalloy.

AV&R assembles robotic systems and provides the software to run them. The robotic components themselves come from outside manufacturers.

When Beauregard joined AV&R six years ago, he was surprised at how little automation was in use by aerospace manufacturers. "I expected to see automation everywhere. To me, aerospace is a modern industry, its specifications are so tight," he says. "But we are still doing things manually." The point is that machines are more accurate than people.

New, rather than existing programs, are most likely to bring change, because change involves investment and customer and regulatory approvals. New programs offer the prospect of the efficiency breakthroughs that robotics promise.

Pratt & Whitney Canada is one example of the latter. It selected an AV&R inspection system for its Mirabel factory north of Montreal, where it is assembling the PW1500G series for the Bombardier CSeries regional aircraft. Before shipment, the engines undergo an AV&R robotic fashion shoot. The robot's camera zooms around every angle of the engine's exterior, firing off about 300 strobe shots in a matter of seconds. Each image is measured against a control profile to ensure that all parts are properly in place. The reason: 80% of all quality problems arise from errors in exterior workmanship. "The goal is not to see what the human eye cannot," he says. "We're there to see better than humans can. Humans are not objective; machines are there to compensate for those [human] problems."

The key to understanding AV&R is in who it hires and the company's youth culture, which regards the unsolvable in robotics and automation as a challenge. "Young people have less experience, so they fear less and are more open-minded," he says. "They eat technology when they wake up, when they have lunch and when they go to sleep."

Another aspect is to stay small. In the world of automation, AV&R is a "drop in the sea," Beauregard says. "So the only way [it] can become different [from competitors] is yearly investments of 10-15% of revenues in innovation. We need to put a solution into made today that nobody [thought] we could solve."

The company works from an evolving three-year technology road map for meeting customer expectations. The plan is subject to adjustment on a quarterly basis and a more thorough review as the fiscal year draws to a close. "The road map shows the vision of where we are going and where our customers are going. We cross-check to put them together," he says.

Big change is not a goal, so setting aside the plan to satisfy a large order leads to short-term vision that is counterproductive. "Our visibility is for three years and each year we add another year," Beauregard says.

He acknowledges that measuring how innovation helps a client is difficult. But it is part of the plan. Robotics makes manufacturing, inspection and repair more efficient and increases quality levels by driving variables out. So the common innovation measure of success is return-on-investment figures.

AV&R VISION & ROBOTICS

A robot checks surface defects under light in front of a camera.

But AV&R takes into account feedback from customers and employees. It uses a matrix to measure customer perception/satisfaction against the company's innovation. "Then we measure that against employees' workloads," Beauregard says.

The future for robotics in aerospace is brightened by the likelihood that manufacturers will pull back work sent to low-cost countries in favor of machines that do not have language/cultural barriers, do have consistent quality standards and do not suffer from repetitive motion injuries.

The company attracts many of its permanent employees with internships for engineering students from Montreal's ETS University. AV&R gravitates to technicians who become engineers. "They're practical," Beauregard says. "You want to have people who are flexible and hands-on."

Robotic Finishing and Automated Visual Inspection - An Interview with Mr Jean-Francois Dupont

insights from industry

Jean-François DUPONT

CEO, AV&R Vision & Robotics

Mr Jean-Francois Dupont, Chief Operating Officer at AV&R Vision & Robotics talks to Kal Kaur, Editor of AZoRobotics, about AV&R Vision & Robotics, Robotic Finishing and Automated Visual Inspection.

Kal - Can you provide my audience with a brief overview of AV&R, its background and the core objectives for this company?

Mr. Dupont - AV&R is defined as the leader in industrial automation for over 15 years. We offer solutions to optimise manufacturing processes and quality control mainly for gas turbine, focussed on critical parts (rotating parts). We have a very strong engineering team whom specialises in mission vision and robotics and we have a very strong name in the industry for Robotic Finishing and Automated Visual Inspection.

Kal - With the main vision for AV&R being a world reference in robotic finishing and automated visual inspection, can you briefly describe what each technique involves and the benefits to each process?

