

Innovation Takes Center Stage

Closing the Year Strong,
as RMS Grows Globally

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Turbo Toons



Exclusive Source for Axial,
Centrifugal & Oil Free Screw
Compressors, Parts & Service

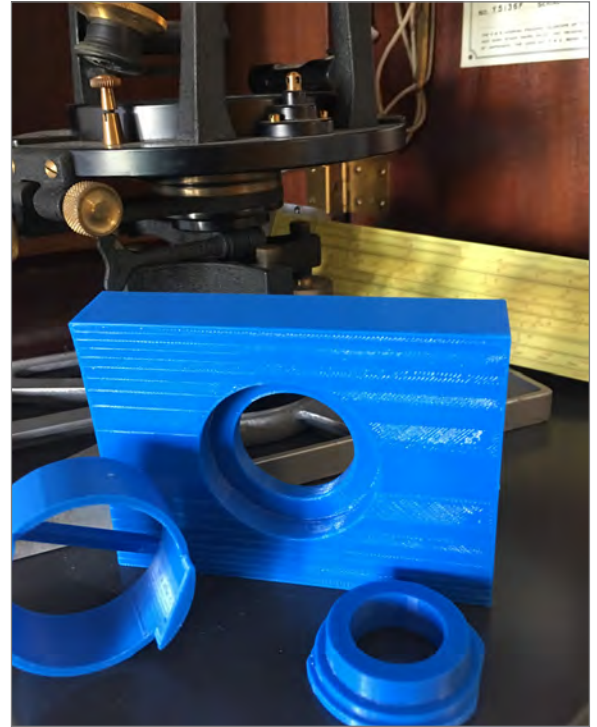
Rapid Prototyping at RMS

Dean Curtis, Senior CAD Designer

With the acquisition of a MOJO 3D printer we have been able to prototype innovative new design, reduce turn-around time, and improve our quality, for many projects. 3D-printed ABS plastic parts provide satisfactory representations of form for finished parts. With this new method, we are able to quickly assess innovative ideas by having a real world models to judge. This provides for rapid iteration from innovative idea to finished product.

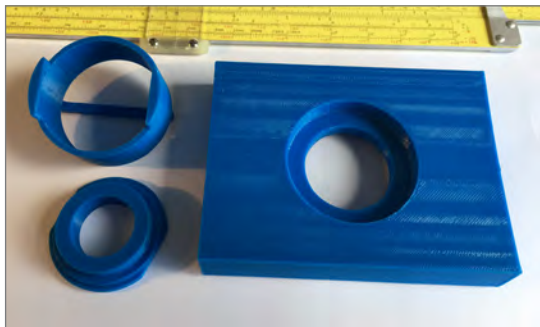
Our extensive searchable library of parts, assemblies and technical data enable us to quickly leverage existing designs. A legacy design from a decades old project can be quickly located, modified and re-created to adapt it to use in a new project.

A recent example is an axial compressor repair. It has been historically difficult to remove the bushings from the inner variable stator rings. We created a modified bushing from a legacy drawing, added some key tabs to it, and were able to use that 3D model to create a removal tool which promises to speed the turn-around time for repairs of this type of compressor.



To verify the design, we printed a small section of the inner stator ring, the modified bushing, the existing variable stator and hardware, and a removal tool we created in SolidWorks. [The time from idea to prototype was approximately 72 hours.](#) The success of the concept, as well as the necessity of a minor design tweak to the removal tool, were immediately apparent.

At this point we were at a total of four working days into the process. Manufacturing drawings and solid models for the modified bushings and the removal tool are in engineering approval, nearly ready to go to the vendor for production.



Had we had to machine a first article, the process would likely have stretched months, and iterations to refine the design would have been far more difficult, costly and time consuming. Innovations like these help us get to solutions more quickly, allowing us to get customers back up and running in record time.

A Tale of Two Turnarounds

Chet Crawford, Design Engineer

RMS was contracted to perform two Centrifugal Compressor Turnarounds within a two-week span. Each of the machines had newly designed items installed and reworks to be executed during the turnarounds.

