SAE INTERNATIONAL

MOMENTUM

THE MAGAZINE FOR STUDENT MEMBERS OF SAE INTERNATIONAL™

KNOWLEDGE TRANSFER THE M-RACING WAY

Time, communication, and creativity are the keys

RECOVERING FROM THE WRECKAGE

U Akron aero team battles back from adversity to set record

The Gang from McGill

Students show poise, professionalism, and promise at AeroTech

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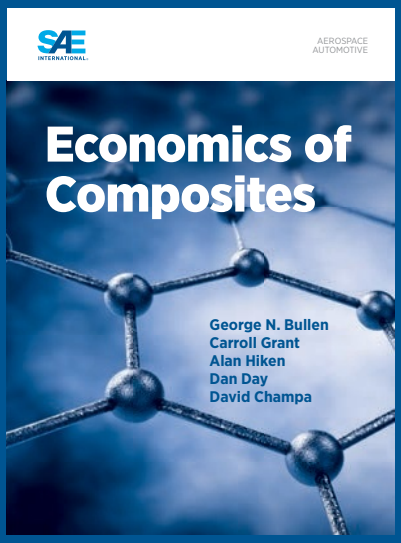
ECONOMICS OF COMPOSITES



By George N. Bullen, Carroll G. Grant, Alan Hiken, Dan Day, David M. Champa

This book, authored by a panel of experts, details composites and the state-of-the-industry to assist engineering and technical professionals in charting a course for achieving economic success from raw material to end-of-life disposal costs including:

- Economics of composite structure
- Specifics of composite assembly
- Spectrum of composite materials
- Product and human health
- Safety and environmental impacts

Strong basic economics concepts that directly apply to the composites industry is provided. This book conveys both the reality of the industry, as well as the trends and constantly emerging challenges that impact the cost of composites and are necessary for return on investment, as well as enabling the full potential of composites.

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Vol 6
Issue 6

NOVEMBER 2015

EDITORIAL

GETTING THE *MOMENTUM* YOU NEED

Patrick Ponticel, *MOMENTUM* Editor

As the sixth year of *MOMENTUM* draws to a close, it seems fitting (and fun!) to ruminate over 2015's half-dozen issues. As editor, I get this spot on page 2 to do that. But your opinion matters more than mine. And so I encourage you to offer your thoughts on what you liked about this year's issues, what you didn't like, and what changes you'd like to see in 2016 to make "your magazine" as engaging and useful as it can be. Email your comments to momentum@sae.org.

Of course, we cannot promise to implement every change suggested. But I and the rest of the SAE Membership business unit team can assure you that each comment will be thoroughly considered. Our overriding goal is to deliver to you a magazine of purpose and value.

MOMENTUM published more student-written articles in 2015 than in any previous year. That was by design. In this issue alone, you will find 5 student bylines covering eight full pages. About 25 students wrote articles or otherwise contributed content for the six issues of 2015. Student-written articles run in the Student Generation section of the magazine. That expansive piece of real estate is "your land"—dedicated (for the most part) to your firsthand, bylined accounts of challenges faced and challenges overcome. If *MOMENTUM* has a heart and soul—a "personality"—it stands out there more than anywhere else.

In 2015, we published what we think was a good mix of technical versus nontechnical student-written articles in Student Generation. Do you think it was a good mix? Or do you prefer one type of article over the other? Do we focus too much (or not enough?) on the SAE Collegiate Design Series?

Student Generation is a priority, but we want to make sure every section hits the mark. Consider the Gear section: Are the product reviews helpful, or could that space could be better used? As for the other sections, do they deliver useful content?

And what do you think of the annual September-issue recap of the SAE Collegiate Design Series (CDS) competitions held earlier in the year? It's an unfortunate collision of schedules that *MOMENTUM* goes on hiatus just as the CDS competitions take place and the academic year closes. All of the competitions are covered in *SAE Update*, the member newsletter that you and all other SAE members receive every month. Is it worth recapping CDS in the September issue of *MOMENTUM*, or is the Update coverage sufficient?

Let me end by noting how much of a pleasure it has been working with student-authors in 2015 (my first as editor). I was impressed with not only the quality of the work, but also the professionalism exhibited in the give-and-take between author and editor. Well done!

GET INVOLVED

- Become a *MOMENTUM* contributor by submitting an article. Add that achievement to your resume. Send an email to **momentum@sae.org** expressing your interest in contributing.
- Spread the word about this magazine to other engineering students and faculty, and encourage them to join SAE today by visiting **www.sae.org/membership.**

SAE International sections

SAE International sections are local units comprised of 100 or more SAE International members in a defined technical or geographic area. The purpose of local sections is to meet the technical, developmental, and personal needs of the SAE members in a given area. There are more than 42 established sections in the United States and Canada, as well as international sections/groups and SAE International affiliate organizations. For more information, please visit www.sae.org/sections.

Collegiate chapters at SAE International

Collegiate chapters are a way for SAE International student members to get together on their campus and develop skills in a student-run and -elected environment. Student members are vital to the continued success and future of SAE. While your course work teaches you the engineering knowledge you need, participation in your SAE collegiate chapter can develop or enhance other important skills, including leadership, time management, project management, communications, organization, planning, delegation, budgeting, and finance. For more information or how to find your local chapter, please visit http://students.sae.org/chapters/collegiate/

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MAYHEM REIGNS AT MUDDY BAJA EVENT

A record number of teams and students competed at a muddy Baja event held Oct. 3 at the **University of Louisville**. Called Midnight Mayhem, the non-**SAE**-sanctioned event attracted more than 50 schools and 720 students, according to Mayhem coordinating team member Brad Cottrell, a former Baja SAE competitor now working for **Cummins**. The endurance race at the annual event begins at 8 p.m. and ends at midnight. A team's performance in multiple dy-namic events earlier in the day determines run order for the endurance race. The top finishers at the 2015 event (Midnight Mayhem VII) were, in order, **Michigan Tech**, **Grove City College** (Pennsylvania), **Purdue University-West Lafayette** (Indiana), **Miami University** (Ohio), and **École de technologie supérieure** (Montreal).

Cars line up for the start of the Midnight Mayhem endurance race. The no. 75 car of Grove City College went on to finish second in the race. (Photo by Justin Whitney)

GET WISE TO SAE D.C. INTERNSHIP OFFER

College students interested in spending a nine-week **SAE International** internship in the nation's capital may apply for it using this form: http://students.sae.org/awdscholar/internships/wisesaeapp2016.pdf. It must be postmarked by Dec. 31. Students meet with leaders in the Congress and the Administration, with prominent non-governmental organizations, and with industry leaders. In addition, each student prepares a paper on a current engineering related public policy issue that is important to their sponsoring society. SAE is one of several participating organizations in the WISE internship program (http://www.wise-intern.org). The SAE intern for 2015 was Vernard Wilson, whose paper can be found in the WISE Journal at http://www.wise-intern.org/journal/2015/WISE2015.html.

The 2015 SAE WISE intern was Vernard Wilson.

COLLEGE STUDENTS PRESENT 'BEST PAPERS'

SAE International honored three students for outstanding technical papers in the commercial-vehicle sector. As part of the honor, each student presented his paper in person at the Oct. 6-8 SAE 2015 Commercial Vehicle Engineering Congress (ComVec) near Chicago. Trevor Hirst of the **University of Miami** was awarded "Best Paper" for his effort, 2015-01-2891 - Bluff Body Drag Reduction Using Passive Flow Control of Jet Boat Tail. Coming in second was Darui Zhang of **Clemson University** for 2015-01-2776 - Model-Based Estimation of Vehicle Aerodynamic Drag and Rolling Resistance. Placing third was Majeed Nader of **Wayne State University** (Detroit) for 2015-01-2844 - Design and Implementation of CRC Module for eCall In-Vehicle System in FPGA.

Darui Zhang presents his paper at ComVec.

