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MRC NEWSLETTER

Maintenance & Reliability Center
The University of Tennessee
"where industry & academia meet"

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MARCON 2006 – A RESOUNDING SUCCESS!

If you missed MARCON 2006, you missed an outstanding conference and an incredible opportunity to network with maintenance and reliability professionals from all over the world. Feedback indicates that the technical program was one of the strongest ever. A blend of tutorials and panel discussions, along with the more typical slate of papers, proved to be very popular with the attendees.

We were blessed to have Paul Casto, Manager of Reliability Technology for Eastman Chemical Company, officially kick-off the conference with his opening day keynote address. He told us how to build a business case for maintenance and reliability based on the direct impact to the company's bottom line. He was followed by Doug Keene, Technical Director of the 402d Maintenance Wing at the Warner Robins Air Logistics Center, who gave our second day keynote address. Doug shared how the C-5 Program at Robins AFB used a combination of Lean techniques and Critical Chain Project Management to reduce the variability in Air Force Programmed Depot Maintenance thus significantly reducing flow days.

In addition to the two keynote presentations, the three tracks of Asset Management, Best Practices/Case Studies, and New Technologies contained a number of powerful papers and presentations. The focus on Lean Maintenance in the Asset Management track, and the addition of several military speakers and DoD contractors provided attendees with some unique perspectives on "pushing the envelope" of maintenance and reliability.

Besides the serious side of the conference, attendees had a chance to relax and have some fun while socializing at the two receptions and at the closing dinner. The dinner attendees were entertained by Dwight McCarter's humorous stories of tracking criminals and dramatic rescues in the Smoky Mountains.

We sincerely thank the great group of presenters and attendees that made MARCON 2006 a resounding success. We could not have done it without you.

Don't forget to mark your calendars now for MARCON 2007, which will be held May 7-11.

Inside this issue:

Director's Corner

Tom Byerley
MRC Director

As I attempt to write this "Director's Corner" it is apparent that it has been much too long since we published the last MRC newsletter. I have no real excuse – we have just been very busy with a number of other activities and somehow the newsletter kept falling to the bottom of the list. Does this sound like something that occurs with some of your maintenance or reliability teams? I hope not – it is all too indicative of a reactive mindset. I think we in the MRC staff are back on a proactive track and you should see regular editions of the newsletter in the future.

Despite the long intermission, the newsletter has undergone a very serious and positive upgrade, thanks to Kim Kallstrom. I have asked Kim to oversee the gathering and inclusion of several technical articles from our members and other sources. I think you will be pleased when you read them and I hope you will agree that these articles are of value to you and your organization. Also, please be prepared to offer your own articles for future newsletters (if you don't volunteer, you should probably expect a call from Kim).

The year 2006 is flying by and much is happening with the MRC. We have placed 29 interns in the field this summer – our largest number yet. We conducted MARCON 2006 in early May with a dynamite program. Our attendance slipped a small amount, but those in attendance were blessed with exceptional content. Our UT-Monash program for "Master's Degrees in Maintenance Management and Reliability Engineering" continues strong and we are preparing to enter into a multi-year extension of our agreement with Monash University.

And while it has not been officially approved, I am confident that we will have a UT College of Engineering "Master's Degree in Reliability and Maintainability" program in place this fall. We are currently awaiting approval from the UT Board of Trustees and the Tennessee Higher Education Commission. Along that same line, we have established a "Minor in Reliability and Maintainability" at the undergraduate level. This is significant in that the recognition appears on the students' official university transcript (our present MRE Certificate is a College function and does not appear on the University's transcript).

We have been very fortunate to be involved with several projects with various member and non-member companies and organizations. While delivering a valuable end-product to these groups, I have also seen a significant benefit in involving more faculty members, to a much greater depth, with the MRC. One of our projects involves a multi-departmental team, including members from the Mechanical, Industrial, Nuclear, and Electrical Engineering departments, working in conjunction with the MRC. Our own Duane Dunlap has done a great job of heading up this effort. This multi-department team approach is fairly unusual in the university setting (unfortunately) but this team has performed exceptionally well and has received much positive notice from the administration.

