Issue 650 / April 22nd, 2025

PEAK OF FLIGHT NEWSLETTER

Apogee Components, Inc. / ApogeeRockets.com / Colorado Springs, CO

How Rocket Science Took Off in a College-Prep School



PEAK OF FLIGHT NEWSLETTER

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COVER PHOTO



Cluster of Apogee Model Rockets:

Apogee Mako (upcoming), Arc Stratus, Invicta, Kronos, Nike Hercules, Catalyst, Hermes HLV, HIROC< Draco

FEATURED ARTICLES



Gen Alpha and Gen Z Model Rocketry

by Patrick McCarroll

Learn about model rocketry success within higher education in the United States

Apogee Components, Inc.
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About this Newsletter

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Editor-in-Chief: Tim Van Milligan
Managing Editor: Michelle Mason
Content Editor: Martin Jay McKee
Layout Design: Ogden Sikel

Model rocket launch of our upcoming kit, the Apogee Mako
Pueblo, CO



Would you like to see your launch photo featured in the *Peak-of-Flight* newsletter? Submit your photo at apogeerockets.com.

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Figure 1: Force stands paired with sensors allow rocketeers to collect force-time data. Photo by Memphis U School.

Gen Alpha and Gen Z Rocketry

by Patrick McCarroll

In 2022, I completed the National Association of Rocketry's narTcert program and received the Rocket Science Teacher Certification. For two years I considered how to teach rocket science at my school, Memphis University School (MUS). It was a challenge. Many students take six classes in a seven-block rotation, play two to three sports, and participate in myriad extracurriculars. At the time, there was no room within any department's curriculum, and to top it off, I had my own full schedule of history classes to consider. After a great deal of thought, I resolved to propose partially online courses in rocket science, and the academic council approved two: Basic Rocket Science and the RockSim Design Challenge. In School Year 2024-2025 I taught the basic course and met the metrics for which I had hoped. This article sheds light on the ways I reached rocket science metrics with both asynchronous learning and in-person teaching.