Mr. Dupont - Right now, there's a lot of pressure on the aerospace and the energy industry. The economy and developmental issues are forcing the engine designers to develop new parts that require complex processes through production and these designs require very strict quality control. These new parts are critical in achieving the performance guarantee. So based on all these new requirements, it's almost impossible to achieve this manually. Right now AV&R is probably the only company in the world with a clear strategic plan to attack these problems. If you look at our solution, it looks simple, but what we do is use a robot with a camera to reproduce human movement with more accuracy and repeatability. The environmental issues are applying stress on the industry to change their strategy in terms of their technology.

Kal - AV&R commit to meeting the needs and constraints of each factory. Can you describe how the company have been able to maintain this commitment over the years?

Mr. Dupont - We maintain this commitment with innovation. AV&R invests 17% of its revenue into research and development to come up with new technologies and to help develop a global market for our products.

Kal - From a geographical perspective, AV&R have a considerable spread of business across the globe. What is the biggest appeal in your service for your customers worldwide and why?

Mr. Dupont - Actually, since we are very focussed, we know our customers and our market very well. I will say that all the engine producers have heard about AV&R and what they see from us is the innovation that we bring to their plants. We have research and development partnerships established with all the major OEMs. We have established relationships with our customers through press releases and word of mouth. We started to do marketing only three years ago but we have long-term partnerships established with most of the OEMs. These R&D partnerships give us the opportunity to develop our solutions based on their future needs and it also maintains us in front of all the competition. We've never had to attend an exhibition. We prefer to have very closed discussions with our customers, we know them very well and invite them to visit us in Montreal.

Kal - For over 15 years, AV&R have provided automated systems to the OEM gas turbine manufacturers. How have the specifications for automated systems changed over this period of time and has this affected your delivery of services to this industry sector?

Mr. Dupont - The changes in specifications help us a lot; we offer value-added solutions so it's not standard automation for repetitive tasks. A couple of years ago, the payback was based on the headcount reduction. Now, if you want to reach the new specification related to the new programmed engine, you need to automate with intelligent systems and the systems will take decisions like human beings - that's the heart of our solutions.

Kal - What are the main needs of the aerospace and energy industries and how do you address these needs with your solutions?

Mr. Dupont - Right now, the quality controls are executed by human operators and inspectors. The industry needs a known subjectivity and this is what we provide with our Automated Visual Inspection solutions.

As for Robotic Finishing, tight tolerances need to be achieved and manual finishing simply cannot do it. AV&R's automated adaptive systems reach these tolerances.

Kal - Can you discuss some examples of projects in both Robotic Finishing and Automated Visual Inspection and whether this has led to the development of new solutions for the core industries that you serve?

Mr. Dupont - When we established our strategy plans, the short term goal was to create automatic rework systems. Our goal is to do automatic rework of the parts. This means that we want to inspect and repair automatically the defective parts without human intervention. To achieve this, we first need to find the defects on the parts by using the first version of our inspection systems using 2D cameras. We realised that it was impossible to establish a reparation scheme for the robot only with this information since we needed to know the dimension and depth of the defect. So we had to implement a 3D scanner in our 2D surface inspection systems. It was not planned in the beginning to have this implementation so we looked around the world for a solution and finally established a partnership with the National Research Centre in Canada. We have signed an agreement with them to do a technology transfer for their 3D scanner and now we are in a position to offer the complete solution, we are ready to do rework: our 2D system finds defects, the 3D scanner characterizes them so the robot can know what amount of material to remove to correct the defect (according to its depth).

In Robotic Finishing, many modifications to the teaching of the robot were necessary and done; the robot needs to be able to calculate its own path and its own reparation recipe without the intervention of a human.

Kal - Considering that you serve some of the world's largest motorists and manufacturers of gas turbine parts such as Pratt & Whitney, GE Aviation, GE Energy, MTU Aero Engines, surely this must come with challenges. Can you discuss some of these challenges and how AV&R have overcome these hurdles?