On a personal note, I have several items to report. Linda Stooksbury underwent a successful knee replacement on May 25 and is now recuperating at home. Kim Kallstrom, whom I mentioned above, has been working with us on a part-time basis and has been very helpful in a number of areas such as MARCON, the newsletter, and various presentations. Ken Piety, whom many of you know from his CSI days, is also working part-time with us to develop more research and development activity. These additional resources are a welcome addition to our efforts.

The rest of 2006 looks to be as busy as the first half and the future appears to be limited only by ourselves and our resources. It is a great position to be in – especially as we stay in a proactive mode. And that means that you should look for the next newsletter in a more timely manner.

Tom

Dr. Toby Boulet and the 2006 MRC Interns

2006 MRC Internship Program

This year a record setting 29 engineering students have been placed in internships with 13 different MRC member companies. The summer officially started May 8, with most of the students attending the one-week training experience we refer to as “Boot Camp”. From there, the interns were dispersed across the United States to a myriad of locations, companies and jobs where they will spend 12 weeks gaining a better understanding of maintenance and reliability in “the real world”. After returning to campus, the interns will present reports on their summer experiences and several of them will participate in our September MRC members’ meeting. We are very proud of our student interns and very appreciative of our MRC member companies that are sponsoring the interns this year.

The interns and sponsoring companies are as follows:

Alcoa	Jennapher Lingo David Teeters
Anheuser-Busch	Douglas Hemme Amy Scott
Arizona Public Service	Dan Harris Kyle Keckler
ASRC	Danny Sale
BE&K	Thomas England
Bowater	Andrew Myers
DuPont	Victor Foster Tricia Goetzka Joshua Miller Anthony Ragghianti Mike Saale
Eastman Chemical	Cheyanne Hardt John Scott
Fluor	Michele Carlson Jesse Dalton Eric Huppi Sean Mailen Josh Mink William Rohr
International Paper	Marcus Balitsaris Andrew White
Michelin	Brice Leffel Dana Sippel Logan Williams
Peabody	Daniel Cohen
Sandia National Labs	William Edgar

Process Reliability

By: Dennis M. Whitty, Reliability Consultant, Alcoa Inc.

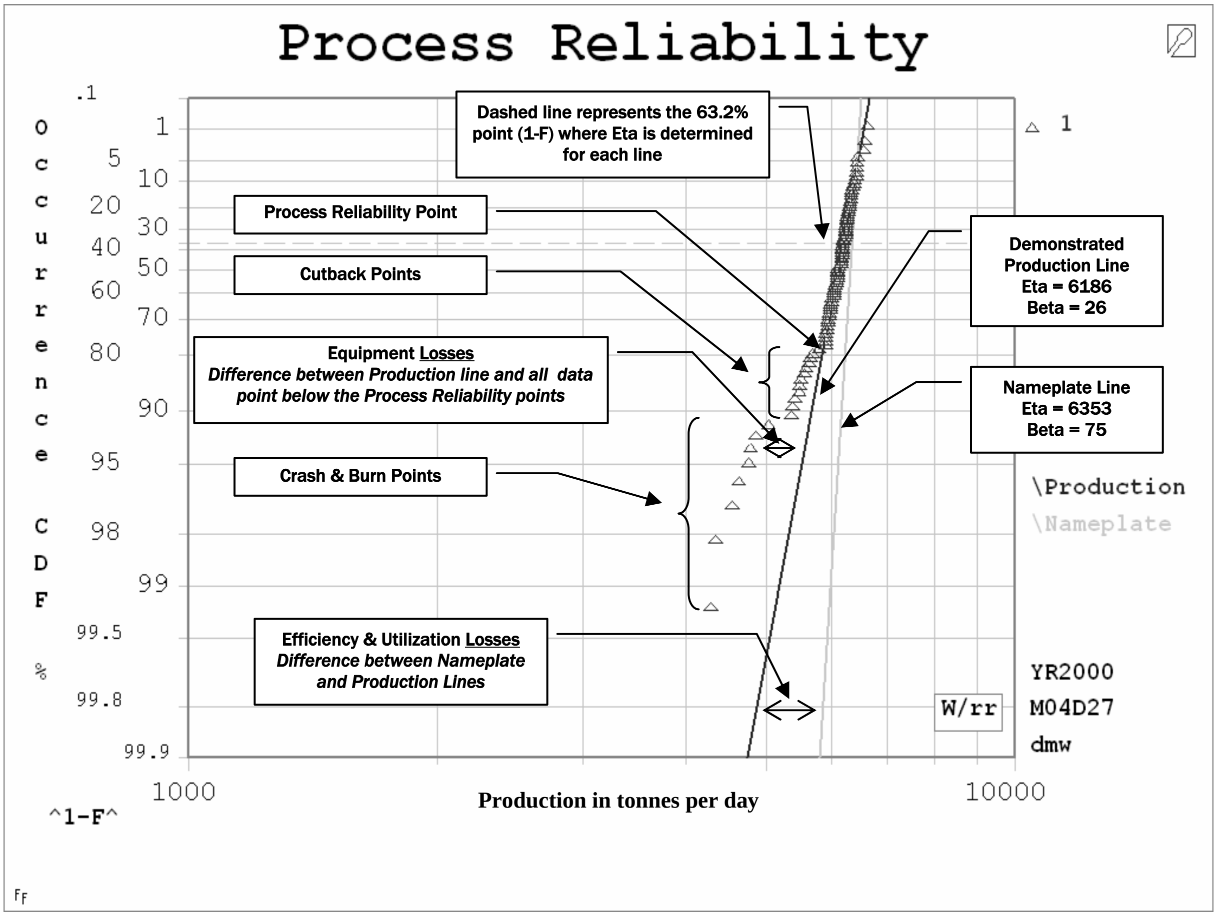
Process Reliability is a high level analysis tool that is used to describe the current capability and variability of a given process or an entire manufacturing facility. It is a special application of Weibull analysis developed by Paul Barringer and is referred to in "The New Weibull Handbook" written by Dr. Robert B. Abernethy. A windows based software package, WinSMITH Weibull by Wes Fulton, has been developed for Weibull analysis and the technique described in this article is semi-automated in the software package. The technique is quick and easy to use. The production data used for this analysis is readily available in most manufacturing facilities.