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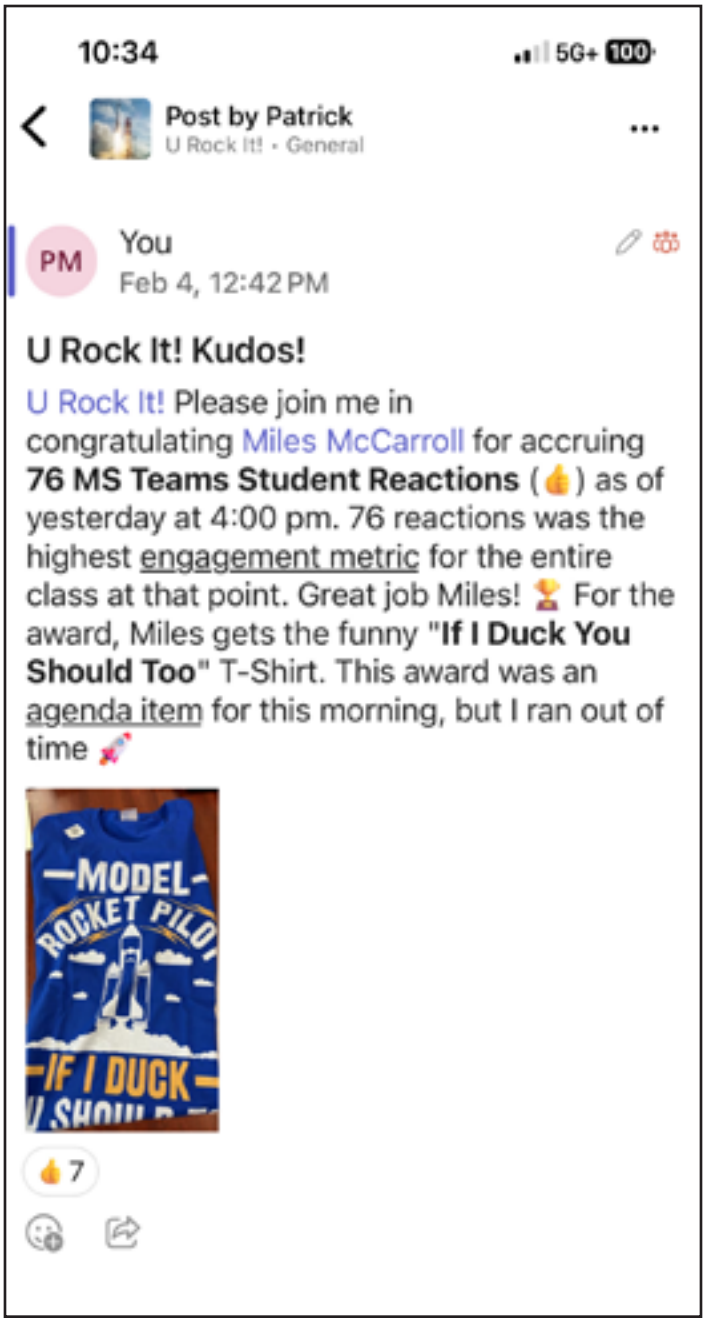
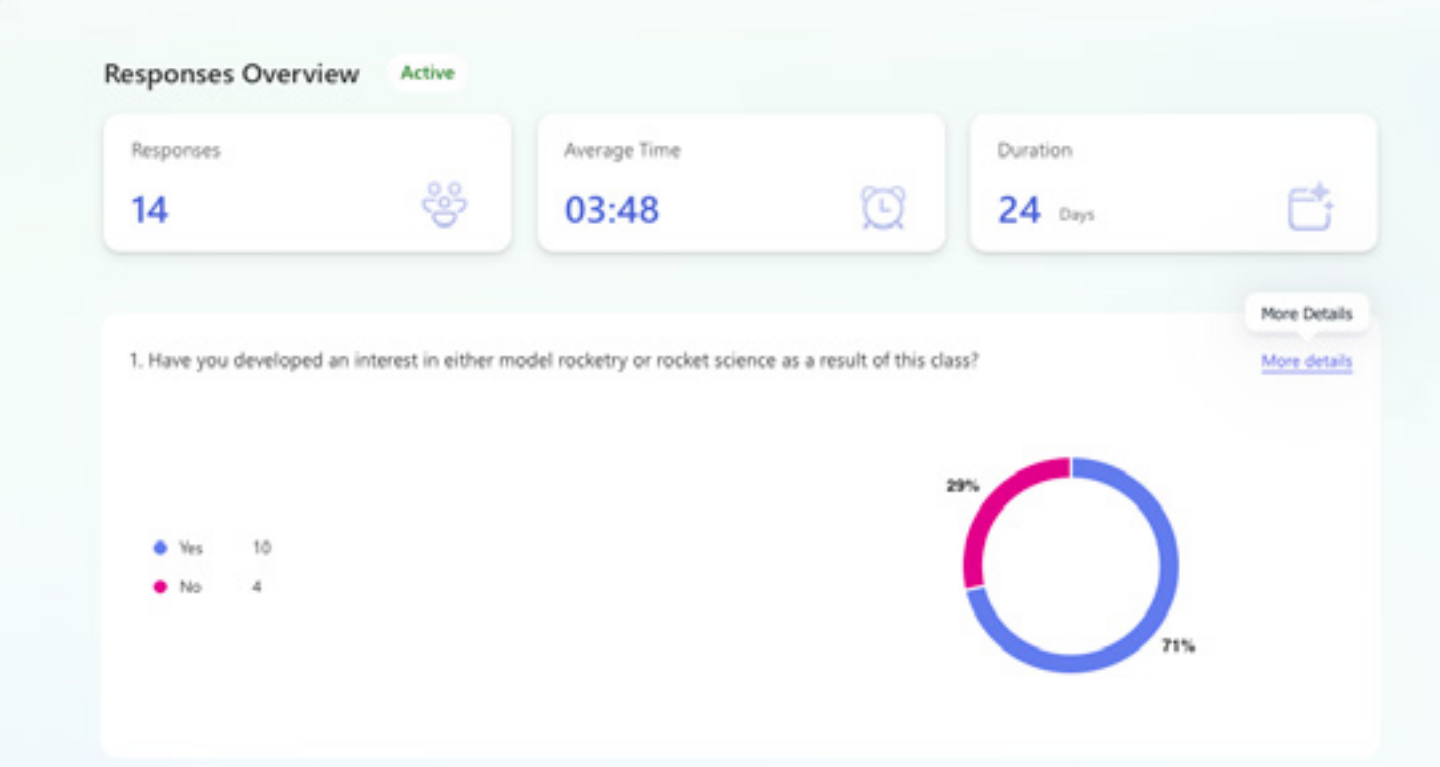


Figure 2: Using collaboration software, rocket science teachers can keep rocketeers engaged. Notice the use of likes and prizes to stimulate engagement. To protect student names, I used a post about my son who took the class.