Mr. Dupont - We are dealing with some big clients in the industry so I will say that the biggest challenge is at the internal side around the intellectual propriety. When a small company deals with a big one, the big one (our client) wants to own everything from research to development, so there is a lot of work to establish our background identification. With new R&D projects, we clearly define what we have developed previously and after that it is easier for us to reflect on what the company owns and what AV&R owns.

Initially, clients were not very receptive to this, but when they realise that we are the only company who delivers that type of solution, we see an opening and considering that we are dealing with all of the big clients in the industry, they realise that everybody contributes to the technology. We re-invest in the technology and in the end everyone invests in the same technology.

Kal - What kind of products in the Aerospace and energy industries do you work on?

Mr. Dupont - Most are critical rotating parts: blades, fan blades, vanes, blisks / IBRs. It is easy to understand that these parts (used in jet engines) need to be manufactured with precision and inspected for defects to ensure the engine's proper running. Finishing on these parts needs to be done and that is where we offer Robotic Finishing systems. Final visual inspection for these critical parts is very important too and that is where our inspection solutions are used.

Kal - The aerospace industry is such a powerful industry and is likely to continue to develop game changing technology. A recent report by Deloitte states that the commercial aircraft sector will see an increase in demand for leisure and business travel in the Asia Pacific region; whereas the defence market is expected to experience a reduction in demands as a reflection of a fall in military spending. How will or has this change affected AV&R in terms of the services it offers?

Mr. Dupont - We are not dealing with the military industry so, for us, to see that the commercial market will increase is good news. When we develop our systems here in Montreal, we're not receiving military parts. It's very complex when dealing with these, so most of our projects have been based on commercial parts.

As for the Asian region, the fact that more planes will land there does not affect us, unless it means more planes; more planes means more engines, so more of our systems are needed. Wherever the planes go, its engine needs to be manufactured and inspected. Nevertheless, we have right now an agent who is working for us and doing support for us in Asia. The culture and language is quite a challenge for us, though we have planned to open an office in this area somewhere in 2015 to help our services grow in the MRO industry since Asia works more with locals. MRO in Asia is a huge market for us.

Kal - The energy sector is constantly under change and transformation to shape the way we use energy. How has AV&R helped energy industry players look for ways to strengthen their enterprise in increasing the performance of this industry?

Mr. Dupont - The energy sector uses the gas turbines at the maximum limit. In aircraft, the turbine works at the maximum when you land and when you take off, but in the energy industry, the turbines are always at the maximum. AV&R provides a solution to allow them to be more repeatable and more precise in the manufacturing process which help them reduce workers' injuries and get the critical rotating parts closer to their physical limits; the more the part is close to its original design, the more it is effective. If the parts can be used longer in the engines, it means less downtime and more money.

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Spatial Profiling

Automated edge profiling and vision inspection optimize blade production

This automated blade profiling system integrates all the required abrasive wheels needed to perform the profiling.

Robotic finishing is about more than putting the final touches on a part. To ensure part quality and process repeatability, a robotic finishing system has to be able to adapt itself to each part and to the variability in that part. Many different tools can be used to achieve these goals, including force feedback components, laser sensors, vision systems, probing, and closed-loop machining systems.

A user-friendly interface and offline programmability are also important.

Once the investment is made in an automated finishing system, the manufacturer can expect benefits such as reduced labor costs, improved part quality and consistency, improved ergonomics and safety, and increased throughput.

Another benefit, according to Eric Beauregard, CEO of AV&R Vision & Robotics, a company that specializes in robotic finishing and automated visual inspection systems, is reduced abrasive use. Optimization of the process can save up to 75 percent of abrasive costs. The material handling process may benefit too.

"Every time you handle critical parts, you have a potential of scratching and damaging some pretty expensive parts. By using robotic technology you reduce this damaging handling by 10 to 15 percent," explained Beauregard. "However, the biggest ROI for customers comes from the consistency of the result that this kind of system ensures. The whole blade finishing process can be redefined with this technology, and as a result, the user experiences an increase in throughput and a decrease in the costs [associated with] poor quality."