For example (see page 5 for graph), daily production numbers for a three-month period in metric tonnes per day (90 points) is plotted on a Weibull graph. A best-fit line is then drawn through the upper portion of the data points that fall in a straight line. This represents the underlying process and contains mainly efficiency and utilization causes of variation. The Beta or slope of this line describes the amount of variation present in the process on a day-to-day basis. The data points that fall to the left of this line represent days that have cutbacks or catastrophic failures. The point where the data starts to deviate from the line is called the process reliability point and gives you the percentage of the days not affected by special causes. Eta is a parameter of the distribution and can be used as a stretch goal when setting objectives or near term improvement goals. A line is then drawn from one of the uppermost points down to the x axis which represent a day with little or no disruptions or losses. The Beta or slope of this line is selected by the user and represents the ideal, benchmark, improvement goal or standard for this process. A vertical line would represent an ideal process with no variation. In the example on page 5, a Beta of 75 was selected to describe world-class performance. At each data point the difference between the two lines can be summed and the total number of tonnes lost to efficiency and utilization issues (common causes) for the 90-day period can be determined. This can be used to quantify the dollar value of improvement efforts or lost opportunities. A similar technique can be used to find the difference between the line describing the underlying process and the data points representing cutbacks and special causes. This represents the tonnes lost to special causes.

Experience has shown that in many manufacturing facilities, the common causes/special causes ratio follows the 80/20 rule. 80% of the losses are due to efficiency and utilization losses that occur day in and day out and 20% are due to equipment losses (special causes). In many facilities, improvement efforts and resources are focused on items occurring within the 20% while the 80% is ignored. The 80% is the hidden factory you often read about.

This type of analysis is visual and puts a quantifiable number to losses or improvement opportunities. If used periodically it can be used to measure progress toward a specific goal or objective.

Additional information and technical papers on this subject can be found at www.barringer1.com



About the Author—Dennis M. Whitty

After serving 6 years in the US Navy aboard nuclear submarines, Dennis attended the University of Iowa and graduated in 1977 with a BSEE. He has spent the last 28 years with Alcoa, Inc. as a Plant Engineer, Engineering Supervisor, Project Engineer, Maintenance Supervisor for craft training and nondestructive testing, Process Improvement Specialist, Reliability Manager for West Australia and most recently as a Reliability Consultant for several business units within Alcoa. His focus is to improve the manufacturing process and equipment to support Alcoa's business plans through the use of reliability concepts and tools.