The Gen Alpha and Gen Z Challenge

How did I arrive at this pedagogy? I knew that students spent free time on their phones and personal devices throughout the week, but no two students did so at the same time. So, in my mind, I slotted the class into that floating target. I would deliver cloud-based lectures and assessments that could be completed remotely at any time. Video assessment software and other online assessment tools were readily available, and I had experience with many. To keep students engaged and informed, I would also use the school's collaboration app (Figure 2). But what about building rockets, in-person teaching, and labs? To address these needs, I anticipated convening during students' Organizational Periods, Wednesdays' open blocks, and teacher office hours. Combining cloud-based curricula and in-person meetups seemed then to be a viable path forward, so I proposed the courses. Halfway through the first, basic course, when I offered fifteen students the chance to win our NAR Section's free NAR membership, 67% said they wanted to be considered. When asked at the end of the course if they had developed an interest in either model rocketry or rocket science because of the class, 71% said yes (Figure 3). And finally, when queried about taking course two, 50% of fourteen respondents said they would enroll. Proof positive that my students had found joy, inspiration, and reward in pseudo-virtual rocket science.

Figure 3: Metric of Success. 71% developed an interest in model rocketry or rocket science as a result of the class.



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Figure 4: Partnering with colleagues can render amazing results. Here, a collaboration of digital artists and communications staff turned my idea of a flying V guitar rocket into reality for the U Rock It! program.

Take Stock!

What assets were at my disposal other than MUS' IT platforms, and how did they shape my planning for the courses? The MUS campus comprises over ninety-four acres of contiguous land in the middle of Memphis, TN. It has many athletic fields that are perfect for low power rockets and static fire labs (see Figure 5). I decided to restrict class builds then to 18 mm or 13 mm motors and launch on campus. The school additionally boasts an amazing faculty that love their subjects and thrill to instruct eager students. So, I decided to approach the class as an interdisciplinary course and wrangle guest lectures and labs from colleagues in multiple disciplines. In this way, students learn that rocket science is a true STEM field that often is a collaboration of minds, fields, and interests. Werner von Braun would not have achieved what he did had he not brought diverse minds together. Guest lectures were in-person on Wednesday afternoons. In Course 1, Basic Rocket Science, a physics teacher led a lab on a body in motion, using motion sensors. Basic Rocket Science also included a session on two-station alt-azimuth tracking taught by a math teacher. In this





latter scenario, the teacher's dad had been a surveyor, and the teacher had his dad's old theodolite in his office. He was extremely happy to teach the class! When I took stock of MUS personnel, I also had a wonderful communications department available. The communications staff protects the school branding, advertises its mission, publishes periodicals, and manages the school's web presence. So in planning outreach, advocacy, and advertising for the courses, I submitted a work request for logo development, and what a cool logo resulted (see Figure 4)! I play guitar and originated the name U Rock It! But the rocket science program logo was a collaborative effort of digital artists, communications staff, and me. Finally, a note about our headmaster. He is a dedicated advocate for our teachers. He encouraged the program to conduct a launch on the main football stadium for an all-school assembly. What a fantastic way to advertise rocketry! I would not have thought to do that. Again, an example of how partnering with colleagues to deliver content can render amazing results.

Launch Liability

Before I sought academic approval, I had to make sure the Board of Trustees and business operations manager were okay with onsite launches. I provided the necessary parties with copies of the NAR liability policy and got approval to form a NAR Section. I arranged separate policies for the school site and the Board of Trustees. I also went to Fire Station No. 41, the fire house that services our campus, to discuss ground crew protocols, launch schedules, and NFPA 1122, the National Fire Protection Association's Code for Model Rocketry. Finally, I worked with our facilities director to determine which municipal and state authorities govern burn bans in our part of Tennessee.

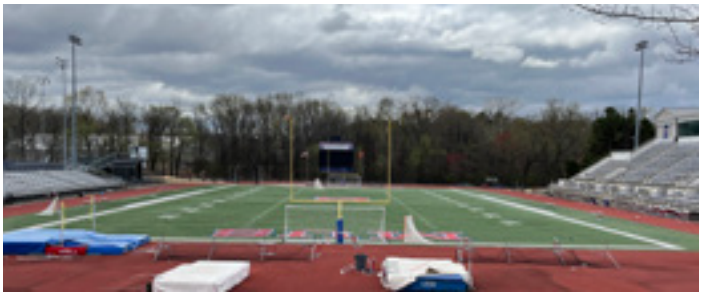
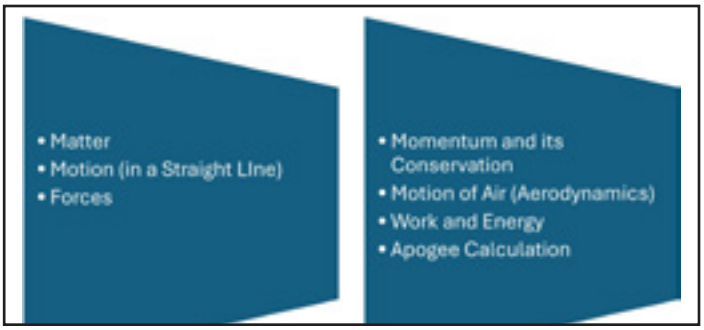