SAE SCHOLARSHIP APPLICATION DEADLINE AROUND THE CORNER

Students who are interested in **SAE International** scholarship opportunities (http://students.sae.org/scholarships/) for the 2016-2017 academic year should be aware that the application deadline is coming up soon. Specifically, the deadline for high-school seniors seeking a freshman-year scholarship is Jan. 15—less than three months from now. The deadline for existing college students for upper-classmen scholarships is Feb. 15. Certain SAE scholarships are renewable, and for those the deadline is May 30. Not including carryovers from prior years, the amount of SAE scholarships awarded for the 2015-2016 year was $69,500.

NOMINATE AN 'OUTSTANDING FACULTY ADVISOR' FOR SAE AWARD

Dec. 31 is the deadline to nominate someone for the award named SAE Outstanding Faculty Advisors Program for Student Branch and Collegiate Design Series Team Advisors (http://awards.sae.org/faculty/). The most effective faculty advisors help their students understand the lifetime value of belonging to SAE International. They educate young engineers about the benefits available to members, encourage them to transfer to professional membership when they graduate, explore the wealth of opportunities for lifelong learning available through SAE (including conferences, technical standards and papers, professional development courses), and most importantly, encourage them to be involved in the many volunteer opportunities and build their professional network throughout their career.

GO FAST. GO BLUE.

FEATURE

The UMich - Ann Arbor team finished fifth overall in the Formula SAE Michigan competition held in May 2015, with five top-ten finishes in various events including fourth in Acceleration. (Photo by Tristan MacKethan)

Behind-the-scenes methods have made MRacing, the team from the University of Michigan-Ann Arbor, a consistent contender in the Formula SAE student design competition.

WHAT EXACTLY DOES IT TAKE TO BE SUCCESSFUL, and how do we prepare our young members to continue that success?

One of the greatest challenges that all collegiate design teams find is the quick turnover of knowledge necessary to continually move forward in their innovative events. Let's face it, students are only on their respective teams for three to five years. In that short time, we are somehow expected to not only learn how to design and manufacture a competitive vehicle, but to also teach new members the ropes and essentially run a business.

And don't you dare forget that we manage to find time to go to school too!

Collegiate design teams have been perfecting the art of passing down information for decades. We at MRacing, the FSAE team from UMich-Ann Arbor, have especially stepped up our game when it comes to sharing our knowledge at a quick rate. In the last two build seasons, our team has primarily consisted of underclassmen and has required a lot of fast-paced learning from them. In situations like these, it's up to the members of the team to decide whether they are going to "sink or swim"—or maybe, in our case, whether they are going to "overheat or compete."

As we finally cross the hurdle where the majority of MRacing students

The College of Engineering at the University of Michigan was founded in 1854. The school's strong partnership with automakers led to the formation of MRacing in 1986. Shown here is the team's car in the Endurance run at FSAE Michigan 2015. (Photo by Tristan MacKethan)

are third year and over, the team members are ready to share some tips that can hopefully be used by our peers on future teams.

There are a few key factors that MRacing members have found to ultimately impact our success. These factors include (but of course are not limited to) time, communication, and creativity.

First and foremost, time is the one thing that every member can contribute to a design team. No matter what their role or their year in school, if someone is putting in the time to find how they can best contribute to the team's success, they are useful to the team. Both old and new members should persistently be working to effectively build a racecar and learn to design a better one in the future. For many of us, especially the young ones, putting in time meant reading relevant articles, machining important parts, and being exposed to every system and test on the car. For those who were older, it meant stepping into a managerial position that oversaw scheduling, manufacturing, and providing insight to underclassmen.

Next, frequent communication is critical. That entails never-ending emails, meetings, debates, questions, etc. At the beginning of each build season, we all verbally recap what we've learned from the year previous and determine what we will improve. We also schedule peer-taught classes highlighting CAD, FEA, and CFD for all new and rusty team members. Most importantly, we keep detailed and organized records so future team members can learn from our experiences. The team will absolutely not function or grow without communication among

GO BIG AND STILL GO FAST

MRacing carbon-fiber team vacuum-bagging the 2015 car's undertray. This was the largest and most time-consuming of the team's layups. (Photo by Tristan MacKethan)

Overall vehicle weight is one of the most important factors in determining a racecar's performance. Isaac Newton told us that force equals mass times acceleration, so for a given amount of force a lighter car will achieve greater acceleration and subsequently higher scores in every FSAE dynamic event.

Due to this simple reality, our team focused heavily on weight reduction when designing and manufacturing MR15, striving for the goal of a 10% weight reduction over the previous year. With the MR14 weighing in at 467 lb (212 kg), MR15 surpassed this goal with a final weight of 419 lb (190 kg).

Much of our weight savings originated in the aerodynamics package, slimming down to 35 lb (16 kg) compared to the original's 62 lb (28 kg). A portion of this savings is attributed to the shear decrease in size of the aero package due to updated FSAE rules. However, aggressive construction changes account for the rest.

Carbon fiber being laid on the mold for the 2015 car's cooling shroud. (Photo by Tristan MacKethan)

All of the aerodynamic components, in both years, were largely fabricated out of carbon fiber. In 2014, the front, rear, and side wings consisted of carbon fiber wrapped around a foam core. We used a wet layup process, which consisted of soaking dry carbon fiber in resin, laying it up on foam that had been cut into the appropriate wing shape, and sealing it in a vacuum bag for the necessary cure time. While cost- and time-effective, this process produced an inconsistent and ultimately heavy product.

For MR15, we transitioned to a resin-infusion process for all aerodynamic components. This consisted of laying up dry carbon fiber on tooling board molds, sealing it in a vacuum bag, and then infusing the resin into the carbon fiber while under vacuum. By precisely controlling the amount of resin in each part, we could achieve a higher fiber-to-resin ratio and produce lighter parts.

We also replaced the foam core with trusses made from carbon-fiber sheet, increasing strength and decreasing weight. In combination, these key changes account for a large percentage of our overall vehicle weight savings.

By Christopher Fowler, a junior in mechanical engineering at the University of Michigan-Ann Arbor and MRacing Suspension Co-Lead.

members, past and present.

Lastly, teams should welcome creativity to the process. With multiple new minds come a thousand more ideas. Inside our shop, there has always been an unspoken invitation for team members to think out loud. Anytime you hear the words "Alright, alright hear me out! Just bear with me. What if...," you just KNOW that either something brilliant or something incredibly absurd is about to be said. One would think that the later these discussions take place, the more ridiculous the ideas are likely to be. But in all seriousness, it is better to discuss one hundred impossible ideas than to miss out on a great one because someone didn't speak up. This is how we encourage young and new members to stay involved and keep thinking.

There are plenty more skills that make for a great team of engineers: leadership, creative design, and oh yeah, money. However, none of the above will take the next car to a higher level without the efficient turnover of knowledge year after year.

To guarantee that information is being shared and passed down, here's what we do: Once a week, we all gather for a mandatory team meeting. In these meetings, team leadership—our captain and technical director—will first review all events and tasks for the week, as well as mention any news or questions from our sponsors. Next, system leads (or anyone in charge of a project) will go one-by-one around the table, voicing their progress and concerns regarding their system over the last few days.

By doing this, we give everyone on the team an update and opportunity to address any issues. Moreover,

> *"You can't expect someone to design their entire system without knowing how it plays into the rest of the car, right?"*
>
> Tanida Haddad

these meetings keep us on schedule and bring everyone into the shop to do some valuable communication and then get back to work.

Another thing the team has emphasized greatly over the past five to six years is saving all files to a network drive. Our drive contains a folder for each year, and then is broken down by subject or system, and then further organized into folders for design, schedule, CAD, sponsors, orders, etc. By documenting all progress in a network drive, team members are able to look back at past designs and gain understanding of how their systems were manufactured in the past, even after other members have long since graduated.

Now, most importantly: When teaching new members to understand their systems, we try our best to put everyone in the same room while designing. Each person that wishes to contribute to the design of the coming year's car is expected to be in our computer lab when everyone else is. During the summer, which is our main

2015 MRacing team captain Joe Hendrickson (right) and technical director Brian McCann wait in line for the tilt test at FSAE Michigan 2015. (Photo by Tristan MacKethan)

"design period," team members will meet every evening and weekend in the same lab to ensure constant collaboration and understanding of what's happening outside of just their specific systems. You can't expect someone to design their entire system without knowing how it plays into the rest of the car, right? As the design process goes forward, we try to hold periodic mock design reviews and exchange feedback on ideas. Tactics like these will ensure members stay well-informed, whether they are new to designing or not.