The first machine to arrive was a barrel style MGGB-633 CONMEC Centrifugal Compressor. The customer required a rerate due to changing performance conditions. RMS took all the necessary engineering and purchasing steps to meet these demands, including:

- RMS designed base plate for new compressor train components (VFD motor and gearbox)
- New seals and bearings to accommodate new rotor dynamics

The hours of engineering that went into the new design and the decades of experience inside our shop are what really sets RMS apart, and **we completed the full scope of the turnaround ahead of schedule.** As we were making the final adjustments to the CONMEC compressor, the second compressor arrived.

This second compressor was a Dresser Rand 646B6 barrel style compressor. The spent bundle was successfully removed using a bundle removal tool that was designed and manufactured by RMS. RMS performed the necessary disassembly, cleaning, inspections and painting scope along with several reworks including the addition of temperature detectors (RTDs) in the bearings.

Once again despite the challenging schedules, we met and exceeded customer expectations.



Ingersoll Rand Barrel Style Compressor



Rotor running position inside CONMEC diaphragm assembly



RMS manufactured Tool at work extracting Dresser Rand bundle

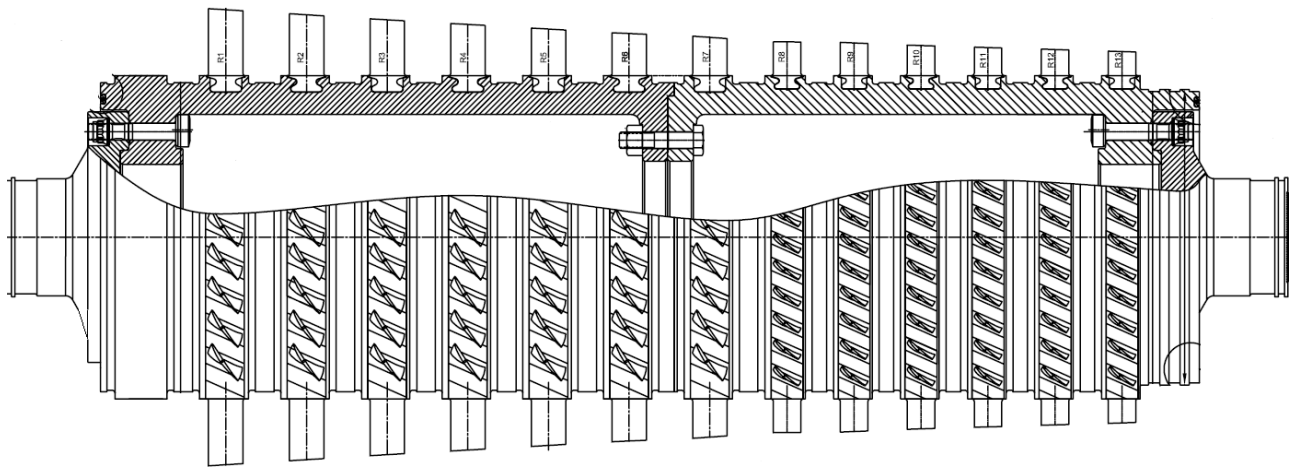


Axial Compressor Rotor Blade Root Redesign

Chris Sykora, Senior Structural Analyst

RMS recently completed the machining of a brand new, upgraded axial compressor rotor for a major West Coast oil refinery. The upgrade of this rotor included a complete redesign of the rotor blade root attachments to the rotor drums. The previous configuration of this rotor used blades with conical seats that were screwed into the hollow drums and attached with nuts inside the drums. While this allows for many different aerodynamic designs since the blades can be rotated, assembly of these blades is a real hassle. Someone has to be physically inside the rotor drums to turn the nuts while the blade is held in position from the outside by another person and blade angles must be checked and rechecked during assembly.

To help the customer avoid this, RMS upgraded the blade root designs to a tangential entry dovetail that is a fixed angle and can be easily assembled, common in steam turbine blades. This was a proven concept that was used on a previously overhauled rotor that was about half the size of the current rotor.