Figure 5: Use those assets! MUS' campus comprises 94 acres in the middle of Memphis, TN, and its many sports fields are ideal places to launch low power rockets. Depicted here is the main football stadium where U Rock It! conducts its primary launches. It's also the site for outdoor assemblies. In SY 2025-2026, one such assembly will be a launch event.

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Syllabus

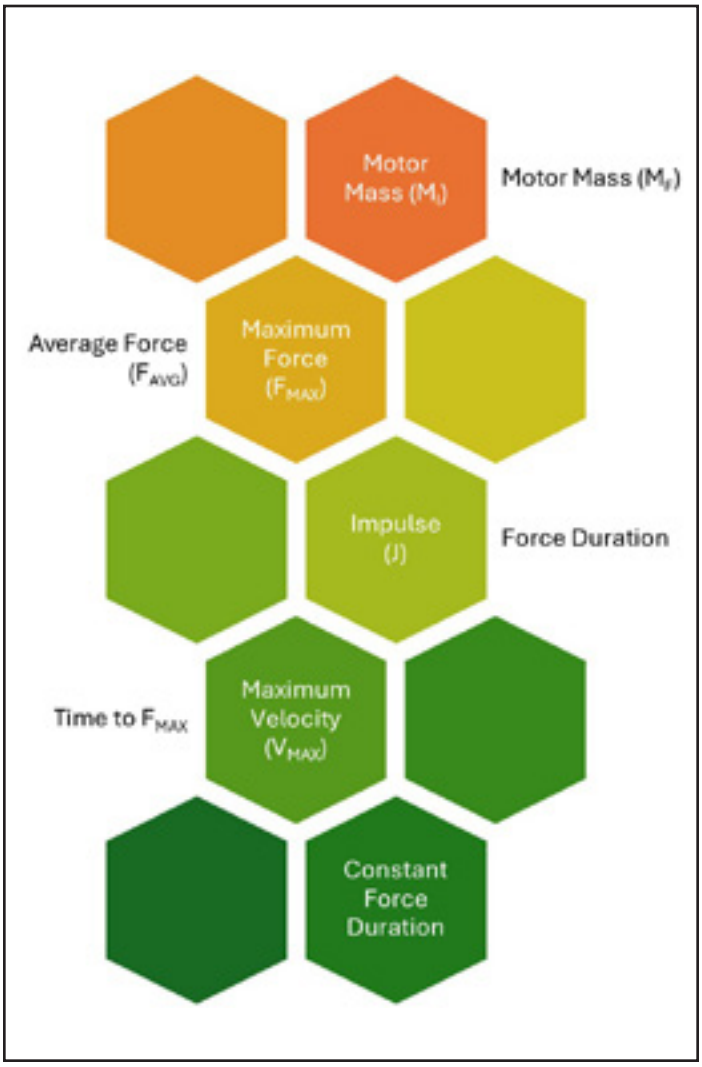
One of the earliest planning hurdles was curriculum. What must be covered? The course had to merit its standing as a quarter course, and it had to reach the necessary mechanics, engineering, mathematics, and design metrics. I considered relying on Thomas Sarradet's Model Rocketry: a STEM-Based Curriculum as it is the primary text for the narTcert curriculum, but I resolved to "go old school" and teach from our beloved Handbook of Model Rocketry. Before I could lay out the lesson plan of readings, though, I had to decide on the concepts and formulas that must and could be covered in only one academic quarter or eight weeks. I came up with a master plan of seventy-three terms and formulas, starting with a body in motion and ending with conservation of energy. The benchmarks fell within seven areas:



The primary consideration was total impulse. Students needed to understand the impulse momentum theorem, and they needed to be able to use its associated formulas. This decision stemmed from my reading of Stine's Handbook and the sudden availability of a commercial thrust stand that pairs with a force-acceleration sensor (see Figure 1). The static fire lab for the device asks students to compare expected values (published data) to performance values (experimental data) and calculate the % error, using the formula:

$$\%\ ERROR = \frac{Variable_{Experimental} - Variable_{Expected}}{Variable_{Expected}} \cdot 100\%$$