When it comes down to it, the students on a collegiate design team are expected to do a lot in their short time as a member. As MRacing celebrates its 30th year in existence, its members are still trying to master the perfect formula (no pun intended) for achieving success both on the track and in the classroom. While being a member of a team like ours, it is important to learn in depth and then teach as much as you can. Because once we're ready to leave the team, all we can do is hope that we've passed down our knowledge sufficiently to those that will follow. ■

Tana Haddad, a junior studying mechanical engineering at the University of Michigan-Ann Arbor and serving as 2016 MRacing Business Lead, wrote this article for *MOMENTUM*.

FORMULA SAE HELPS PAVE TRACK TO TOP OF THE RACING WORLD

Eric LaRoche speaking to media at the 2015 IPEA Regional Final, Beijing.

PRACTICAL EXPERIENCE IS THE CATALYST for applied engineering skill, and for me, the Baja SAE and Formula SAE programs cultivated these skills in a way that the classroom alone never could.

Prior to earning a place on the **Infiniti** Performance Engineering Academy (IPEA) in 2014 and working at **Infiniti Red Bull Racing** for 12 months, I graduated from the **University of Maryland** with degrees in aerospace engineering and mechanical engineering. It took me seven years to complete those degrees (along with some other experiences along the way), and the last four of those years were dedicated to a passion I found in motorsports with the Terps Racing Baja SAE and Formula SAE programs.

From designing an anti-roll bar to applying pseudo-inverse airfoil design theory, vehicle dynamics simulation to single-cylinder engine vibrations analysis, my time in the **SAE International** student racing series exposed me to a phenomenal amount of engineering applications.

Nowhere has this experience proven more valuable than working at the highest level of motorsport, with four-time **Formula One** World Champions Infiniti Red Bull Racing. Whether I'm evaluating traces on data-acquisition software, flying to Abu Dhabi to help manage aerodynamic testing of GP2 cars, or sitting at my desk designing a new simulator component from scratch, it is a dream to be able to work on something I love and with such talented people.

I actually only heard about the academy by chance, when last year a friend mentioned the IPEA opportunity had been forwarded to students by email. I found it in my deleted emails only two weeks before the deadline. Needless to say, I haven't looked back and have relished every minute of the experience. My reaction to Adrian Newey announcing my name as a winner really speaks for itself—overwhelmed and agog at the prospect of such a life-changing opportunity.

It's very evident to me that my FSAE experience was hugely advantageous in making this possible. In the SAE programs, students work toward a common goal out of desire and passion. Both Baja SAE and Formula SAE gave me the context and motivation to learn with fervor the fundamental sciences behind racecar engineering. It got me out of my comfort zone and helped me conquer the steep learning curves often encountered in engineering, and I was able to take my education way beyond the level of the classroom.

One thing that I have really learned to appreciate from my FSAE days is, for example, the ability to communicate. To articulate and explain myself with confidence started with the leadership and mentoring of students (and interested non-students, such as family members), both within and external to the SAE programs. In the early days of Infiniti Red Bull Racing, the walls of the design office were knocked down to facilitate greater interaction and knowledge sharing. Now, the entire design office is an open floor plan, built specifically to encourage open communication. This way of thinking is something that I would whole heartedly encourage in engineering students today.

The experience has also been an incredible insight into Infiniti's partnership with the team. As the Official Title Partner and Official Vehicle Performance Partner of Infiniti Red Bull Racing, the two organizations are learning from each other in terms of their people, processes, and technology. Being at the forefront of this exchange has been unreal. Infiniti actually flew me and the other academy winners to Japan very early on in the placement last year to experience an Infiniti prototype vehicle test with none other than Sebastian Vettel when he drove for the team.

I also travelled to China in July and helped judge Chinese engineering students for their chance to win a place on the 2015/16 Infiniti Performance Engineering Academy. It was a very surreal experience sitting on the other side of the desk, having been in their shoes last year. Slightly different to our academy placement, this year's intake will also be working on road car projects at Infiniti's Technical Centre for Europe in Cranfield, specifically on Infiniti's Q30 model, so it will be interesting for them to have hands-on experience of both sides of the garage.

Now that the IPEA has come to a close for me, I am beyond excited to reveal that the team has invited me to stay on beyond the 12 months in a new vehicle dynamics capacity, working on the performance aspects of the F1 car.

What is clear is that while these opportunities encourage the next generation of engineer, professional opportunities at the highest level are still few and far between. Therefore, assertion is a must. I would absolutely encourage young engineers out there to get involved with Baja and Formula SAE, develop their knowledge, and with hard work and dedication, give themselves the best chance possible to make it.

It's been a brilliant ride for me, and I'm excited for what comes next! ■

Eric LaRoche, a recent graduate of the University of Maryland with degrees in aerospace engineering and mechanical engineering, wrote this article for *MOMENTUM*.

As part of its presentation to the SAE Board of Directors, the University of Akron Zips Aero team included this 3-D computer model of *Thunder*.

FEATURE

'SHE'S GONE'

Presenting their winning aero design to the SAE International Board of Directors, University of Akron students tell a story of engineering excellence and resiliency.

IT FELT SURREAL TO STAND IN FRONT OF THE SAE INTERNATIONAL BOARD OF DIRECTORS. Representatives of Zips Aero from the University of Akron had been invited to the recent SAE 2015 AeroTech Congress & Exhibition in Seattle based on our winning performance at April's Aero Design West student competition. Prepared to speak on behalf of our team, I thought back to the events leading up to the competition.

The weeks before competition are the most stressful of the year. It was eight days away and our team was fairly unprepared. Our Regular Class plane, *Flash*, was incomplete, uncovered, and untested. *Thunder*, our Advanced Class entry, was on yet another test flight to evaluate the latest mechanical repairs.

I'd been called before from the field. Usually it's "Liz, we forgot the socket set," or "We need a hacksaw...," but this was different. With a somber tone, my co-captain, Evan Henrich, simply said, "She's gone." After completing a successful drop, *Thunder's* secondary spar failed and she plummeted to Earth. A shattered mass of sticks and foam lay in the grass.

Producing a competitive plane for the SAE Collegiate Design Series is a yearlong process. We start with project planning to organize the efforts of the 20 students on our team. We perform trade studies to optimize subsystems, select a general configuration based on design constraints, and write a code to evaluate aircraft performance. For each step, we must balance the time spent to ensure quality with the time necessary to test-fly.

Our design philosophy for *Thunder* centered on a stable platform to drop a humanitarian aid package accurately. To this effect, we chose a high wing, tricycle landing gear system, and a conventional tail. The contoured fuselage design reduces drag and features a nose-mounted camera to aid in target visibility.

Zips Aero team members Evan Henrich and Janelle Archer present to the SAE Board of Directors (inner circle) on Sept. 23. (Photo by Patrick Ponticel)

Flash focused on fully optimizing the given dimensions and power plant for the allotted take-off distance. A low-drag v-tail design was chosen to decrease overall height. This shorter tail allows for a larger wing, and thus increases cargo capacity.

The build process for each plane takes about 10 weeks. Our wings, which incorporate high-cambered airfoils, demand a build tolerance of ±0.003", roughly the thickness of a fingernail. With a partially tapered planform for *Thunder* and a semi-elliptical planform for *Flash*, the construction of each wing required hundreds of man-hours.

Thunder's wing returned to our workshop in shambles. The main spar was sheared in two. Fifty percent of the leading and trailing edge would need to be fully replaced. Furthermore, the entire fuselage was destroyed and the landing gear resembled an aluminum pretzel. I knew that with two days needed to ship the planes, we had just six for a near total rebuild of *Thunder*, on top of the completion of *Flash*.

We could not show up to competition empty-handed. I pulled the other captains aside and we all agreed that we *had* to rebuild, that she *would* fly again. A call went out

> *"I stayed in the workshop to continue rebuilding Thunder, worrying constantly that we might have zero planes at the end of the day."*

to everyone as a rallying cry. For the first time all year the entire team was in the workshop at once.

