



Society of Aircraft Performance and Operations Engineers

*Welcome to the SAPOE Newsletter. We encourage our members to contribute ideas and articles for future newsletters.*

**A Quarterly Newsletter, dependent on community involvement**

**Issue 3 - Winter 2013**

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*The latest from your Society's leadership*  
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## President's Message

*Paul Geieman is the new president of SAPOE and a Technical Fellow with Boeing's Flight Operations Engineering. He can be reached at [paul.d.giesman@boeing.com](mailto:paul.d.giesman@boeing.com)*

Well, an era has ended at SAPOE with Roy Maxwell's retirement from the presidency. We all owe Roy as well as the other founding members a debt as they made this organization happen. I take the responsibilities of replacing Roy very seriously and I want to help our organization move forward, hopefully getting SAPOE more engaged in our day-to-day professional lives.

I would like to thank both Jorge Lasso for taking the vice presidency, and Paul Hannah for running for the Presidency. I also want to take this opportunity to further commend Paul. Paul has done an outstanding job of supporting SAPOE in every way possible from getting his company to sponsor dinners to taking on the task of organizing the speakers program at the 2012 SAPOE Conference, as well as many other contributions. Paul has assured me that he will continue to be as involved in the organization as much as possible.

For this organization to continue to grow and thrive it needs additional help from the members. I do recognize that we all lead busy lives between our jobs, families, hobbies, etc. However I hope more of our members can set aside a few hours a month and donate their

valuable time and talent to help with the tasks that will make the organization grow and prosper. To this end, I would like to start my term by making a call for volunteers to help the SAPOE members with the tasks they have agreed to do for our organization.

As you can see, our intrepid editor has put out another newsletter. The newsletter is currently a one-man show with the exception of the people who have written articles. If other members of our organization volunteer to help Craig we could have a newsletter more regularly, and hopefully this will spur better communication between members. I also hope members will consider writing an article for the newsletter where they tell their fellow members about places they have been or things they have seen or their unique hobbies. In fact, I hope to convince one of my colleagues at Boeing into writing a brief story on his hobby because I think it is not only very cool, but also an impressive accomplishment. Contact [craig.nordstrom@united.com](mailto:craig.nordstrom@united.com) if you can help.

Chad Gill has put the SAPOE web site ([sapoe.org](http://sapoe.org)) together by himself. Everything Chad has developed for the site, he first had to learn how to do. I hope other members will contact Chad and let him know he can call on them to help with ideas and improvements for our web site. [chad.gill@united.com](mailto:chad.gill@united.com)

Carl Allen is creating an outreach program. Currently envisioned as a presentation SAPOE members can take to colleges and universities to introduce students to the specialty of

performance and operations engineering. If you would like to assist in this project, either by helping to develop material, by reviewing and commenting on draft materials, or by delivering materials and providing feedback, please contact Carl. His email is [Carl.Allen@HorizonAir.com](mailto:Carl.Allen@HorizonAir.com).

We plan to have a conference again this year; I hope you can step up and help out if the board calls on you for support.

One thing I would start is a "Question of the Month". This would consist of a question on physics, regulations, definitions, and interpretations of rules, history or whatever else the members wish to throw out there. Something that gives you a reason to take 10 minutes and learn something about our profession you might not have learned otherwise.

My thought is this could serve the organization in multiple ways such as spurring discussion between members, passing on changes or interesting facts we have come across on our job, give us older fogies a recurrent, help all of our members learn more than they get the opportunity to learn in their day to day work, and help us create a database of questions that could be used in the future.

Let me give some examples:

*(continued on page 3, but please don't skip the exciting Treasurer's Report on page 2 just to rush ahead to Paul's examples)*

# Membership Report

[Walt Blake](#) is SAPOE's membership coordinator and a retired Boeing Flight Operations Engineer. The following is a summary of both his membership report from the 2012 Conference and the current Membership Report on [sapoe.org](#).