This Montreal-based company, which designed its first fully integrated robotic finishing system in 1997, creates systems that help to optimize the manufacturing of critical parts for gas turbines. AV&R's robotic finishing systems perform complex machining operations such as deburring, profiling, polishing, and blending. Its 2-D and 3-D automated visual inspection systems inspect gas turbine parts such as blades, vanes, and blisks to find defects like dents, pits, and scratches. The company is a National Instruments-certified alliance partner and is a Level 4 authorized integrator for FANUC Robotics.

AV&R's ultimate goal is to combine its two areas of expertise in one automated system. This system would finish a part and perform its final surface inspection. Recently the company designed a system that creates high-precision elliptical profiles on blades and vanes within a 50-micron tolerance of the engineers' nominal design. It incorporates both adaptive and closed-loop capabilities coupled with final leading and trailing edge inspection.

A proper leading and trailing edge profile reduces fuel consumption in the power plant. The cell can be used to create leading and trailing edge shapes on new blades and to repair blades during their service life.

Components that typically require leading and trailing edge profiling are compressor blades and variable vanes, both within a 50-micron tolerance.

"Blades and vanes have specific challenges," explained Beauregard. "You often need to adjust the material removal and tooling to [a specific] location on the part. Their various elliptical shapes and material composition also impact the scope of work to be performed."

Until recently this type of work would have been done manually.

"An OEM customer or blade supplier had, until recently, no other choice due to the complexity of theses blades. Now design engineers can optimize their blade designs to achieve better performances, such as better fuel consumption and lon-

ger time on wing," said Beauregard.

An automated blade profiling system integrates all the required abrasive wheels needed to perform the profiling within a closed cabinet, in which the robot manipulates the blades or vanes. Typically, the precise positioning requirements for aerospace industry parts used to discourage the use of robot positioning devices because they could not deliver the required tolerances. A combination of complex software algorithms and a compliance system that features feedback sensors that are both adaptive and closed-loop have changed that. The addition of a vision system that compares the CAD drawing to the real part in the cell is the final touch.

"The unit will work to get the part done within the tolerance required by double-checking itself with the inspection device if required," said Beauregard.

Each part inherently has variations resulting from the production process that are different from the required final tolerance. This means that fixed machining parameters cannot always be used.

Adaptive processing automatically calculates machining parameters according to the specific geometry of each part. This allows for parts to come into the cell with variations and leave with consistent results.

In some cases, closed-loop machining also can be used. After the adaptive profiling, the part is taken to the inspection device. Thanks to the feedback this device provides, the profile can be adjusted automatically if required.

"This closed-loop capability can be useful for blades that are refurbished, because every blade coming into the system will be completely different," said Beauregard.

If the part is outside preset tolerances, the cell sends an alarm signal and the operator can then investigate the upstream issues and save precious time and dollars.

Part Inspection

Traditionally, inspection is done manually with an optical comparator, which has a high potential for inaccurate readings, according to Beauregard.

"To be most efficient, it is important to measure and meet tolerances as early in the process as possible," he said. "It is better to catch a problem before a lot of value has been put into the part."

Automated visual inspection systems inspect a part's surface to ensure it does not have defects such as dents, pits, and scratches. In the event that a defect is found, the part may need to be reworked or even scrapped.

Today visual inspection of parts is done manually, but benefits of an automated visual inspection system typically include:

- Elimination of human subjectivity.
- Complete inspection with guaranteed results.
- Feedback on the process quality.
- Higher production rates.
- Elimination of the possibility of a non-conforming part being shipped.

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Robotic finishing systems perform complex machining operations such as deburring, profiling, polishing, and blending.

After profiling, the part is taken to the inspection device. Thanks to the feedback this device provides, the profile can be adjusted automatically if required.