Tangential entry rotor concept

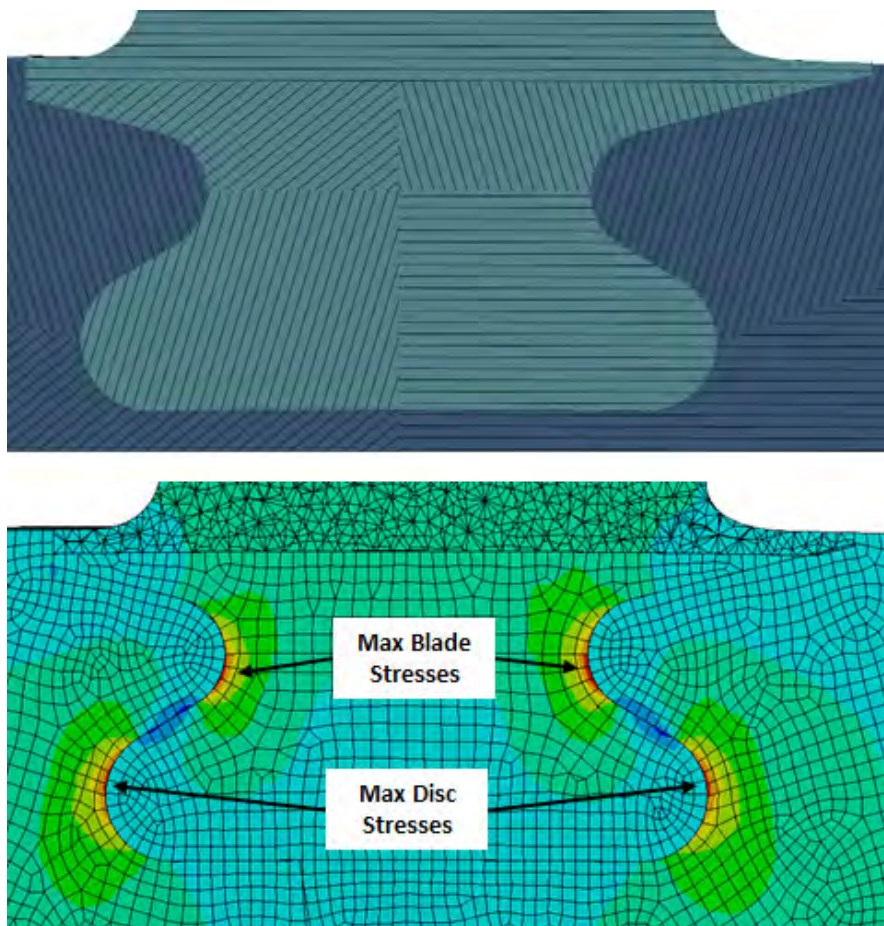
In order to qualify this upgraded design, the new blade roots of all 10 stages had to be analyzed for stresses and vibrations, while trying to replicate the previous aerodynamic design as close as possible to maintain performance.

The first step was to analyze the stresses in the blade roots with a 3D solid ANSYS model of the entire blade, the section of rotor drum around the blade root, and the spacer pieces used in between blades. Parametric optimization routines in ANSYS were used in the preliminary design of this blade root in order to minimize the stresses by adjusting the flank angle, neck width, and fillet radii. Adjusting some of these parameters larger or smaller caused tradeoffs in blade versus disc stresses, so the proper application of the multi-objective genetic optimization algorithms in ANSYS was critical to finding the best design. RMS has both the software capabilities and engineering knowledge to implement this kind of optimization on many different projects.

The next step in the redesign was to check that the vibration frequencies of each rotor blade were appropriately separated from the excitation frequency stimuli. Campbell diagrams were used to interpret the modal analysis results from ANSYS. Since the blade roots were significantly altered compared to the old screw-in design, the vibration frequencies of some mode shapes were different than the original blades. As a result, there were several preliminary blade designs that had unacceptable frequency separation margins that could have resulted in damaging resonance during operation.

The blade roots on those blades were further adjusted in order to tune the natural frequencies away from excitations on the Campbell diagrams and stresses were re-analyzed. A few of the blades also required iterating on the aerodynamic design to modify the airfoil shapes to avoid potential resonances, since blade root changes were not effective enough on their own. One of the stages of the blades was also modal impact frequency tested to validate the FEA results, since it had closer margins than could be accepted based on the analysis alone.

Ultimately, the new blades were successfully designed such that they met all RMS design criteria for compressor blades and are now being prepared for assembly into the finished rotor and reinstallation at the oil refinery.



Tangential entry blade root design and resulting stresses

Training Success

Steve Kaulius, Director / CC New Business Development

On November 13-14, RMS held its first Centrifugal Compressor Roundtable in Bethlehem, PA. Thanks to a request for training from the engineering team at Philadelphia Energy Solutions, we decided to implement this concept for a wider audience. We had 13 people from four different customer sites attend the training. In addition to PES, we had customers from P66 Bayway, Delaware City Refining, and Paulsboro Refining.