As of the end of 2012, SAPOE's membership was at 171. However, membership as of the 2012 Conference had reached 155, so word of SAPOE is spreading! SAPOE now has representatives from 49 airlines (an increase of 3 the past year) spanning 30 countries (up 1). There are also 33 affiliated organizations (manufacturers, regulators, etc.) taking advantage of the SAPOE network.

The full membership report is available on the Publications page in the Members Only section of [sapoe.org](#)

If you have any questions or comments about the membership process, such as changes to your data in the roster, those concerns can be sent to Walt at [membership@sapoe.org](mailto:membership@sapoe.org)



## ABOUT SAPOE

President - [Paul Giesman](#)

Vice President - [Jorge Lasso](#)

Treasurer - [Mike Byham](#)

Secretary - [Ravin Agarwal](#)

Webmaster - [Chad Gill](#)

Thank you for taking the time to read the SAPOE newsletter. I still hope to eventually publish quarterly, but we will depend on you, the members, for content in future editions.

We welcome all submissions for technical and industry news. This is the forum that will be read by your counterparts worldwide. Has your regulatory authority imposed a novel (worthy or otherwise) requirement on your operation? Tell us how you resolved it. Have you been facing an unusual operational challenge? Lend your peers your insight into how you not only conquered the technical aspects, but also how you brought other stakeholders (management, labor groups, regulators, etc.) into agreement over the ultimate solution.

We also welcome non-technical articles. Have you been traveled somewhere that the members might find appealing? Write a travel article for us and include photos! Is there an air show or other unique event occurring in your region? Give your fellow SAPOE members the inside information to make the most of a visit to your area. While aviation-centric destinations are obvious, feel free to expand the memberships' knowledge of where else we might exercise our pass travel privileges!

More information can always be found on our website, [sapoe.org](#).

Respectfully,

Craig Nordstrom - Newsletter Editor

# Treasurer's Report

[Mike Byham](#) is the founding treasurer of SAPOE and the director of Operations Engineering at US Airways. As always, Mike reminds members to establish a V1 policy \*before\* getting into your car.

Hello Members,

It's that time of year again and I'm happy to report that we're still in the black. As of this writing, we have a little more than \$4,000 (USD) in the bank. There were two unusual items in our 2012 ledger. The first was the purchase of our invoicing program. The free trial ran its course and we had to pay \$70 to continue using the software. The second was a tax exempt filing fee for \$400. The US Internal Revenue Service required us to file a second time and the fee is a necessary payment to ensure we stay in the good graces of the IRS and comply with US Federal Tax laws.

We anticipate our bottom line total to increase to close to \$7,000 once 2013 member dues are paid. Per the requirements of our constitution, you can expect to see an invoice for 2013 dues prior to January 1<sup>st</sup>, 2013. If you have already paid your dues for 2013 (thank you!), you will still receive an invoice, but it will show a zero balance.

Since we have promised to be completely transparent with the Society's finances, we continue to post a workbook showing income and disbursement of funds on the website. It is available in the "Members-Only" section and looks like this:

ITEM	2012											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Donations - PayPal	\$425.00	\$480.00	\$335.00	\$510.00	\$120.00	\$580.00	\$105.00	\$90.00	\$270.00			
Donations - Direct	\$90.00	\$150.00	\$105.00	\$0.00	\$30.00	\$30.00				\$295.00		
Website Costs												
Tax Exempt Status Filing Fee							(\$400.00)					
PayPal Fees	(\$20.30)	(\$20.23)	(\$51.98)	(\$22.89)	(\$3.24)	(\$25.53)	(\$4.55)	(\$4.57)	(\$10.84)			
Interest Income												
Event Expenditures									(\$1,845.24)			
Shirts Costs												
Shirts Income												
Account Fees (invoice program)			(\$70.23)									
Member Gifts									(\$1,633.96)			
<b>Total Balance</b>	\$5,113.50	\$5,723.27	\$6,041.06	\$6,528.17	\$6,674.93	\$7,259.40	\$6,959.85	\$7,045.28	\$3,825.24			
Transfer PayPal to Account			\$2,048.32						\$1,772.83			
<b>Available Account Balance</b>	\$3,638.52	\$3,788.52	\$5,871.61	\$5,871.61	\$5,901.61	\$5,931.61	\$5,531.61	\$5,531.61	\$3,825.24			