The design and build is traditionally divided into electrical and mechanical subsystems, with a senior member as the leader and younger members for support. Now everyone had a mechanical task to complete.

Aerospace systems students taught computer engineers how to lay up carbon fiber. Mechanical engineers taught electricals how to mill beams. Many called off work and skipped classes to staff the workshop at all hours. With so many members foregoing their specialties and sleep for the needs of the team, *Flash* was finished in two days.

Saturday morning a skeleton crew staffed *Flash's* first test flight. I stayed in the workshop to continue rebuilding *Thunder*, worrying constantly that we might have zero planes at the end of the day. Then the call came from Evan. "She's beautiful."

We arrived at the SAE Aero Design competition site in Van Nuys, Calif., four days later, and with one more all-nighter, *Thunder* was flight-ready 15 minutes prior to technical inspection. On her maiden flight she delivered a humanitarian aid package 7'3" from the target, a new world record. She went on to take first place overall in Advanced Class. *Flash* finished third overall in Regular Class and placed third in the Payload sub-event.

Our accomplishments were made possible through the dedication of our entire team.

Still flying high from our success at competition, we were honored to receive an invitation to give our first-place Aero Design West Advanced Class presentation at AeroTech. It was an extraordinary opportunity to tell our story. ■

Elizabeth Hammell, an electrical engineering major and co-caption of the Zips Aero team at the University of Akron, wrote this article for *MOMENTUM*.

SAE Board members and staff (left) engage Zips Aero co-captain Elizabeth Hammell (third from right), co-captain Stephen Veillette (second from right), and former co-captain Evan Henrich after the team's presentation. (Photo by Patrick Ponticel)

Team members from the University of Akron (group at far end of table) and Cal State University-Northridge wait for their turn to present to the SAE Board of Directors. To hear firsthand from the various beneficiaries of SAE products and services, the SAE BOD invites groups or individuals to present at its periodic meetings. The SAE Collegiate Design Series was the showcase subject at the Sept. 23 meeting. (Photo by Brian Fell)

Cal State University-Northridge's Aero Design entry on display at the SAE Board of Directors meeting. (Photo by Brian Fell)

ON-SNOW TESTING FOR SNOWMOBILE ACCIDENT RECONSTRUCTION

A level-3 "expert" rider performing the cornering test on the 20-ft (6-m) radius track. The rider leans far toward the inside of the track radius to keep the snowmobile turning at a higher velocity.

Snowmobile acceleration, braking, and cornering performance data are not well developed for use in accident reconstruction. Snowmobile accident path analysis presents a special challenge in accident reconstruction in that snow conditions change continuously, and some traditional reconstruction techniques used in the automotive realm (e.g., tire mark analysis) are not applicable.

Researchers from Brigham Young University, Collision Safety Engineering LC, and Asay Engineering collaborated to formulate and present reference data for comparison and analysis of motion in snowmobile accident reconstruction. The main objective was to gather data that would be useful for comparing limits of cornering geometry and linear acceleration.

EXPERIMENTAL METHODS

Two unmodified two-cycle-engine snowmobiles were used for the testing: a single-passenger sport snowmobile and a two-passenger touring snowmobile. All tests that included a passenger were performed on the touring snowmobile. Volunteer riders ranging in age from 17 to 84 years were sorted into three skill levels: novice, intermediate, expert. A flat test site was used for all tests, which were conducted during a single day to minimize variation in weather and snow conditions.

Lateral acceleration "cornering" tests were conducted using circular tracks on smooth, compacted snow of three different radii: 20 ft (6.10 m), 35 ft (10.7 m), and 65 ft (19.8 m). For each cornering test, the test rider was instructed to bring the snowmobile to speed around the track, and then to lap the circular track several times at the highest speed they could safely negotiate. In tests where a passenger was included, the passenger was instructed to sit in the passenger seat with hands gripping the passenger handgrips and lean toward the inside of the turn.

A performance computer was mounted behind the seat for each test and was used to measure acceleration (using an accelerometer) and speed (using a GPS). Timed video was recorded of each test. The fastest lap time and the radius of the turn were used to calculate the average lateral acceleration for the fastest lap using the formula shown in the equation:

$$\text{Acceleration} = (\text{velocity}^2)/(\text{radius})$$

Experiments showed that test riders followed a path keeping the center of the snowmobile approximately 5 ft (1.5 m) from the edge of the marked radius; therefore, the turn radius guidance markers were placed 5 ft closer to center than the desired turn path. Tests were conducted in both clockwise (CW) and counter-clockwise (CCW) directions.

Since snowmobile controls are asymmetrical (e.g., the throttle is controlled by the right hand on the snowmobiles), analysis to compare the effect of the asymmetry of the controls was done. Using data from the cornering tests and performing a two-sample T-test, no significant difference was found between the CW and CCW tests of this type.

Linear acceleration and deceleration tests were conducted on a level snow surface with packed uniform snow conditions from regular traffic. Six test conditions were performed to obtain linear acceleration and braking (deceleration) performance. Each test condition was repeated (four runs per test condition) where the snowmobile was accelerated at full throttle to between 40 and 60 mph (64.4 and 96.6 kmh) and then braked to a stop. The acceleration and braking results were calculated using the GPS on the performance computer. Average peak acceleration was calculated using the data from 0 and 30 mph (0 and 48.3 kmh); above 30 mph the acceleration decreases notably, as seen in Figure 1.

Braking tests were performed in two modes: full service (hand) braking and coast down (engine braking). Peak deceleration was calculated using the data from 40 and 15 mph (64.4 and 24.1 kmh); below 15 mph the acceleration changes notably. Higher values for braking were achieved by using the handbrake than by using engine braking alone. The track was locked in every handbrake test, and the track slipped in every coast-down test.

TEST RESULTS

Various conditions affected the maximum lateral acceleration that could be achieved by the test riders. Even on carefully packed and leveled snow, discontinuities in the snow surface and variation in steering angle made it difficult for test riders to reach and maintain a maximum speed at a given steer angle (cornering radius).

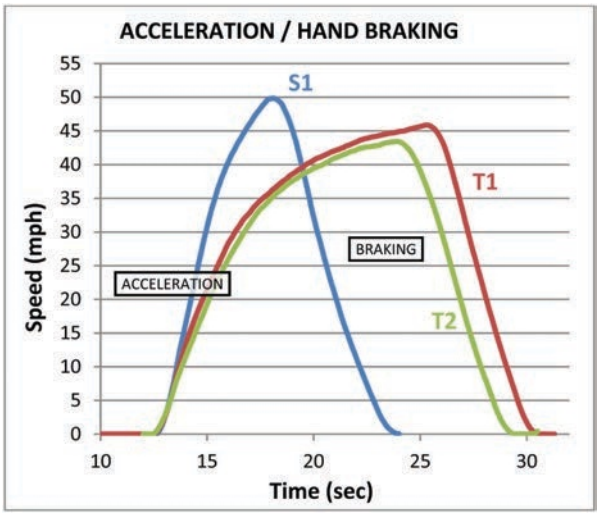


Figure 1. Speed/time plot for run 1 of tests 11, 13, 14 (acceleration followed by hand braking and full-locked track).

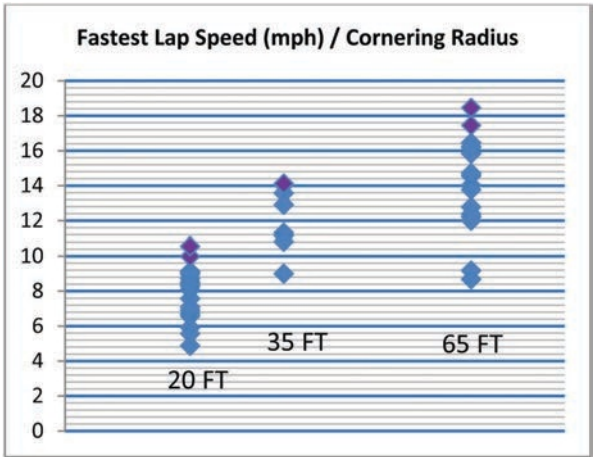


Figure 2. Fastest lap speed/cornering radius.