MARK YOUR CALENDARS!!

The MRC Fall 2006 Member's Meeting will be held September 20-21st.

UT Professor Developing Guidelines for "Maintenance Based Value Stream Mapping"

Dr. Rupy Sawhney, a professor in UT's Department of Industrial and Information Engineering, and one of his graduate students, Soundararajan Kannan, presented a paper titled "Guideline for Developing a Maintenance Based Value Stream Map" at the MARCON 2006 conference. The focus of this paper was to establish a Value Stream Map (VSM) specifically to assist organizations in streamlining their maintenance activities, and thereby reducing their Mean Maintenance Lead Time (MMLT). The approach involved a three-phase process.

Dr. Sawhney

The first phase was to develop a framework that would identify and encompass all the necessary and appropriate maintenance activities and assign VSM symbols. The seven categories identified and assigned symbols were: equipment breakdown, processes, physical flow, information flow, data box, delay and timeline.

The second phase was to develop a step-by-step standard mapping process by which maintenance practitioners in industry could baseline maintenance activities in terms of the components of MMLT (Mean Time To Organize (MTTO), Mean Time To Repair (MTTR) and Mean Time To Yield (MTTY)).

$$MMLT = MTTO + MTTR + MTTY$$

The third phase involved performing a dynamic analysis of the VSM through computer simulation, using software to incorporate variation, and resulting in calculations of MTTO, MTTR, MTTY, MMLT and the efficiency of the maintenance function.

Editor's Note: Watch for a copy of Dr. Sawhney's paper and model on the MRC website and on www.Reliabilityweb.com/tutorials in August. The model will be posted online to get feedback from the maintenance community. Dr. Sawhney may be reached at sawhney@utk.edu.

Five New Companies Join MRC

In the last year five new companies have joined the MRC, giving us 32 current members and five affiliate members. Please join us in welcoming:

Baker Hughes INTEQ - January 2006

International Paper - November 2005

Ivara Corporation - September 2005

Sandia National Laboratories - August 2005

Shaw Industries, Inc - September 2005

Scenes from MARCON 2006

Equipment Reliability:
Getting Fast, Focused, Sustainable Results

In an equipment-intensive operation, reliable equipment is the key to competitiveness. Throughput is highest and costs are lower on all fronts: utilities, labor, overtime, repair parts and supplies, raw materials, and finished products. Reliable equipment performs as intended—the first time, every time at the lowest possible cost. The problem is, that many companies and plants overlook what it takes to make equipment reliable. And, because they are often “resource constrained”, they tend to be more reactive in their maintenance work than they truly want to be. Reliable equipment comes from a purposeful focus on **three elements of productivity** (people, work processes, and equipment) and from recognizing that most of the causes of poor equipment performance are outside the direct control of the maintainers (schedules, waiting, setups, startups, repair parts, operating efficiencies, quality, and yield losses).

First, the **equipment** data tells us the nature and extent of the performance and reliability problems. And equipment data comes from three different sources:

1. The performance numbers (spreadsheets & charts: production, quality, maintenance, cost, etc.)
2. The people closest to the equipment (operators and maintainers)
3. Direct observation (look at it)

Second, **people** have to turn that data into information, prioritize it, then turn it into reliable, consistent actions.

Third, **work processes** define what **people** must do to prevent and eliminate equipment problems—step-by-step procedures, methods, SOPs, detailed job plans. These **work processes** also form the basis for “best practices” or standardized work and for training, which in turn leads to the elimination of equipment problems.

The problem is that many people in industry today are not formally trained to **follow a proven work process** to perform critical tasks correctly the first time, every time. In small- to mid-sized operations, more than 80% of maintenance personnel have not been formally trained to do the tasks they are performing every day.[1] If they are trained, they might not be held accountable for doing things the right way. Unfortunately, many well-meaning leaders in today’s plants **assume** that their people have all the right skills and knowledge to properly perform the assigned work. But the biggest variable in equipment performance and reliability is human-induced failures—each person, each crew doing critical tasks however they please.