You'll notice that there are two bottom lines – one that includes the funds residing in PayPal and one that doesn't. The funds are transferred from the PayPal account to the SAPOE bank account on a random basis and ad hoc when necessary. Your dues will show up in the "Donations" line as direct when paying by cash or check. Speaking of donations, we'd like to thank our 2012 Sponsors. They happen to the same as our 2011 Sponsors. We certainly appreciate the continued support. Please visit their websites and see what they're all about. We should support those who support us. ☺

AeroData Inc. - <http://www.airportanalysis.com/Official/>

MDA Corporation - <http://www.mdacorporation.com/corporate/index.cfm>

The Boeing Company - <http://www.boeing.com/>

As always, if there are any questions regarding the use of your dues, please don't hesitate to contact me at [treasurer@sapoe.org](mailto:treasurer@sapoe.org).

## The Long and Winding Road

Roy Maxwell is SAPOE's first President Emeritus. He can be reached at [roy.maxwell@delta.com](mailto:roy.maxwell@delta.com).

Our editor had suggested that I use this column as an opportunity for a farewell address. That is not going to happen! First of all, I am not going anywhere. While I was pleased to release my leadership position to our incoming President, our Constitution provides for some continuity in the organization by allowing the Past President to serve as a non-voting ex officio officer during the term of his successor. And second, the first thing that comes to my mind when I hear "farewell address" is George Washington, and while I greatly admire our work in forming SAPOE, we aren't at that lofty level... Yet!

I will, however, try to relate my recollections about how SAPOE came into being. It starts with an aborted attempt in the 1970s. Many of you will remember Don Collier at the Air Transport Association. Prior to the ATA, Don was the Chief Aircraft Performance Engineer at Delta, and he saw the value of forming an organization for our profession. It was not, however, well received by our airline management who held such a tight control on the Engineering Department that all correspondence went in and out under the signature of the Vice President. Maybe they were concerned that it could take on the flavor of a union instead of a professional organization. I don't remember who all was involved at other airlines, but this effort died quickly and may have played a roll in stifling any new efforts for decades.

I took on responsibility for weight and balance in the early 1970s and became active in the Society of Allied Weight Engineers (SAWE), attending most of the annual conferences up into the 1980s. I found these events to be of great value in meeting my counterparts at other airlines and airframe manufacturers. People like John McCarty at United, Harvey Waldron at TWA, and Brian Chapman at Southern. Yes, the same Brian Chapman who went on to have a long career in performance engineering at United. The SAWE became a model for what Brian and I thought SAPOE should be, and their Constitution was the starting point for ours.

Before deregulation of the airline industry in the U.S., performance engineers had a loose network through the ATA to disseminate information about airport construction and regulatory changes. This was primarily done by teletype, phone, and mail, but with a few meetings called in Washington, DC. With deregulation and consolidation of the industry in the 1980s, the ATA was faced with financial constraints and shifted focus away from its technical role. (One of the last major technical efforts was development of the draft Advisory Circular on

Airport Obstacle Analysis which became a very divisive political issue, and it languished in draft form for over 20 years.) At the same time, the major U.S. airlines were consolidating, becoming international operators, and getting more involved in IATA. The SCAP project started out as a joint ATA/IATA effort, but IATA ended up providing all the organizational support. The SCAP development effort required frequent meetings for several years, and provided the opportunity for performance engineers around the world to get to know each other and recognize how specialized our profession really is. Performance engineering participation in IATA continued with the Aircraft Performance Task Force and the development of the Airport Obstacle Database. The AODB eventually faded as priorities and budget constraints dictated.