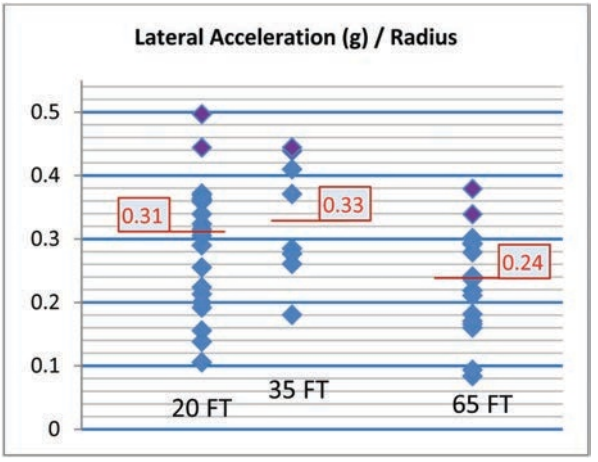


Figure 3. Lateral acceleration/cornering radius (medium *g*-level shown in red).

Test runs were run clockwise and counterclockwise for each radii.

Minimum and Maximum Lateral Acceleration by Rider Level, *g*		
Rider Level	**Minimum**	**Maximum**
1	0.08	0.29
2	0.16	0.41
3	0.34	0.50

Snowmobile steering involves complex interactions between the snowmobile drive and steering components (track and skis), and the snow surface that require the rider to continuously adjust steering angle to maintain a turn of desired radius. Riders were not able to simply set a steering angle and maintain a given turn radius. At lower speed and a smaller turn radius, maintaining a consistent path around the turn was more difficult. This led to more correcting and adjusting by the rider, contributing to longer lap times and resulting in lower lateral accelerations with increasing variation in the data. Lateral accelerations due to cornering vary widely by rider experience, and to a lesser extent by cornering radius. Overall averages for lateral acceleration based on experience level were calculated from the obtained results (Figure 2).

Fastest lap times correspond with the best lap produced by a given test rider by cornering radius (Table 1). Lateral acceleration tests produced results ranging from a minimum of 0.08 *g* for novice riders to a maximum of 0.50 *g* for expert riders. Two expert-level tests were performed at each cornering radius, and the values for cornering at 35-ft radius are very similar: 0.438 *g* and 0.444 *g* (Figure 3). The minimum acceleration corresponded with the lowest of the best (fastest) laps achieved by the rider at that level and turn radius.

In all tests, the objective was to explore the limits of rider/machine capability. This testing helps to reveal the complex nature of snowmobile cornering, even in a simple circular cornering maneuver, and highlights the difference between experienced and inexperienced riders in these maneuvers. The data resulting from this project are valuable additions to the limited research done for snowmobile accident reconstruction, and further research would be very beneficial for engineers working in this field of study. ■

Wyatt Warner, a junior at Brigham Young University studying mechanical engineering with a minor emphasis in manufacturing, wrote this article for *MOMENTUM* based on an SAE International technical paper (2015-01-1431) co-authored by him; Mark H. Warner and Jon E. Bready of Collision Safety Engineering LC; and Alan F. Asay of Asay Engineering.

NASA TEAM COMPLETES THIRD PHASE OF UAS FLIGHT TESTING

Technologies considered necessary for unmanned aircraft systems (UAS) to safely avoid other aircraft while moving through airspace recently were put to the test recently using **NASA**'s remotely piloted Ikhana aircraft.

Equipped with a prototype system of detect-and-avoid (DAA) sensors working in concert with airborne and ground-based computers, Ikhana made 11 flights involving more than 200 scripted encounters with approaching aircraft.

Depending on the specific scenario, either Ikhana detected one or more approaching aircraft and sent an alert to its remote pilot to take action, or Ikhana itself took action on its own by flying a programmed maneuver to avoid a collision—which NASA describes as an aviation first.

"We recorded some valuable data that will take some time to analyze fully, and we expect we'll need to make some minor refinements to our algorithms, but from what we saw during the tests, the results look promising," said Dennis Hines, Director for Programs for the NASA **Armstrong Flight Research Center**.

The Ikhana UAS is shown flying over the Mojave Desert during a flight from NASA Armstrong Flight Research Center, Edwards, CA. (NASA/Carla Thomas)

NASA researchers (from left) Martin Hoffman, John Freudinger, and Ed Koshimoto observe one of the FT3 tests from the Research Ground Control Station at NASA Armstrong. (NASA/Ken Ulbrich)

Staged from Armstrong and flown over the high desert of California, the DAA research was designated FT3, the third in a series of flight test campaigns for NASA's Unmanned Aircraft Systems Integration in the National Airspace System (UAS-NAS) project.

According to Frank Pace, President of Aircraft Systems for **General Atomics Aeronautical Systems**, Inc., "This flight test campaign represents the maturity of our detect-and-avoid system."

As a NASA industry partner, the company developed one of the three primary DAA sensors flown on Ikhana, in this case a prototype radar system. It also contributed Ikhana system and self-separation and collision avoidance alerting logic software.

The other two sensors included an Automatic Dependent Surveillance–Broadcast (ADS-B) from **BAE Systems**, and a second generation Traffic alert and Collision Avoidance System (TCAS) from **Honeywell** International, Inc.

ADS-B is a satellite-based navigation tool in which an aircraft determines its position and then broadcasts that infor-

mation, enabling other nearby airplanes equipped with the same tool to know where everyone is in the sky.

As its name implies, TCAS keeps an electronic eye on the sky immediately surrounding an airplane. Should another airplane with a similar device fly too close, an alert will prompt the pilot to take action.

Honeywell supplied a specially instrumented twin-engine King Air to serve as an intruder for NASA's Ikhana UAS.

Honeywell also provided software that enabled the three sensors to work together, as well as a specially instrumented aircraft to play the role of an intruder encroaching on Ikhana's airspace.

"This phase of flight tests, and our ability to meet the challenge of integrating UAS into the NAS, wouldn't be possible without the strong partnership that exists between NASA and its aeronautical industry partners," Hines said.

Knowledge gleaned from the data recorded during this third phase of UAS-NAS flight tests not only will help researchers plan the next phase of flight tests—now targeted for next spring—but also will help inform organizations developing UAS-related operating standards.

Honeywell supplied a specially instrumented twin-engine King Air to serve as an intruder for NASA's Ikhana UAS. (NASA/Ken Ulbrich)

By Jean L. Broge, Managing Editor, *Aerospace & Defense Technology*

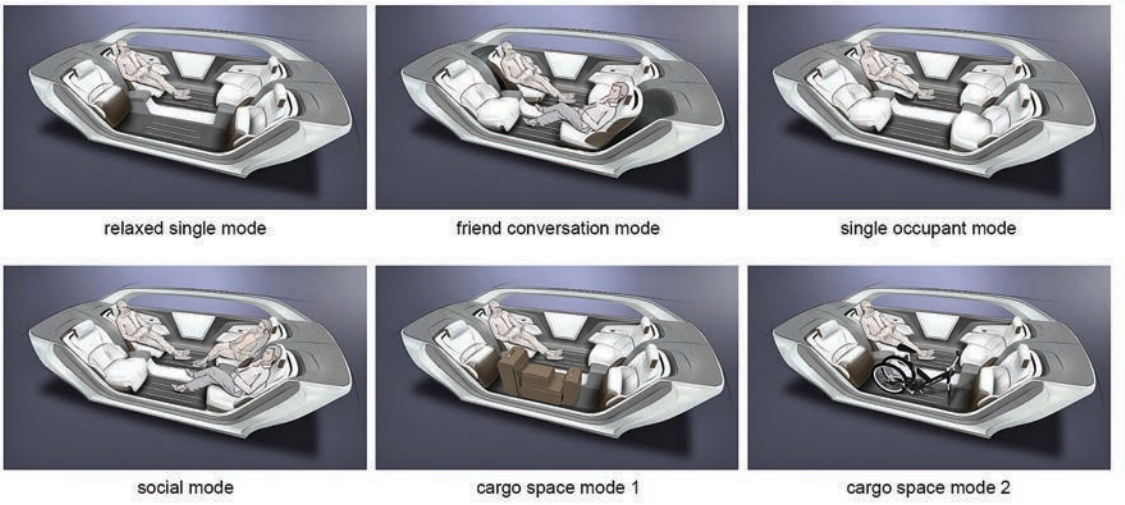
JOHNSON CONTROLS, FAURECIA ENVISION INTERIORS FOR AUTONOMOUS DRIVING

As the automotive industry moves to more autonomous driving, the requirements for vehicle interiors and seating will "radically change" as well, according to **Johnson Controls**. The supplier foresees the driver's seat becoming a "comfortable control unit" as additional assistance systems come on board. Company executives shared their vision of the forthcoming shift at the recent IAA (Frankfurt Motor Show) 2015.