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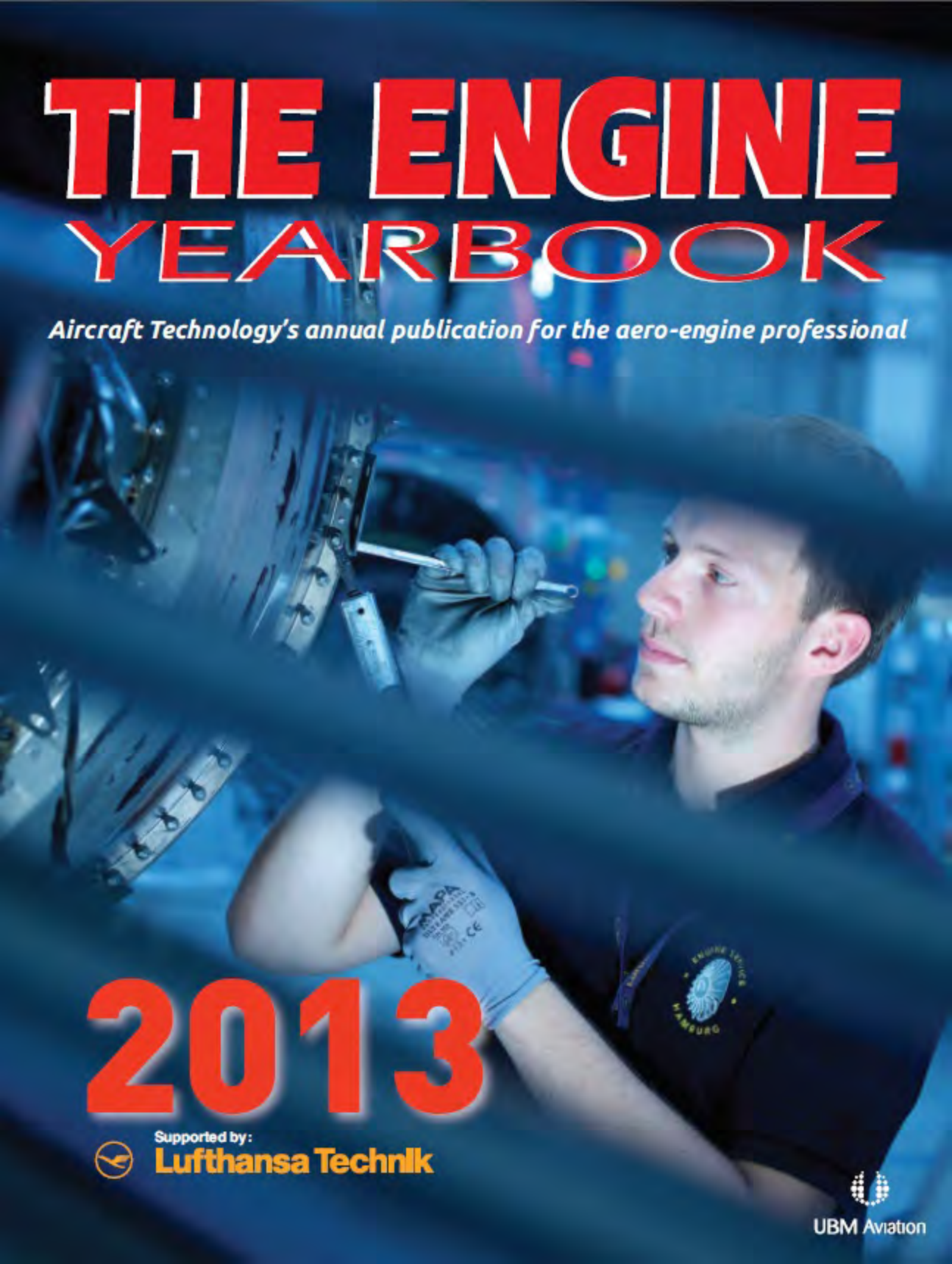

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Robotic finishing and inspection

The machines-versus-humans debate has persisted since the industrial revolution. One might think that high-tech manufacturing industries such as aerospace are already reliant on robots but, in fact, many processes still require human input. Making the case for a move to automation is AV&R Vision & Robotics.