I customized the lab and required students to apply the above analysis to the below enumerated data points:





In the end, after streamlining the needed mechanics principles, the Basic Rocket Science course readings looked like this:

Handbook of Model Rocketry (7th Edition): Readings by Week	
1	Ch. 1: This is Model Rocketry
2	Ch. 5: Model Rocket Motors
3	Ch. 8: How High Will it Go?
4	Ch. 9: Stability
5	Ch. 10 Model Rocket Aerodynamics
6	Ch. 17: Altitude Determination
7	Ch. 18: Model Rocket Ranges

Assessment & Lectures

Once I had the readings set, I had to figure out how and when to deliver assessments and lectures. I developed a lesson plan in which, for each reading, students would take an online, open-book quiz of twenty-five to thirty multiple-choice or true / false question with each rocketeer getting two chances per quiz. I also decided that each week I would record a physics lecture, stepping students through the mechanics needed for the static fire lab. To check for understanding, I would use a video assessment tool that allows one to embed questions into the video clip (see Figure 6). The software scores student entries at the conclusion of the video, so participants know immediately whether or not they understand content. Once the class convened, I also required rocketeers to take handwritten notes of the mechanics lectures and upload them via the school information system (SIS). In this way, I guaranteed



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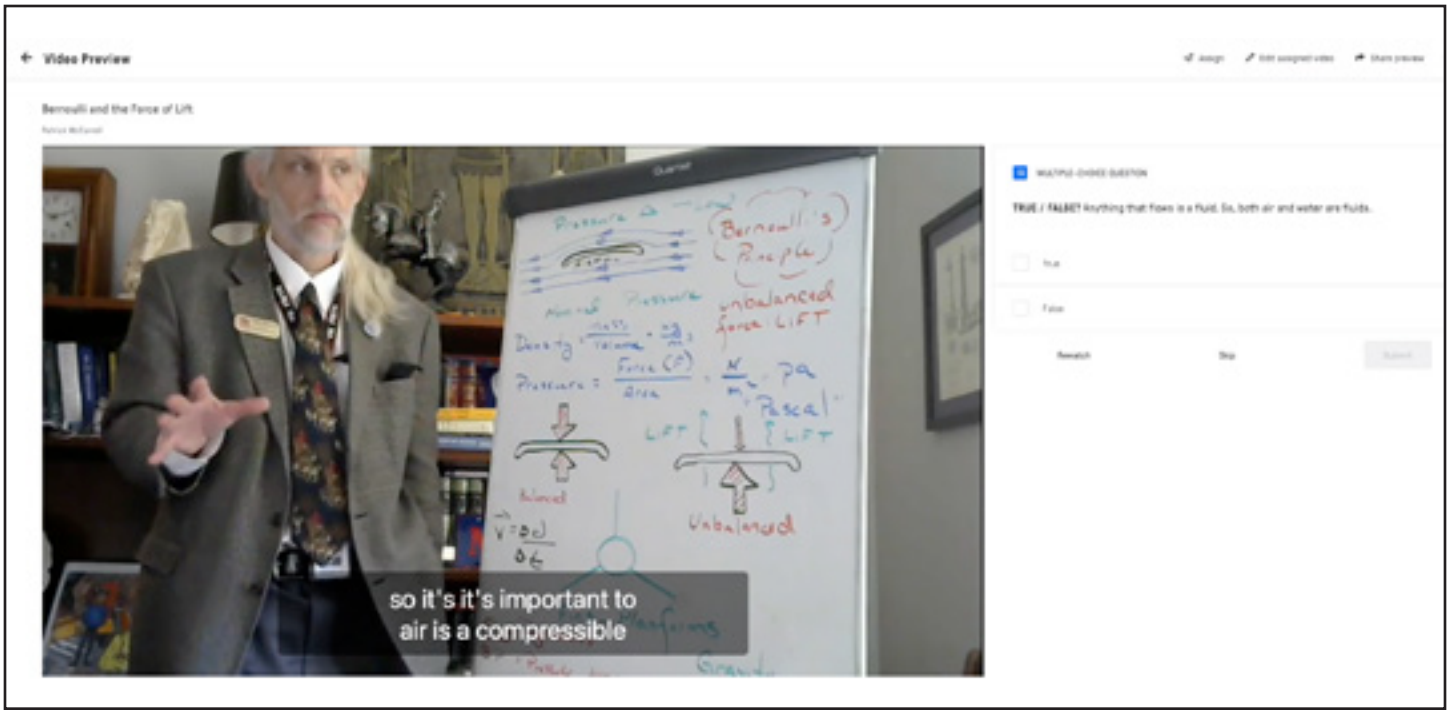
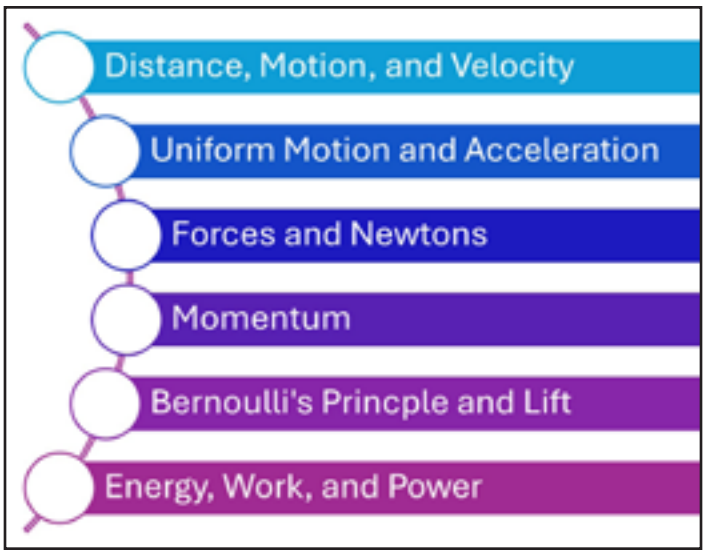