"Autonomous driving is on its way," said Dr. Detlef Jürss, Group Vice President and General Manager Product Group Seating Components at Johnson Controls. "In the future, the role of the person in the driver's seat will shift from that of an 'active driver' to that of a 'supervisor' who must be able to intervene whenever necessary. The seat will become a multi-talented interior component that provides its strengths in safety, comfort, and entertainment."

But it's still a long way off until the vehicle takes over all control functions and the driver simply assumes the role of passenger, according to Jürss. Challenges that must first be overcome include

Johnson Controls' new SD15 seating demonstrator features a power driver seat mounted to a curved track, eliminating the need for separate, complex mechanisms found in conventional seat arrangements. A control console is mounted directly to the seat structure that moves with the occupant, offering wireless charging options for mobile devices.



Johnson Controls foresees the driver's seat becoming a "comfortable control unit" as additional assistance systems come on board.

details concerning the necessary investment-intensive infrastructure, liability and legal issues, ethical aspects (who do the safety systems protect?), technological feasibility, and safety.

"The seat will become much more of an integral part of occupant protection, which will be linked with all active safety systems within the vehicle," said Jürss.

Anticipated features of autonomous-vehicle interiors include a driver's seat that can rotate to allow direct communication among passengers, or fully recline to a resting position. To enhance safety in such situations, seating components will be linked to the vehicle's entire network of sensors and be capable of interaction, according to Johnson Controls.

The supplier already has developed the first approved fold-flat rear seat structure—similar to a business class seat on an aircraft—for an automaker and is bringing it to series production. The product complies with automotive safety regulations thanks to sensor technology that raises the seat to an upright position in the event of a crash.

Autonomous driving levels according to NHTSA

NHTSA Levels	0 No automation	1 Function-specific automation	2 Combined function automation	3 Limited self-driving automation	4 Full self-driving automation
	Warning telltale lights & automatic convenience	Cruise control, automatic braking & lane keeping	Adaptive cruise control with lane centering	Driverless Car	Prototypes
Type of control					
Legal & moral responsibility					
Safety requirements (global scenario)	Seatbelts & airbags optional	Seatbelts mandatory & airbags optional	Seatbelts & airbags mandatory	Seatbelts & airbags mandatory	Eventual relaxation of legislation
Time accepted for inattentiveness	< 2 sec	< 2 sec	< 2 sec	Transition time of about 15 – 20 sec	NA – only input destination
Influence to vehicle interior	NA	NA	NA	Minimal	Potential paradigm shift
► ► ► ►	1980s	2000s	2015	2025	2035

Majority of vehicles on roads in 2025

"In the future, the role of the person in the driver's seat will shift from that of an 'active driver' to that of a 'supervisor' who must be able to intervene whenever necessary," said Johnson Controls' Dr. Detlef Jürss.

Increasing comfort and well-being is another major focus for seating in autonomous vehicles. The seat must be able to react independently to sensor-based evidence of drowsiness or tension—for example, with an automated alarm or position adjustments over longer distances such as a massage function or pneumatic side bolsters.

"The seats of the future must offer the occupant, as a passive driver, all possible options for work, entertainment, and communication while traveling," said Jürss, citing the integration of tablet holders, reading lights, and headphones as examples. "We can also envisage making the unused front passenger seat more flexible, turning it into an additional mobile office or living space when unoccupied, and offering non-slip compartments for personal items, drinks, or electronic devices, which can also be charged wirelessly."

The supplier's SD15 seating demonstrator at Frankfurt showcased some of these solutions, which are already under development.

Johnson Controls is not alone in addressing what the interiors of autonomous vehicles might look like. **Faurecia** revealed at the Frankfurt Motor Show its Intuition demonstrator comprised of innovations enhancing onboard connectivity. Faurecia already is finding that vehicle occupants want more autonomy and more opportunities to personalize their interior with seamless connectivity to the outside world.

"With Intuition, Faurecia is bringing not only better, but more intuitive, connectivity on-board vehicles," said Gherardo Corsini, Customer Marketing Director, Faurecia. "Though we've not yet seen fully autonomous cars, we're starting to develop the technologies needed to bring them to the road while offering passengers a preview of the innovations that will be part and parcel of the vehicle cabin of the future."

Automatic adaptability to the driver's situation is key. When a vehicle transitions to an autonomous mode, Intuition offers more comfort. Drivers can elongate their seat to relaxed mode while the center console slides back so the screen is always within reach. The screen also pivots toward the user for ease-of-use.

The ambience of the vehicle cabin also can adapt to the situation. For example, when the vehicle is in "partial hands-free mode" and the driver's seat is in the "relax" position, interior light settings can automatically change to provide a more soothing environment.

Faurecia's Intuition demonstrator for autonomous driving stresses comfort and connectivity for the driver and other occupants.

Intuition incorporates a soft aluminum surface called DecoControl Alu, a monitoring and decorative zone set along the lower edge of the IP. Capacitive switches are integrated into the surface. Also note the "invisible" black screen located on the passenger side, shown here lit up in active mode.

The design study also emphasizes the integration of personal electronic devices. Smartphone and tablet screens can be projected onto the center console's touchscreen to provide vehicle occupants access to mobile functionalities. Wireless charging stations, using induction technology, are located in the side doors, the glovebox, and the center console.

Another innovative feature of the Intuition concept is a "smart" decorative aluminum surface that forms a tactile dashboard, replacing traditional controls with touch-sensitive, integrated capacitive switches. Slight vibration and illumination are used to signal actions. Faurecia says it will increasingly employ this and other types of "infoskin" for switchless controls in its concepts and products. DecoControl Alu, as it's called, is expected to first appear on 2018 model year vehicles.

Invisible screens and high-definition screens are also incorporated. The supplier has developed black panel technology that's integrated with the instrument panel facing the front passenger. The screen remains invisible when not active, lighting up when in use. Located on the center console, high-definition, curved screens offer high image resolution and packaging freedom.

Intuition and all its features are ready for program development with automakers, Faurecia claims. The supplier foresees such designs and functionality inside the vehicles of 2020 and beyond—at the midpoint in the evolution of autonomous cars.

By Ryan Gehm, Associate Editor, *Automotive Engineering*

SOFTWARE'S GROWTH SHINES SPOTLIGHT ON ELIMINATING DEFECTS

Software is becoming a greater factor in vehicle development, prompting a heightened focus on reducing the number of defects in code. Early planning, discipline, and continuous attention to detail are a few of the techniques that can help design teams eliminate defects.

Unlike hardware and mechanical faults, software defects are often quite visible. Another difference is that programs are often judged by what they don't do as well as by how well they work, according to panelists at the **SAE** 2015 Commercial Vehicle Engineering Congress.

"Any implementation that doesn't meet customer needs has defects," said Mike Repko of **PACCAR** Technical Center. Repko spoke during the "Getting to Zero Software Defects" executive panel.

The potential for defects is soaring along with the volume of software on advanced vehicles. Programs now provide many of the new features and functions on vehicles, marking a dramatic change from just a few years ago.