The list of considerations when designing commercial aero engines is formidable and includes fuel burn, emissions, engine noise, weight, temperature, materials, durability, and operating cost. All these factors and more are carefully factored into the design of every part of an engine. Accordingly, engineers can take years to design extremely precise jet engine parts. Yet all that time would be wasted if the precision to manufacture them to such exacting tolerances was not achievable.

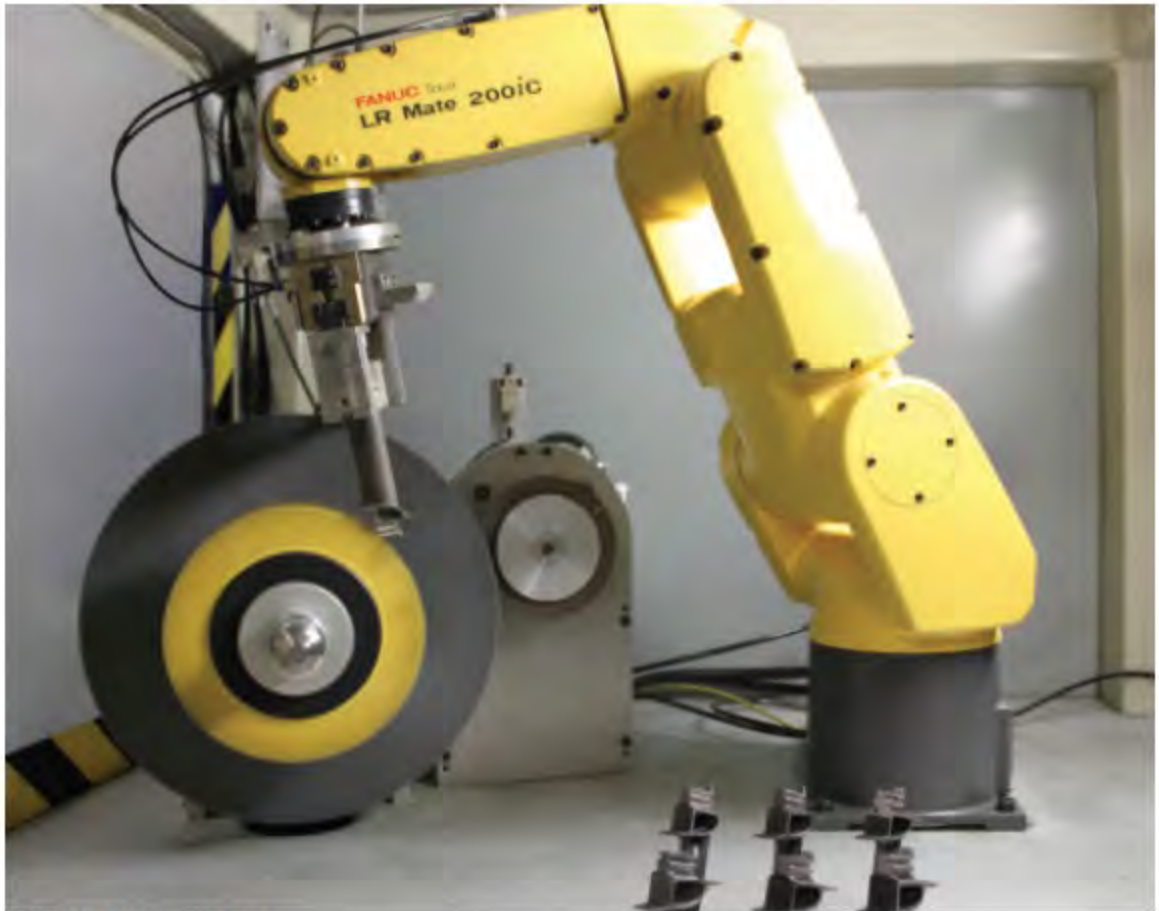
There is no doubt that the same attention put into design should go into the manufacture of critical parts, but, sadly, that is not the case. Humans manufacture the critical rotating parts of jet engines and they cannot reach the blueprints' precision. Until recently, this was where the discussion ended. Luckily, the OEMs are now starting to benefit from automation.