Some of us started talking about the need for an independent professional society for performance engineers during the FAA Aviation Rulemaking Committee (ARC) established in 2003 to rewrite the Advisory Circular on Aircraft Weight and Balance Control. We also talked about the need for some minimum level of competence and the possibility of establishing a licensing mechanism for performance engineers. My eyes were opened about the double-edged-sword nature of licensing when one of the FAA leaders told us about his response to a proposal by a flight attendants' union to license them. They thought it would facilitate their members' movement from one airline to another if there was standardized training and licensing, and were prepared to suggest a training curriculum and testing process to the FAA. However, the flight attendants were not prepared for the FAA's question of what criteria should be used to revoke the license. The regulator who grants a license must have the authority to take that license away as well. The proposal for licensing flight attendants never went anywhere, and this made me quite circumspect about whether we should pursue it for our profession.

Most of the same airline performance engineers involved with the W&B ARC also participated in the TALPA ARC. This was a much bigger effort, involving more meetings, time, and people. It gave us another chance to talk about the need for a professional society. Mike Byham was the most persistent in bringing it up every time we got together. Mike, Ravin Agarwal, Brian Chapman, and I finally sat down together after one of the meetings in March 2008, to discuss how we should proceed. One of the things I remember we thought was important was that it be broad-based so that younger engineers would have the same opportunity to get to know their counterparts that we had from which we had benefited by participation in industry meetings. To achieve this, we had to keep dues low, and we felt we could do this by

embracing a web-based approach, eliminating the cost of paper publications and mailing. We also saw the value of technical conferences where we could meet face to face and share our experience, and perhaps even more importantly, have some fun.

Even with the low-cost approach, we realized we needed more than a few hundred dollars to get started. We were each willing to pitch in enough to do that, but then came up with the idea of offering others the opportunity to participate in the launch by making a contribution and getting the designation of "charter member". The response was greater than I anticipated, and we quickly found ourselves with more money in the bank than time to do all the things we wanted to do. Those pesky day jobs just kept getting in the way, and it was fall of 2009 before we could put together our first conference. This was the point at which I was confident we had a critical mass of participants who were going to see SAPOE through the start-up process and turn it into an enduring organization.

*(For Roy's vision of where SAPOE might go from here, please see the President's Message in the previous editions of the SAPOE Newsletter at [sapoe.org](http://sapoe.org) - Ed.)*

### President's Message *(continued)*

*Under what circumstances can the accel-stop distance available be less than the runway available?*

*Under what circumstances can the takeoff distance available be shorter than the runway available?*

At the 2012 conference many of us learned about this issue when Bruce Love talked about AC150-5300-13A.

Or how about:

*What was Henri Pitot trying to measure when he invented the pitot tube?*

Or maybe something as simple as:

*What is PRNAV?*

I would appreciate it if all the members of the organization would send me a question or two that we could consider using.

I look forward to the next two years; I hope I meet as many of you as possible that I haven't had the opportunity to meet yet. I hope at the end of the two years we can look back and see that the organization has matured and there is an increased acceptance of SAPOE by the companies for which we work.

# They're exactly the same...except they are completely different.

SAPOE member Dave Sorrell compares the primary ways to set engine thrust.

Today's jet engines are truly amazing engineering works of art. These modern engines are capable of producing nearly double the thrust compared to an engine two decades ago. The single most influential factor in achieving that kind of increase has come about through the growth of the high bypass fan at the front of the engine. The fan section alone now produces approximately 80% of the total thrust. The other 20% comes from what is known as the engine core; the compressor / combustor / turbine sections.

Jet engines all produce power in a like manner. The compressor section in the front part of the core causes the air to become super compressed (dense) as it enters the combustion section. Here, the burner area ignites a mixture of fuel and the super dense air to release an incredible amount of energy into the turbine section. The spinning turbine harnesses this energy to turn the huge fan in front of the engine as well as the compressor section, perpetuating the cycle. As more fuel is fed into the burner section, more energy is released and the engine generates more thrust. The various engine manufacturers have established methods by which to accurately measure the amount of thrust being generated. General Electric (GE), Pratt & Whitney (PW), and Rolls Royce (RR) are the 3 leading manufacturers of large commercial airplane jet engines.