So what is the secret of generating revenue and lowering operating costs fast? Focus, focus, focus! Focus your reliability efforts on the critical few pieces of equipment in your production process flow. Look for the constraints first. This will lead to improved throughput and revenues. If the causes of constraint are related to equipment performance and reliability, then follow this simple process:

1. Gather data to define the problem(s): type, frequency, duration, reasons, effects of, etc.
2. Prioritize the impacts of the list of problems: downtime, costs, delays, rework, etc.
3. Identify the possible causes of the biggest recurring preventable problem (focusing on one at a time).
4. Define possible solutions to the big problem (operations, maintenance, parts, training, modifications…).

5. Try one of the possible solutions and measure the results:
    a. If it works, standardize the new work processes.
    b. If it doesn't work, go back to step 3.
6. Standardize the proven work process ("best practice"). Train everyone involved.
7. Hold people accountable for using the new work process. Measure the results.
8. Improve the work process, if needed, with a consensus from those performing the work. Measure the results.
9. Go back to step 2. Pick another big problem, and follow the steps.

Sound familiar? It should. This is the same basic process used in the Toyota Production System (Rules in use #1 and #4) (See *HBR,* Bowen & Spears [2]), in Lean Manufacturing (eliminate waste), in Six Sigma (DMAIC), Deming's "plan, do, check, act," in Total Productive Maintenance (5 basic pillars), the Scientific Method, and NASCAR's top race teams. History shows us that these methods work fast. Why not follow the proven models and focus on results? Beware of shortcuts. Reliable equipment comes from reliable proven methods. Try it!

References:
(1) Over three years of anecdotal evidence from the author's conference, seminar, and workshop participants.
(2) Harvard Business Review, Sept-Oct 1999. Decoding the DNA of the Toyota Production System; Bowen and Spears.

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The Top Ten Attributes of the "Holy Grail" of Condition Monitoring

Adapted from a presentation presented at the 2006 MRC Winter Meeting by Richard Piety, Director of Engineering for the Asset Optimization Division, Emerson Process Management. The topic addressed features that users are searching for in a condition monitoring system.

What would be needed?

1. Long-life – 10 years without maintenance
2. Self-powered – no battery change for the life of the sensor
3. No wires – wireless or use other existing wired infrastructure
4. Cheap – less than $135 - $225 per machine monitored per year
5. Dependable communications – no-worry placement of sensors with no vulnerability to interference or security issues
6. Ultra-simple installation – preferably no tools required
7. Configuration is preferably self-learned by the sensor, but OK to enter fundamental design data in response to a few basic prompts
8. No limitations to the machinery monitored
9. No limitations on the environment
10. Data is output in the form of machine health trends and work orders – no analyst required

Mean Time Between Failure – Is it a True Measure of Reliability?

Mean Time Between Failure (MTBF) is often discussed, but not often used as a measure in maintenance.

Where reliability procedures are used and the vast majority of maintenance is proactive, MTBF is not very useful as a measure, but many organizations can use MTBF as a way to start towards improved reliability.

To be able to measure MTBF, certain elements of information need to be consistently captured and analyzed. The nature of the equipment failure and the work order need to be recorded. The precise time and date need to be captured for both failure and work order. If you are already recording this information for every failure and asset service activity, then you may have the data required to measure MTBF. At the start of the journey to improved reliability, an organization needs to begin to measure their performance. Until that happens they can't identify whether or not they are moving in the right direction.

MTBF can give an indication of progress. I have seen it used to measure the time between points where the asset is out of commission due to breakdown. This gives a statistic that was used to determine the frequency of failure of assets. Combined with the average time the asset was out of commission after each breakdown, an organization would calculate the time the asset would be available. Combined with other down-time factors, this number was used for estimating production output in order to schedule the factory. Sometimes the measure was used to determine whether MTBF was accelerating and an asset was beginning to enter its "end of life" phase.

Unfortunately, this whole process assumed that there was predictability to the failure process; that equipment would be repaired, enter service, parts would wear out, and then a failure would occur, after which the cycle would start over. Our experience is that this is only true of very simple pieces of equipment and then only if replacement parts have a very consistent standard of quality. As soon as we begin to apply this thinking to more complex equipment, the breakdowns become random.