Other training that RMS has done this year includes our yearly FCC Roundtable and several on site training sessions. Customers included Flint Hills Resources in Corpus Christi, TX and HollyFrontier Refining in El Dorado, KS (on their rerated hydrogen recycle compressor and system).

We've also done Lunch-and-Learn presentations for:

- Kinder Morgan in Houston, TX
- ChevronPhillips Chemical in Baytown, TX
- ExxonMobil in Baton Rouge, LA
- Andeavor (now Marathon) in Martinez, CA
- Valero in Benicia, CA
- Chevron in Salt Lake City, UT

If you would like to have training at your facility, please contact your local sales person or Steve Kaulius in our Bethlehem, PA office.

RMS Expands US Footprint

John Bartos, CEO

The acquisition of the AC Compressor business in the 2nd quarter of 2018 has necessitated the expansion into new facilities for the growing RMS team. The newest RMS facility is in North Houston, conveniently located near Houston's George Bush Intercontinental Airport. RMS corporate reduced rates are available at the Houston Marriott North located just across the driveway from the offices. The new Northchase facility will serve as the Houston main office for ACC engineering, sourcing, project management, sales and commercial operations. The new office joins the RMS network that includes headquarters and manufacturing in Bethlehem, PA; ACC centrifugal compressor engineering and sales in Appleton, WI; and RMS manufacturing and repair in South Houston (also conveniently located near the Hobby Airport). We look forward to seeing many of our customers in the near future at one of our locations!



Headquarters
2760 Baglyos Circle
Bethlehem, PA 18020

ACC CC Engineering & Sales
1981 Midway Road, Suite A
Menasha, WI 54952

South Houston Office
11410 Dumas Street
Houston, TX 77034

Northchase Houston Office
16676 Northchase Drive, Ste 400
Houston, TX 77060

High-Speed Team Building: RMS at MSR

While they might not be able to say “RMS at MSR” three times fast, that didn’t stop the RMS team from getting some track time in at Houston’s Motor Speedway Resort (MSR) in Angleton, TX. Several members of the RMS team got together over the Thanksgiving holiday for a fun day of on-track activity.



Is anyone surprised that people who work in the turbomachinery industry have an affinity for other forms of high-performance equipment? For many, that interest extends to fast cars. This gave the team a new opportunity to test their knowledge and skills to reach *the finish line*.

The RMS team puts their full focus and effort into everything they do, whether that *finish line* is at the end of a race track or reaching a customer deadline ahead of schedule.

Roughly once (sometimes twice) per month a group of members at MSR organize “SRDs” (Stress Relief Days) for their non-member guests to come out to the track to improve their driving skills. The emphasis, as always, is on the safety of everyone involved.

The day begins with a driver’s meeting where several experienced drivers explain the rules for the day, and provide coaching on safety and responsibility. Novice drivers are then encouraged to participate in “ride-alongs” with experienced MSR members to learn the layout of the track, and get additional tips on car positioning, braking points, and other helpful advice.

Those drivers then progress to their own cars to partake in lead-follow sessions where an experienced driver leads a new driver around the track to further instruct the unique “lines” of the course.

Finally, the new drivers are permitted to drive solo around the track observing all of the lessons learned to that point. The end result is a day of camaraderie filled with adrenaline that allows each participant to expand their driving skills, in a controlled manner on a real racing circuit.



Part of the RMS team enjoying some track time at MSR - Left to right: Kishan Agravat, John Bartos, and Nick Schneider

“I greatly enjoyed the track day experience at MSR this past Saturday. It allowed me to not only test the limits of what my car is capable of, but also bond with my coworkers through a shared passion.”

- Kishan J. Agravat, Engineer I

“Racing events like the MSR track day are an adrenaline rush that you simply can’t find anywhere else - getting to spend just a few hours in that environment is always an incredible experience. I can’t say the same for my tires, but I definitely had a great time!”