"Twenty years ago, two of us wrote all the software for a combine," said Ashley Greer of **Deere** & Co. "Today we have 60 people, and that doesn't include people in other facilities. We're seeing a shift as software becomes the first thing developed. In the past, it was close to the last."

That drive to push software issues earlier in the development process takes many forms. Model-based design is becoming far more common, as are simulations and validation.

"We need to focus on upfront validation so people aren't writing code that isn't what's needed. We also need to simulate as much as possible early on in the process," said Timothy Burns of **Gulfstream** Aerospace. He noted that while Gulfstream makes planes, its challenges are quite similar to those of commercial vehicle developers.

Verification is another critical step. Tests can be run throughout the development process, but that doesn't always ensure a low defect count. Tests done in silos may not foretell faults that show up when all systems are integrated.

Writing software for Deere combines now requires more than 60 programmers.

"Typically, testing approaches are vertically integrated, engines, hydraulics, etc.," Burns said. "Ultimately, it all comes together in the flight deck, and the pilot looks at it as a horizontal system, not a bunch of vertical systems."

A number of programming strategies have been created to maximize the efficiency of software development. Agile software development, which is particularly suited to the cross-functional demands of off-highway markets, is one part of a comprehensive programming strategy.

"Agile software development processes highlight a lot of problems, but it doesn't fix them," Greer said. "Managers have to make continuous improvements to make sure things get fixed and fewer problems arise in the future."

These issues are almost certain to become more complex as the volume of software rises. Managers must be able to respond to the inevitable changes that occur during designs. Software changes in one area may impact other systems, but there is never enough time to check each system every time something is altered.

"As software complexity grows, we need to better manage change," Burns said. "From a scheduling perspective, you can't examine every system every time you change one thing. It's a big challenge to manage change."

However, panelists agreed that it's often difficult to scrupulously apply long-term strategies when day-to-day demands get in the way. Greer compared the goal of implementing best practices and building quality software to losing weight. People say they want to lose weight, but they don't want to stop eating ice cream.

"We want quality software, but we don't want to take the steps to get it," he said. "Best practices for writing software are well known. Why isn't the industry following them?"

A strict programming environment is only part of the equation. Writing useful, reliable code requires an overall approach that includes technology and a realistic analysis of personnel.

"You need disciplined people who understand the technology and their role in development," Repko said. "People think the processes are about things like standards, but the real key is to look at the people involved and the technologies that are involved, then customize everything around your goals, setting things up so the team can excel at building software that the customer wants."

Panelists also spent a fair amount of time talking about those customer wants. Interactions with customers help companies determine what features and functions are needed. But costs always come into play.

"When you do focus groups, you also need to look at costs. People may want something, but they won't pay for it," Greer said. "Once products get into the field, we're seeing faster feedback with social media."

By Terry Costlow for *SAE Off-Highway Engineering*

THE GANG FROM MCGILL: DESTINED FOR GREATNESS?

Eleven students from Montreal university journey to Seattle for an education on aerospace technology and aerospace careers.

Fourth-year mechanical-engineering student Hussain Boxwala (left) organized the McGill University student trip to the recent SAE 2015 AeroTech Congress & Exhibition. (Photo by Brian Fell)

FEATURE

"As technical leaders, [talent development] is the most important investment that we're going to make," said Boeing President and CEO Dennis Muilenburg, an aerospace engineer who began as an intern at Boeing and rose through the ranks to become President of the company in December 2013. "And that's one of the reasons I find [AeroTech] to be so important…It is our responsibility to invest in this next generation of talent."

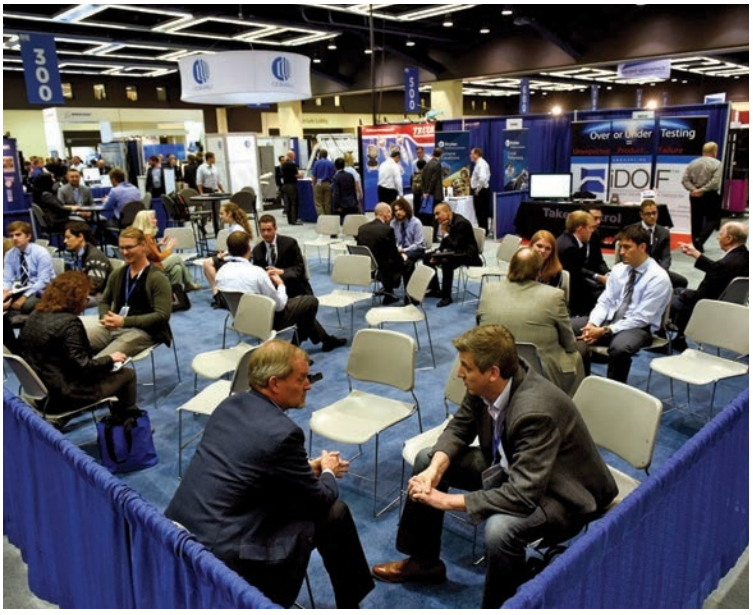
WHEN THE PRESIDENT AND CEO OF THE WORLD'S LARGEST AIRCRAFT MAKER (**Boeing**) opens an **SAE International** conference voicing great concern about a leaking and creaking aerospace engineering workforce pipeline, it's worth listening.

Dennis Muilenburg's clarion call for greater attention to talent development (http://www.nxtbook.com/nxtbooks/sae/15UPD10/) fell on properly attuned ears at the SAE 2015 AeroTech Congress & Exhibition Sept. 22-24 in Seattle—perhaps upon none with more force than those of 11 students from **McGill University** in Montreal.

The students constituted a large and pleasant presence at the Congress and were active participants in several sessions and activities. Had Muilenburg not rushed off after his keynote address, he might have been heartened to witness the week-long demonstration of competence, poise, and inquisitiveness by what *MOMENTUM* playfully calls "the Gang from McGill—Destined for Greatness?" It's not a slogan that their "leader," fourth-year mechanical engineering student Hussain Boxwala, necessarily endorses, but it works for the purposes of our story here.

So does "go-getter" as a personal moniker for Boxwala. It was his idea as Vice President–Academics, Student Executive Council, McGill Institute for Aerospace Engineering (MIAE), to form a student contingent for AeroTech. He attended the last

Students from McGill University and young engineers from Boeing (top) constituted the bulk of attendees at the AeroTech Career Development session on Sept. 22. Speakers were Dan Freeman (middle), Director of Payloads Engineering, Boeing Commercial Airplanes, and Mike Vander Wel (bottom), Chief Engineer for Equipment and Tool Engineering, The Boeing Company.



"Speed Mentoring" was another special AeroTech feature engineered specifically for young professionals and students.

AeroTech two years ago in response to an SAE call for student volunteers, diving in head-first and helping out in various ways at that Montreal event. He became fully engaged with SAE in the process.

"My dad is also an engineer, and he would always tell me how important technical conferences were to attend," the younger Boxwala told *MOMENTUM*. "And so the volunteering offered me an easy way to get involved."

> "How am I going to get myself to AeroTech this year? It's all the way in Seattle."
>
> McGill University student Hussain Boxwala

Having found great value in his first AeroTech experience, Boxwala was intent on doubling down for the next one while also exposing other McGill students to its charms. He made a convincing pitch to the MIAE, which approved funding (including airfare, accommodations, and conference costs) for 11 students.

"To be fair," he said, "this all began when I thought, 'How am I going to get myself to AeroTech this year? It's all the way in Seattle.' I can't deny that there was a bit of self-interest involved in planning the trip!"

Judging by his fellow students' opinions—and his own—about the value of their attendance at AeroTech 2015, the MIAE's investment was a well-spent one.

Like the other students, Mikel Garcia-Poulin had to demonstrate sufficient ambition and academic excellence to power through the MIAE's screening process for the AeroTech educational experience. "Since I'm in my final year of study," the mechanical engineering major said, "I'm going to be looking for work. I wanted to start to build a network base. And so far, on this first day of the conference, it's been a big success. I saw some really cool presentations and I met a lot of people in the industry."