Figure 6: Video assessment tools like this one allow teachers to check for understanding while the lesson is in session. Notice the question that has popped up to the right of the lecture on lift and Bernoulli's Principle.

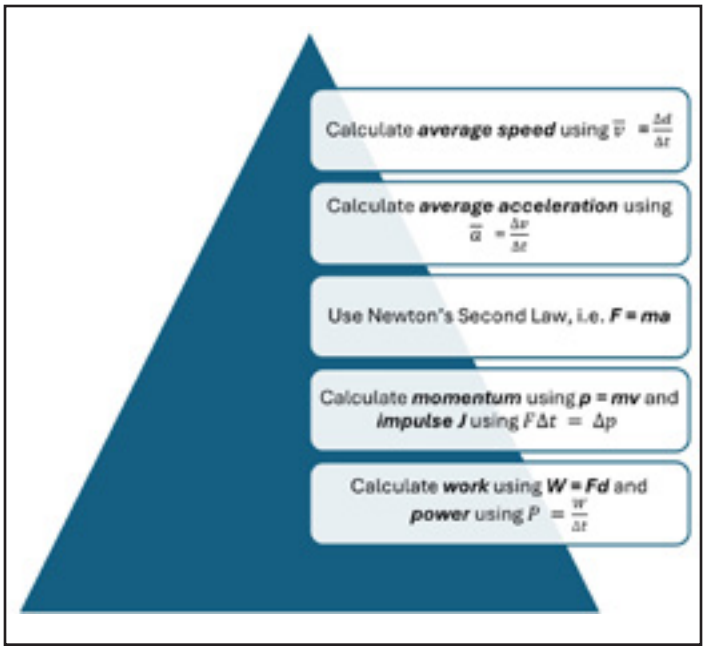
that students did more than watch and click; they also synthesized, summarized, and physically interacted with the material. Finally, for each week's physics lecture, I posted calculations and example problems for students to complete. Equations and concepts remain bound to the realm of ideas until one uses them; once utilized, they become tools. The recorded physics lectures progressed this way:



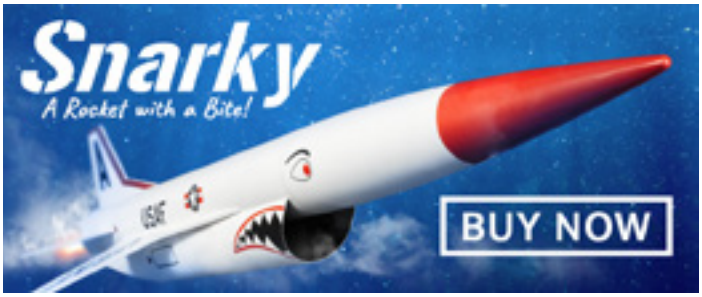


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The brief number crunching assignments asked rocketeers to:



For some weeks, lectures addressed lab preparations and rocket range protocols instead of mechanics, so not all lectures supported the static fire lab. It should be noted that the basic course ended up being algebra-based as some students were freshmen still enrolled in geometry. That is the only requirement for the course, incidentally. Students must have completed or be enrolled in geometry. The rationale? Coursework includes two station alt azimuth tracking, and without basic trigonometric foundations, two-station tracking is incomprehensible. The only calculus component for the course was integration of force time curve areas. I allowed, however, the lab software to integrate the areas, so rocketeers did not manually calculate impulse using calculus. Nor were they required to add up geometric area shapes under the curves as I find that too frustrating for students.