Precise automation

Although robots are often thought of as relatively imprecise, many tools can be used to obtain robust and precise results. These include force-feedback components, vision systems, laser sensors, probing, active compliance, adaptive machining, closed-loop machining and Leica calibration. With a proper mix of these tools, AV&R Vision & Robotics from Montreal, Canada, has developed robotic finishing systems that can reach a level of accuracy as precise as 37.5 microns (± 1.5 thousandths of an inch).

"Our goal is to empower our customers to meet the specific requirements of the blueprints," says Eric Beauregard, AV&R's CEO. "The closer the part is to its original design, the more efficient it is, the longer its life-cycle, the less fuel it requires, and so on." With this in mind, the company spent 15 years increasing its robotic systems' performance and recently marketed an automated leading and trailing edge profiling system which creates high-precision elliptical profiles on gas turbine blades and variable vanes. This system was selected as an Industry Game Changer in June 2012 by the Society of Manufacturing Engineers (SME) in their annual challenge, 'Innovations That Could Change the Way You Manufacture'.

"We are very proud of this award since it describes exactly what impacts result from this technological advance. OEMs should change their production processes to include



Robotic deburring system from AV&R.

high-precision automation", explains Beauregard. "Not only does the addition of an AV&R Robotic Finishing system helps plants improve quality and consistency by eliminating human subjectivity, but it also improves ergonomics and safety, and increases throughput."

As each part has inherent variations resulting from the production process, fixed machining parameters cannot be used to finish critical parts, which means that finishing is done manually to counter such variations. With the use of adaptive machining (which automatically calculates machining parameters according to the specific geometry of each part) automation can overcome that deficiency. This is what allows AV&R to obtain precise and repeatable results. Even if parts come into its profiling system with variations, they leave with consistent results.

In some cases, closed-loop machining can also be used. After profiling, a part is taken to an inspection device. Thanks to the feedback this device provides, the profile can be adjusted automatically if required. "This closed-loop capability can be useful for blades that are refurbished because every blade coming into the system will be completely different," says Beauregard. "It marks an end to losing precious time and dollars — if the part entering the system is outside preset tolerances, an alarm signal is sent to the operator so he can investigate the upstream issues."

"There is no doubt that the same attention put into design should go into the manufacture of critical parts, but, sadly, that is not the case."

Automated Visual Inspection system from AV&R looking for surface defects on high pressure turbine blades (airfoil and dovetail).

In 2012, there is no reason for manufacturers of engine parts not to automate some of their production processes to ensure quality and consistency. "OEMs and their supply chain should react promptly and automate their production, but we must not cut corners in final inspection either," remarks Beauregard. A part can be perfectly manufactured and still display tooling marks that make it unusable.

Inspection

Surface inspection is a necessity for certain consumer goods as customers avoid even superficially damaged merchandise. However, the finish of jet engine blades is just as important, not for aesthetic reasons but for efficiency and service life. Thus, final inspection of a jet engine's critical rotating parts is mandatory and this rule is understood and endorsed by the entire industry. But here again human inspection can prove inadequate. "Making the production department's worst nightmare real, final visual inspection should be automated too", Beauregard states.

A complete visual inspection of components must be performed to evaluate if any random defects are present. To perform this AV&R offers Automated Visual Inspection Solutions. The goal of these systems is to inspect critical gas turbine parts to ensure there are no surface defects such as dents, nicks, pits or scratches. These surface defects start to be a concern from 100 microns diameter and 25 microns in depth, so the systems need to be highly accurate.

With an automated machine a small lighting or process variation can be seen as anomalies, leading to a mismatch between the customer's actual quality evaluation and the system output. This results in the rejection of the part. Special algorithms are needed to generate intuitive results and minimise false defect detection. Furthermore, to ensure that every portion of a part has been inspected, special handling and image processing synchronisation is needed.

AV&R's systems have been developed to answer these technical difficulties. But finding defects is not the end of the inspection process. An evaluation is then required to determine whether a part can be reworked or not. To this end the shape and topography of defects must be discovered and this requires a 3D data acquisition system such as AV&R's 3D Automated Visual Inspection Solutions.