Each time an engine is designed the method by which thrust will be measured is re-evaluated. Historically the manufactures seem to have settled on their preferred way of measurement. GE typically uses a method called N1, PW uses EPR, while RR uses Integrated EPR.

**N1** is simply the fan section spin rate (RPM) measured as a percent of the nominal design spin rate, e.g. 98.7%.

**EPR** is engine pressure ratio. It is the relationship between the higher air pressure coming out of the turbine section compared to the lower air pressure entering the compressor section, e.g. 1.981 EPR. N1 is still available measure of fan spin rate for an EPR engine.

**Integrated EPR** is an expansion of regular EPR. It was recognized that a large amount of thrust is due to the fan, therefore a method was established to measure the pressure differences in front of and behind the fan

section and include this in the thrust calculation, e.g. 1.973 EPR. This method is rather difficult to design, however, and is phasing out.

So what's the difference? Why choose one way over another? There are benefits and tradeoffs to each method.

## **EPR**

There is general agreement that EPR is an accurate method by which to measure thrust. Any change within the engine, whether it by changing fuel flow or due to deterioration of the compressor or turbine, results in pressure changes that are immediate and measurable. However, these pressure changes are only being monitored across the core section. The amount of thrust from the engine as a whole is then correlated based on core EPRs measured during testing.

## **N1**

Using N1 as the method of measuring engine thrust is a balance between reliability, accuracy of measurement, and ease of maintenance. As stated earlier, N1 is fan RPM. Changes to N1 result in changes to thrust, but N1 is not directly linked to exhaust pressure and consequently allows for more thrust variation. These variances, however, are accounted for within the electronic power management system. Maintenance- and reliability-wise, an N1 based engine has neither any pressure ports and tubing to troubleshoot, nor any pressure probes to ice up or clog with debris.

Each engine manufacturer tries to accurately relate actual thrust with the thrust measurement system they use. In doing so they must guarantee that the engine will produce a certain amount of thrust for a given set of conditions. The amount produced can be more for the condition, but certainly not less. With this in mind some conservatism is built in. During engine testing, when establishing the thrust measurement system to actual thrust relation, EPR based engines generally have a smaller amount of conservatism built in than N1 based engines. Both EPR and N1 based engines then use software within an electronic engine control (EEC) system to narrow the amount of excess margin. This "trimming" of the margin is done on each individual engine. Reducing the amount of excess margin is necessary for a couple of reasons. The first is to achieve the

minimum level of thrust for a given power setting for which the engine was certified. The second is to avoid engine wear and tear due to producing excess thrust.

Deterioration effects on thrust is the last area to discuss. Manufacturers try to design some amount of margin into the engine that will compensate for thrust lost due to deterioration.

## **Fan section deterioration**

Deterioration in the fan section will cause both an N1 and EPR engine to experience some loss in thrust. An N1 engine, spinning at a certain rate, expects to produce a certain amount of thrust for that spin rate. The EEC knows nothing of the lower thrust level produced by the fan just that the RPM is meeting the required level. So, the total thrust from the engine is less. An EPR engine, also experiencing a drop in exhaust pressure, is able to detect the pressure drop by virtue of the thrust setting being based on pressure measurement. To compensate for this pressure drop, a higher spin rate is required to get back to the target EPR. The total thrust loss, then, is less for the EPR engine.

## **Core section deterioration**

Deterioration within the core section (compressor / turbine) will require more fuel flow through the core to achieve the same energy output. Setting N1 the same as a pre-deterioration N1 will yield a constant thrust from the fan, but the core will give more than nominal thrust as the core burns more fuel to provide the required N1. The net result is a higher total thrust. An EPR engine, on the other hand, will see a drop in N1 for a given EPR. Less spin for a given EPR means less fan thrust while maintaining the minimum certificated thrust.

We need to keep in mind when looking at these deterioration issues that thrust losses due to deterioration are slight, usually on the order of only ½% of total thrust. However, severe fan damage could be as much as 2-3%.

In conclusion, both methods are proven means of measuring thrust. Each has their own philosophy in regard to what they feel the most important issues are with respect to accuracy, maintenance, and implementation.

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