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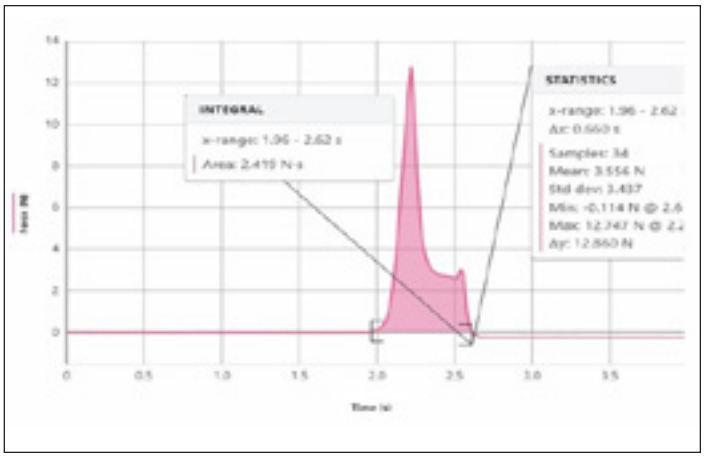


Figure 7: Calculate impulse! Here, rocketeers use software to calculate impulse from a static fire force-time curve. The integral displays correctly in N·s.

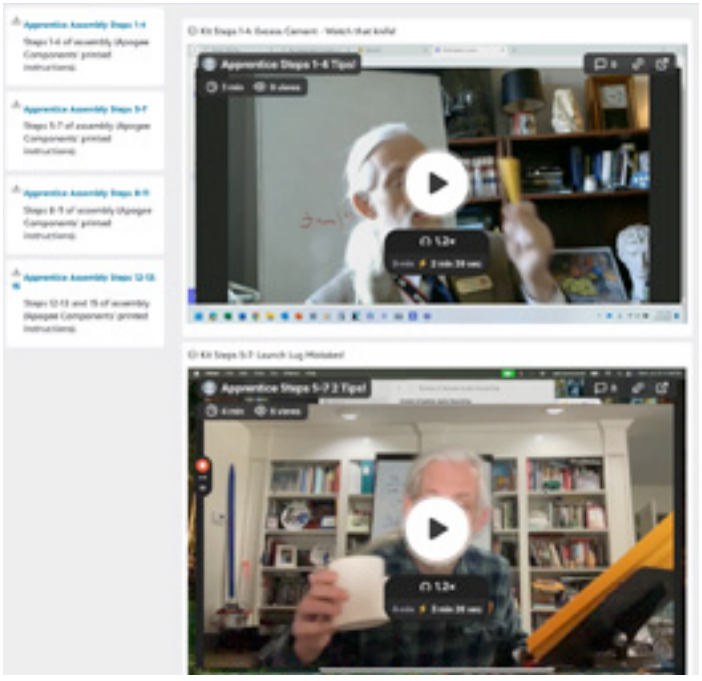


Figure 8: With each week's Apprentice steps (instructions posted on left taskbar), students get brief construction guidelines where I share past mistakes and insights. These accompany Apogee's construction video.

Build Those Rockets!

But where is the rocketry build, you might ask? For each Monday, students completed a few steps of Apogee's Apprentice rocket kit at home. They submitted progress photos via the collaboration software (see Figure 9). My favorite submission was sent with the following text message: "Steps 1-4. Very fun to build already."