For their trip to Seattle, the Gang from McGill worked in a technical tour of Boeing's Everett plant for wide-body aircraft. Shown is the 787 assembly line. (Photo by Boeing)

For Frédérick Chagnon, the Speed Mentoring feature of AeroTech was "very helpful. I got some real nice tips from people who have been in the industry for a very long time. And what I like about the technical sessions is they are really varied, diverse, so we can see little bits and pieces from a lot of different fields that maybe we did not think about before. And it's going to help us—I know it's going to help me—find the path I want to start my career on."

Christina Harvey found enough value in the event that she signed up to become an SAE student member on the spot. "It's been an amazing experience," she said. "The technical sessions today were so cool with all the brand new aircraft designs. It's just insane to see what we're learning in school applied to real-world operations."

> "What I like about the technical sessions is they are really varied, diverse, so we can see little bits and pieces from a lot of different fields that maybe we did not think about before."
>
> McGill University student Frédérick Chagnon

Echoing what Boeing CEO Muilenburg stated at the outset of AeroTech 2015, Boxwala noted that there's an imminent flood of aerospace engineers out of their jobs and into retirement. "So there's a lot of leadership positions that soon will be available to young professionals such as ourselves. And SAE is really trying to promote that—they're trying to get students and people who have just entered the industry...to take further steps in their careers."

To that end, AeroTech organizers included a Career Development session at which many of the McGill students and several young professionals—mainly from Boeing—participated. "It was a group of maybe twenty of us with two very established [presenters] from Boeing, and we could ask whatever we wanted—any tips we needed, what to do when you have certain situations on a job, what to put on your resume," said Boxwala. "SAE is really trying to push us to become the 'next SAE,' the 'next Boeing,' the 'next Airbus.' It will be good to see how far we can take this in the next few years."

How far, or in what direction, one sees Harvey (the McGill student quoted above) go in the next couple years will have to remain a mystery for now.

"I'm personally struggling to decide if I'm going to do a master's or go right into the industry," she said. "I found that speaking with the executives [in the Speed Mentoring sessions] and attending the technical sessions really gave me a brand new perspective on what I should do and what I want to do."

Well, Christina, what do you want to do?

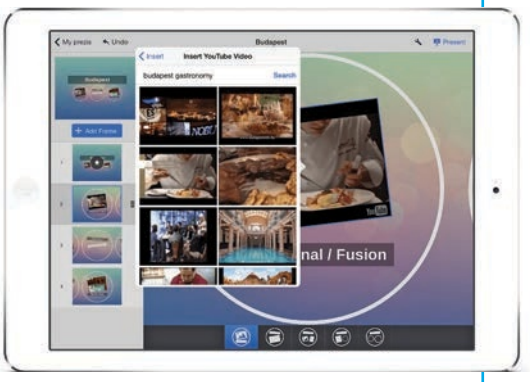
"Too soon. I'll get back to you." ■

By Patrick Ponticel, *MOMENTUM* editor

GEAR

PRESENTATION SOFTWARE

Prezi is the presentation platform that helps you connect more powerfully with your audience. Unlike slides, Prezi's interactive, zoom-able canvas lets you show relationships between the big picture and fine details, putting your ideas in relief. With Prezi, your message is more likely to resonate, motivate, and be remembered. Prezi's open canvas lets you read the room and adapt on the fly to fit your audience. Fast-forward straight to the bottom line, or spend more time zooming in on the details. A full library of prezis can be customized, so there's no need to start from scratch. The product includes an advanced image editing feature. The desktop apps for Mac and Windows let you present even when there's no Internet. Creative visual storytelling is also the premise behind Prezi's newly released Nutshell app, which combines animation and photo bursts to generate short, cinematic narratives. The base software is free, but there are premium options.



BACKPACK CONTENT PROTECTION VIA AIR

Airbac's AirTech is a multifunctional backpack suitable for university students and many other user types. A patented air-support system allows the weight in the backpack to rest comfortably just above the waistline, literally taking weight off the back and shoulders. Padded shoulder straps and patented air support system adjust to a customized fit. Features include a separate 15-in (380-mm) laptop pocket, an iPad pouch, side mesh pockets, multi-zipper storage, and a front pocket with clip. The pack measures 13 in (330 mm) x 9 in (230 mm) x 19 in (480 mm). Constructed of fine nylon, it weighs 2.6 lb (1.2 kg). The price for the pack shown here is $89.99.

BENDABLE CUPS

Carry your drink with confidence with the Silicone Cup by **Snow Peak**. They won't break if they're dropped. Although these completely clear vessels still look like

classy glass cups, they are actually sturdy silicone, which is bendable. The drinkware is great for camping or anywhere else you can't bring glass. The Silicone Cup is available in highball, rocks, and wine tumbler sizes.

GET SMART ABOUT IPHONE PHOTOGRAPHY

Smartphones come in all sizes, and there's a tripod adapter that works for them all. The smartMount from **iStabilizer** can hold any device up to 3.5 in (90 mm) wide. This includes iPhone 4, 5, 6, 6 Plus, 6S, and 6S Plus, as well as the Galaxy Note 3, 4, and virtually every smartphone available on the market today. It also accommodates smartphone cases. The single-piece unit uses basic spring-clamp technology and weighs only 27 g (1.0 oz). It extends from a base height of 56 mm (2.2 in) to a height of 85 mm (3.3 in). The price is $19.95. For information about tablet devices, go to http://www.istabilizer.com/products/istabilizer-tab-mount.

RECOGNIZE MOBILITY ENGINEERING STUDENTS & EDUCATORS

Nominate an outstanding student, young engineer, or educator for the following SAE Awards:

Ralph R. Teetor Educational Award

November 15 Deadline

This award recognizes and honors younger educators who are successfully preparing engineers to meet the challenges that face society. Learn more and submit your nomination: http://awards.sae.org/teetor/

Honeywell Outstanding Collegiate Branch Award

December 1 Deadline

This award recognizes SAE Collegiate Branches for exemplary performance. Learn more and submit your nomination: http://awards.sae.org/branch/

William R. "Bill" Adam Formula SAE® Vehicle Development Grant

January 15 Deadline

This grant provides funding to a formula SAE® team to assist with the development of their project. Learn more and submit your application: http://awards.sae.org/adamfsae/

Henry O. Fuchs Student Award

February 28 Deadline

This award recognizes a graduate or recently graduated student (i.e. post doctorate or new professor) that is working in the field of fatigue research and applications. Learn more and submit your nomination: http://awards.sae.org/fuchs/

For the complete list of student awards, visit students.sae.org. PLUS, be sure to check out scholarship opportunities available to both undergraduate and graduate students - go to students.sae.org/scholarships for more information.

Find out about the WISE (Washington Internships for Students of Engineering) Program

December 31 Deadline

This program seeks applications from outstanding engineering students who display evidence of leadership skills and have a keen interest in public policy.

Learn more and submit your application: http://www.wise-intern.org/

SAE values and appreciates the time you spend completing a nomination. If you need any assistance, please contact the SAE Awards staff at awards@sae.org, or SAE Customer Service at +1.877.606.7323 (U.S. and Canada only) or +1.724.776.4970 (outside U.S. and Canada).

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THE MEMBER CONNECTION

It all starts at connection.sae.org: your link to the membership community.

Through this forum, members can connect to other industry professionals, the SAE Membership Team for support, and much more:

- Learn about the latest member benefits and volunteer opportunities
- Get involved in discussions on the latest technical topics and increase your professional network
- Engage with other mobility engineering professionals like you in the industry-specific Aerospace, Automotive, or Commercial Vehicle sector communities
- Explore industry spanning topics in the cross-sector Open Forum

If you have any questions about your membership or your benefits, please contact your membership team:

Toll-free: +1.877.606.7323 (U.S. and Canada)

Phone: +1.724.776.4970 (Outside U.S. & Canada)

Fax: +1.724.776.0790

Email: CustomerService@sae.org

Remember to take advantage of all the benefits we offer our Members:

- Technical Discussions and Networking Opportunities on the Member Connection
- Conferences and Events
- Professional Development Training
- Industry-Specific Information and Publications
- Partner Program Products and Services
- Career Advancement Tools
- Award Recognition and Volunteering Opportunities

To find out more, visit sae.org/membership.

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