- Nick Schneider, Account Manager

RMS Images Featured on Turbomachinery International 2019 Handbook

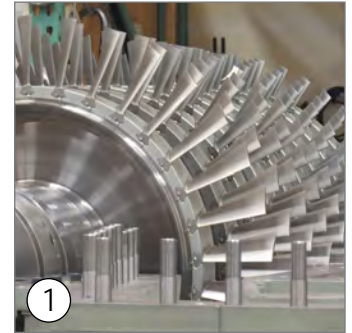
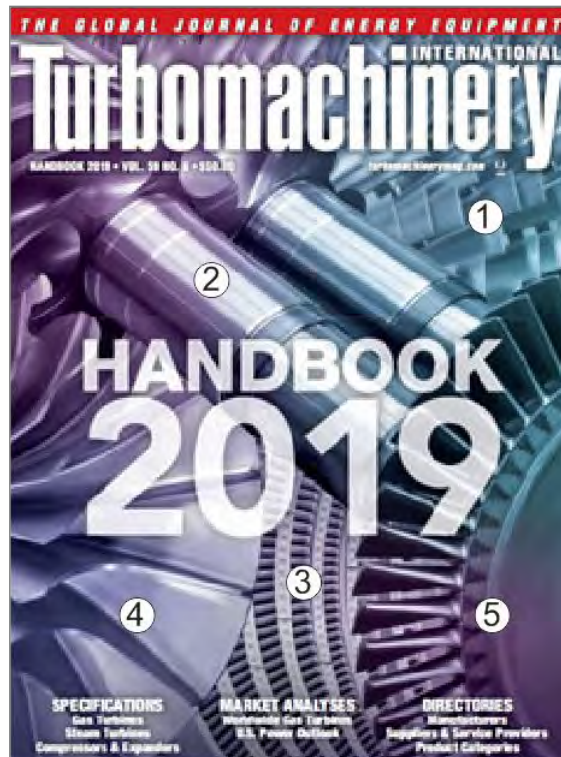
RMS was honored to be asked by Turbomachinery International for permission to use images from an RMS ad campaign for Turbomachinery International's 2019 Handbook. The rotor images all were captured from RMS work-in-process and were first used as a part of the RMS "Restoring More than Just Confidence" series of advertisements. We thought the readers of "The Finish Line" might be curious as to the back-story behind the image, prior to the Photoshop wizardry of our marketing department.



The male and female 6-3/4" oil free screw rotors were taken from a photograph depicting their inspection after 5-axis milling of the profiles. RMS now serves as the OEM for AC Compressor oil free screw compressors. Sizes range from the smallest at 6-3/4" all the way up to 25" rotor diameters.



This is an impeller for an AC Compressor D36JR in Mechanical Vapor Recompression (steam) service. This rotor was a duplicate to the running rotor. This order and the engineering was performed prior to the AC acquisition so we reverse engineered the design.



This is the axial compressor for a fluid catalyst cracking unit in a Texas refinery. RMS disassembled, cleaned, and inspected it before installing new bearing housings, rotor discs and blades.



We performed a Phase I inspection and did the minor repairs to the shaft and disc of this E-148 FCC Expander rotor. The blades were scrapped due to erosion and the customer had provided a set of spare blades for blading and balance. The blades were OEM supplied, but we discovered that one blade had material left on the fir tree outer radius - it would not assemble to the disc. We sent the blade back to the supplier to correct the issue.



This is a steam turbine rotor for the main air blower train from a Texas-based refinery. RMS performed the turnaround on that train early in the year. This is the spent rotor that came out of the machine. It is currently undergoing repairs after the phase 1 inspection. We are replacing the last 2 rows of blades seen in the right side of the photo along with HP seal sleeves.

Don't Be Foiled by Hazards this Holiday Season

While getting into the holiday spirit at our Northchase Houston office, the RMS team was going about their usual morning routines - grabbing coffee and enjoying some breakfast. A distinct smell of something burning arose from the breakroom, alerting several staff members. It was soon discovered that the decorative, gold-foil surrounding the festive napkins and paper plates the team was using leftover from Thanksgiving celebrations were entirely incompatible with microwave use. The end result was the foil overheating and subsequently igniting the surrounding paper napkin.

Fortunately, the damage was limited to the minor inconvenience of a stinky breakroom, but had this hazard not been quickly identified, it could have been much worse. All of the potentially harmful plates and napkins have been safely discarded of, but this served as a reminder to stay vigilant for hidden hazards this holiday season.



See you at SynGas 2019!

In March 2019, RMS will be participating in the SynGas 2019 gas conference in Houston. We hope to see you there!