The reasons lie in the interrelationships of the operating pieces of the equipment and how it is used. First of all, with many parts that wear at different rates and need replacement, we can't apply a single curve of wear, aging and failure, to a complex asset. Even if we could calculate the rates of wear for all the different pieces of the asset and then determine the "schedule" at which they would all need replacement, operating conditions for the asset vary in a way that would impact each of those wear curves differently. Rarely does a piece of equipment make exactly the same item day after day. Temperature, humidity, and run rate change constantly, impacting the wear rates further. Predicting a wear rate for a single part of an asset is difficult; doing it for the entire asset is impossible.

So what is the value of MTBF? For complex machines, as a means of determining any kind of scheduling or capacity information, there isn't much value at all. This includes determining how much production you can expect, how often to replace parts, or as an indicator of whether the machine needs replacement. What MTBF will tell you is where your maintenance people are spending the majority of their time. In other words MTBF will tell you whether or not a machine is a "bad actor" but not why.

As one of the first steps to embarking on a reliability program, this is useful information. It tells you where to start. And starting in the right place is critical if you want to achieve results quickly.

Fixing the “bad actors” first frees your maintenance people to engage in more proactive work and begin your journey to a reliability-oriented organization.

But once a company begins to use proactive reliability processes, the measure of MTBF loses meaning. Proactive maintenance procedures mean that service of equipment takes place before the traditional definition of failure, and even before functional failure. The equipment will be serviced at the point where there is sufficient lead time to make the repair before the failure occurs. The level of performance that indicates the asset will reach failure within the lead-time to repair is determined using work identification.

Repairs are now performed before a critical (traditional) failure occurs. If reliability procedures are executed perfectly, a failure that impacts production will never occur and MTBF will trend towards infinite. While this sounds like a very positive indicator, it is misleading. Equipment is taken out of service to perform repairs, making it unavailable for production and adding to the cost of operations. MTBF does not recognize this impact.

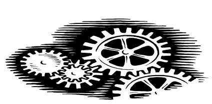
Can we measure MTBF for every time the asset is taken out of service to perform a proactive maintenance activity? This would not be a meaningful measure either. In fact it could be very misleading. Since proactive maintenance activities are completed much faster than a repair after a critical failure, the number of times the asset is out of service could be the same, while the overall availability for production could be much higher. Should we estimate the time left before the asset failed, since we know the part needed replacement? This would at best be a rough guess and would not necessarily indicate that the machine would have failed at the estimated time, since most critical failures are caused by a combination of components failing. Under these conditions, meaningful MTBF statistics cannot be generated. New measures are needed to generate meaningful statistics.

We need to look at the cost of failure avoided. Particularly the value of production time that was gained by improved reliability. A critical (traditional) failure will cause the asset to be out of commission much longer than service before the functional failure point. This value of that extra production time is often the most significant saving of reliability programs. It also keeps us from trying to run our equipment at excessive feed and speed rates to make up for lost production. This also helps improve our time between service points.

We need to have the capability of measuring the value of production gained through improved reliability. To accomplish this we need to add fields in our CMMS that will retain the average revenue per hour of production, the average duration of a critical failure induced period of downtime and multiply the two by the number of proactive service events on an asset to determine the amount of additional revenue made available.

In the meantime, there is reliability software available that can distinguish emergency work orders from proactive work orders. This means that we can measure MTBF in a meaningful way, in the early stages while reliability procedures are being put in place. This will be a contributing factor to helping us prioritize which assets to work on first.

Keep in mind that you need to look at all the measures of the impact of reliability. MTBF becomes less useful after reliability practices are put in place. You need to look at KPIs, like the value of production capacity saved through proactive maintenance to get a complete picture.



If you would like a copy of the “MTBF Users Guide” send me an email at ricky.smith@ivara.com.

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We're on the Web!
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MRC 2006 Calendar of Events

August 1	2007 UT-Monash Registration Opens
August 4	MRC Interns' Last Day of Work
August 26 - 29	UT/Monash Residential School
September 12 - 15	PdM Conference (Chattanooga)
September 20 - 21	MRC Fall Members Meeting
October 23 - 25	SMRP Annual Conference (Birmingham)
December 5-8	IMC Conference (Daytona Beach)

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