In a field-proven solution, AV&R uses a six-axis robotic system to handle the parts. This gives maximum flexibility for all required points of view. A complete 2D surface inspection is first performed to quickly identify suspicious areas. Each time such an area is found, it is located on the CAD model of the part. The transfer of this defect from the 2D image to the 3D CAD gives the position of the defect in relation to the robot world coordinates.

The robot then automatically moves the part to position a suspected defect for imaging by a 3D surface profiler. A local characterisation of the defect with high precision is taken, determining if the suspicious area is a defect and, if so, its severity. The part is then approved, rejected or reworked.

This automated system is unique and is a potential game-changer: imagine being able to find and characterise surface defects automatically instead of having to train inspectors each year. Even though AV&R's robotic systems are not stand-alone for the moment (a certified inspector is required to assist), a time will come when they will become self-sufficient.

Creating Standards

One of the worst parts of the inspection process is decision making. As subjective as it was with humans, some subjectivity remains with automation. The extent of this is determined by the customer, for whom AV&R can customise tolerances within a system. As long as universal standards are not defined for automated visual inspection, AV&R will keep on adding subjectivity to its systems, even though they were actually meant to remove it.

"Other than university testing in labs, we're the only company automating final quality inspection in shops; we are therefore creating standards."

To establish industry standards, a discussion group was recently formed between leaders in visual inspection from the main OEMs around the world. They agreed to meet and discuss their different and common needs for the automation of their visual inspection. This group should establish universal standards according to the specific needs of the industry.

The need for efficient, safe and fuel-saving engines is universally understood. We admire design engineers and their amazing results, so why not manufacture engine parts to perfection and inspect them the best way available?

AV&R's automatic blade blending system.

"As long as universal standards are not defined for automated visual inspection, AV&R will keep on adding subjectivity to its systems, even though they were actually meant to remove it."

THE GLOBE AND MAIL

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CASE STUDY: AV&R VISION & ROBOTICS

Pushing right buttons yields success for Quebec automation firm

It's one thing to have strong skill sets. It's another to leverage them for full advantage. Montreal-based AV&R Vision & Robotics has done both.

The company was applying its expertise in automated visual inspection and finishing of high-value components across a range of industries, but it wasn't until AV&R honed in on opportunities in aerospace that its business really began to take off.

"Six years ago, aerospace represented just 30 per cent of our business," says AV&R CEO Eric Beauregard. "Today it's nearly 75 per cent of our revenue, which has more than doubled over the same period."

AV&R, which last year won the prestigious 2011 Desjardins Entrepreneur International Commerce Award, began its successful climb after introducing its automation expertise to aerospace manufacturing.

"Traditionally, the final inspection of high-end engine components has been done manually by technicians and engineers. The market wanted to automate these processes for the sake of better objectivity and consistency."

AV&R CEO Eric Beauregard says applying automation expertise to aerospace manufacturing has been a key to the company's success.
PHOTO SUPPLIED

Through persistence, AV&R team made inroads with Canadian OEMs including Pratt, GE and Rolls Royce. "We targeted the early adopters; they have the means and the interest. It's tough to get in, but when you find the right people, their authorization to buy new technologies can be substantial."

By delivering on its promises, investing in its own continual improvement and demonstrating an ongoing interest in collaborative R&D, AV&R built strong partnerships with the biggest players in the aerospace industry.

"As soon as you do that, then they introduce you to their partners and their suppliers to explore ways that you can work together."

For AV&R, this included partnering with OEM technology labs, including GE Aviation. "We bring the background IP. We protect it. They package it for their own needs. It provides us with opportunities worldwide that would otherwise be too expensive for us to pursue."

AV&R's efforts have taken its business from Canada to the U.S., EU, the Middle East and Asia, where Canadian embassies and the Canadian Trade Commissioner Service have helped AV&R further expand and diversify its contacts.

"We are living proof that you can survive in manufacturing, but it has to be high-tech, high-productivity and high-quality," says Mr. Beauregard.

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