About SynGas

Every year attendees have the opportunity to participate in many peer to peer breakout sessions which focus on relevant content in the SynGas industries. SynGas Association provides professional moderator training to both producers and suppliers who lead these unique sessions every year at our annual conference.

Learn more at syngasassociation.com/syngas-2018/



MARCH 11, 12, 13 – 2019

The RMS Family Grows

Please join us in welcoming the newest RMS team members!

Charles “Chet” Crawford III • Design Engineer I

Chet has held various positions since his graduation from Pennsylvania State University with a degree in Petroleum and Natural Gas Engineering. His most relevant industry experience includes approximately three years of maintenance, operation, and design in the field of hydraulic fracturing.

Thomas Class • Network Administrator

Thomas joins RMS with 10 years of experience working in network/infrastructure support and network security. Thomas has held roles of increasing responsibility including Network Technician, and most recently Network Analyst II.

Sherry Lee • Accounts Payable

Sherry brings a wealth of knowledge to the accounts payable position, with more than 17 years of experience of supporting various roles. Her experience and proven track record will be invaluable in helping us to achieve departmental goals and objectives.

Ronald Burrell • QC Inspector

Ronald joins RMS with 13 years of experience in machining and inspection operations, in addition to his experience generating and processing NCRs, managing ITP compliance and conducting second and third party witness inspections.

Joining our South Houston team:

Marco Rodriguez • Global Logistics Traffic Manager

Hilario Limon • Senior Mechanic

David Martinez • Mechanic

Jordan Franco • Mechanic’s Helper

Eladio Moreno • Welder

Santiago Aleman • Welder

Matthew Levy • Accountant I

Matthew has worked for Formosa Plastics handling benefits billing, payroll processing, and ensuring the company was in compliance with year-end filings. In addition, he worked for Publicis Group as a Client Financial Specialist and was promoted to Treasury Disbursement Specialist having oversight over \$500 million in advertising invoices monthly.

Ferrie Navoa • Designer

Ferrie joins RMS with experience in Autocad and Solidworks, with degrees from Northampton and NJIT. He most recently worked for Mobility Elevator and Lift Company.

Corey Bartholomew • Buyer/Purchasing Coordinator

Corey comes to RMS with more than 17 years of experience in different facets of materials management. In his new role, he will be responsible for buying our MRO supplies, catalog hardware, inspection, testing, calibration, and more.

Nigam Sheth • Sr. Lead Engineered Order Manager

Nigam joins RMS with 11 years of Project Management and Sourcing experience, primarily on the AC Compressor Products. Most recently Nigam was a Project Manager for GE Energy connection/ABB Automation.

Joining our Appleton, WI team:

Anthony Kenney • Assembler

James Hudson • AC Compressor Senior Engineer

Recent Promotions:

Dora Montalvo • Project Controller

Todd Koehler • Design Engineer II

Glenn Adams • Manager of Accounting

Debbie De Lara • Marketing/Projects Administrative Coordinator

Teaming Up in Our Communities



As we proceed into the holiday season, RMS has been focused on helping those less fortunate. The RMS office in Bethlehem, PA has been collecting for the local Toys for Tots Drive since late November, and we are overjoyed to see the team has collected two full bins of toys! Meanwhile, the Houston RMS-Mepco facility teamed up with their local homeless shelter to participate in a blanket drive for the homeless in Houston.

We appreciate all the generous donations from our staff, making it possible for so many to share in the magic of the holidays this year.

Join the RMS Team!

We currently have the following positions open at RMS.

RMS Mepco – South Houston, TX

- Senior Mechanics
- Mechanics

RMS Northchase – North Houston, TX

- Senior Administrative Assistant / Office Coordinator

To apply, please send your resume (Attn: Human Resources) to:

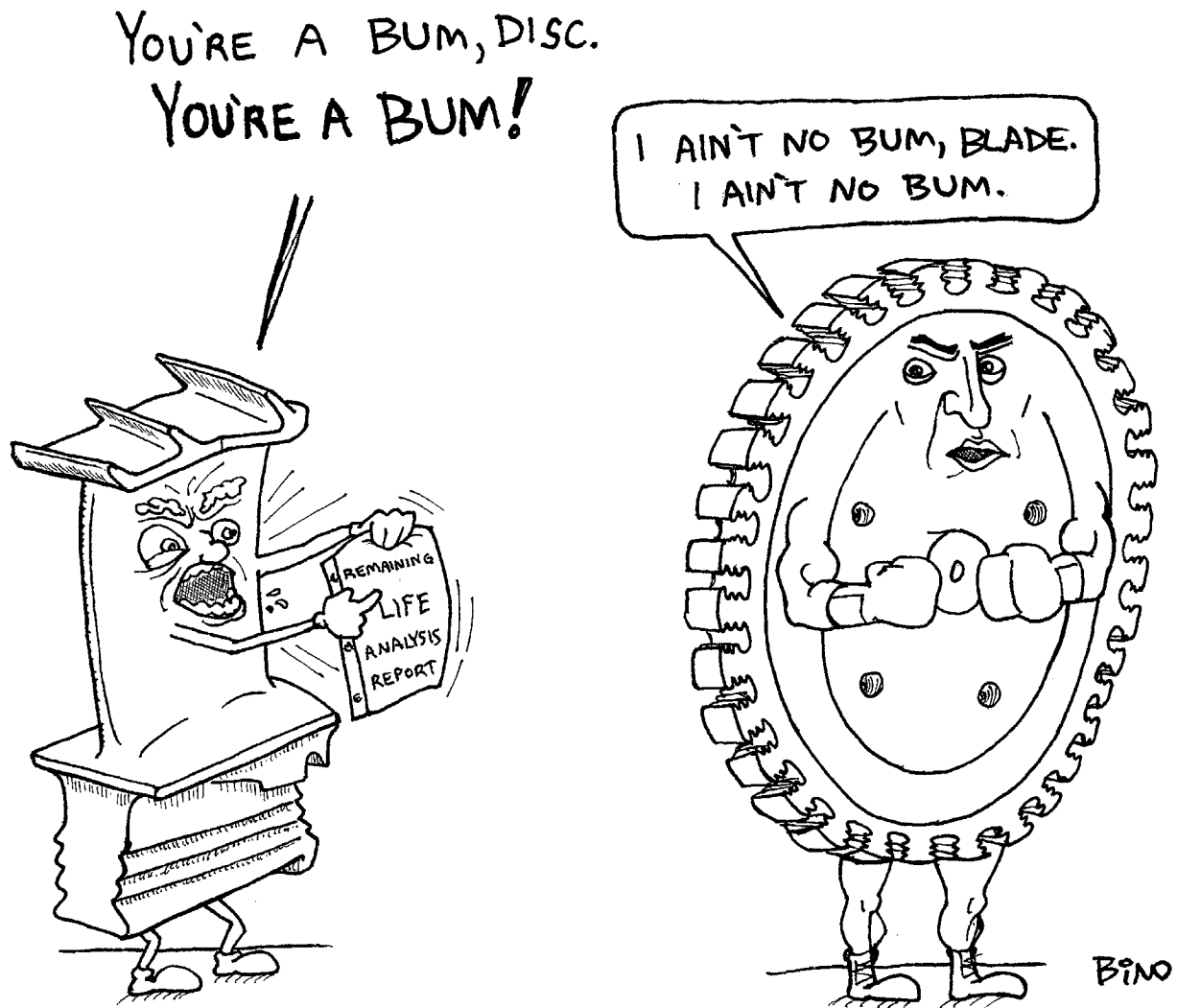
HR@rotatingmachinery.com

or

2760 Baglyos Circle, Bethlehem, PA 18020

THE FINISH LINE

Turbo Toons by RMS's own Marc Rubino, Principal Engineer



Happy Holidays from RMS!



No matter what holiday you celebrate, from the RMS family to yours, we wish you a safe and happy holiday season and a peaceful and prosperous New Year!

As the holiday season is upon us, we find ourselves reflecting on the past year and those who have helped to shape our business. It's been quite a year for us all! We hope that 2018 has been just as memorable for you, your colleagues and your loved ones.

We look forward to working with you in the years to come.



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- Analytical Evaluations
- Dynamic Balancing
- Machinery Installation, Redesign, Repair, Commissioning, Overhaul, and Rerates
- Reverse Engineering
- Third-Party Inspection
- Consulting
- Orphan Equipment
- Labor and Labor Supervision
- Spare Assemblies and Components
- Remaining Life Assessments
- Design Engineering
- Surplus Equipment Rejuvenation

We provide the turbomachinery support and expertise you are looking for.

Corporate & Appleton Engineering Offices

484-821-0702

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