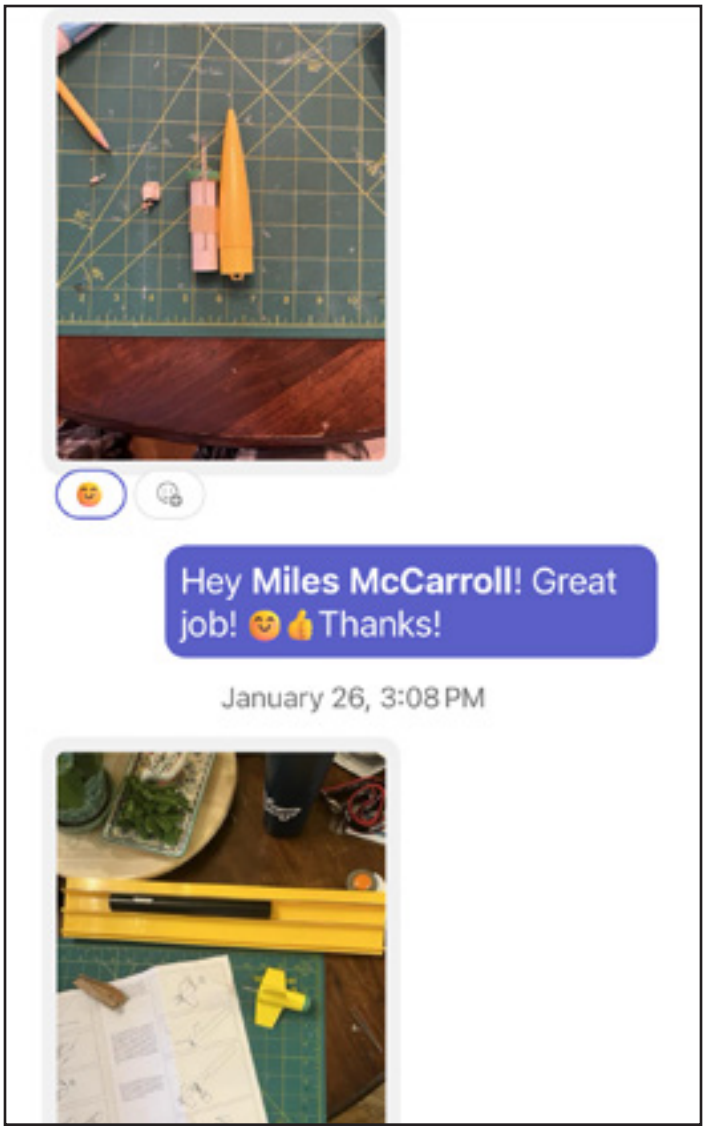
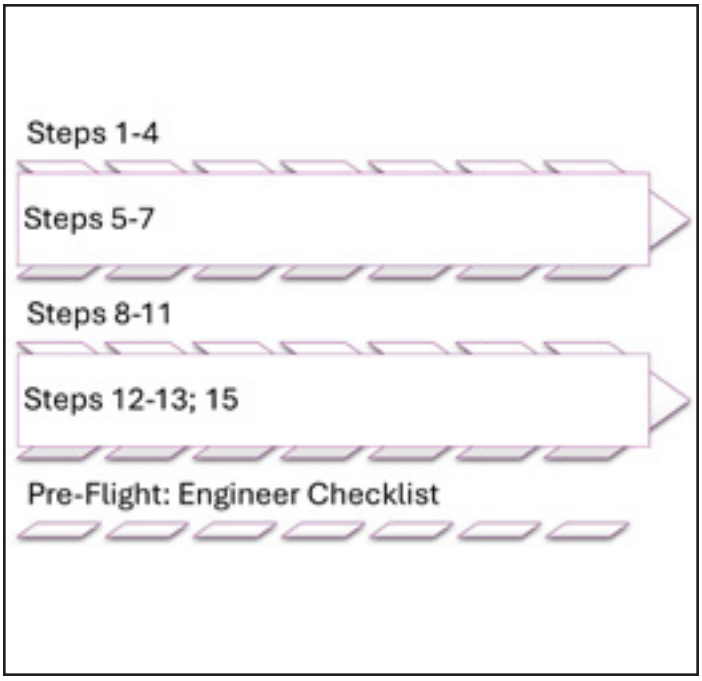


Figure 9: Rocketeers submitted progress photos via the school collaboration software. I use my son's posts to protect other student names.

I would like to interject that I was shocked by how many students were intimidated by the prospect of buying glue and building a kit. Can you imagine? Like most readers, I have built models since I was small, and I am over 50. The gift of handcrafting is immeasurable. I love teaching mechanics and the secrets of a matter-based, atomic universe, but it is equally rewarding to watch teenagers light up with the discovery of building rockets. I keep a maker-space desk in my office to help students should they need hands-on building guidance. I also post quick building tips videos online for the assigned steps (see Figure 8). All students watched Tim van Milligan's Apprentice Construction Video as a homework assignment in the online video assessment tool, but I added my videos too as my students needed to hear from me what mistakes I had made over the years and how best to tackle the assigned steps. The lesson plan for the build was:







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Lessons from Pre-Flight Safety Checks

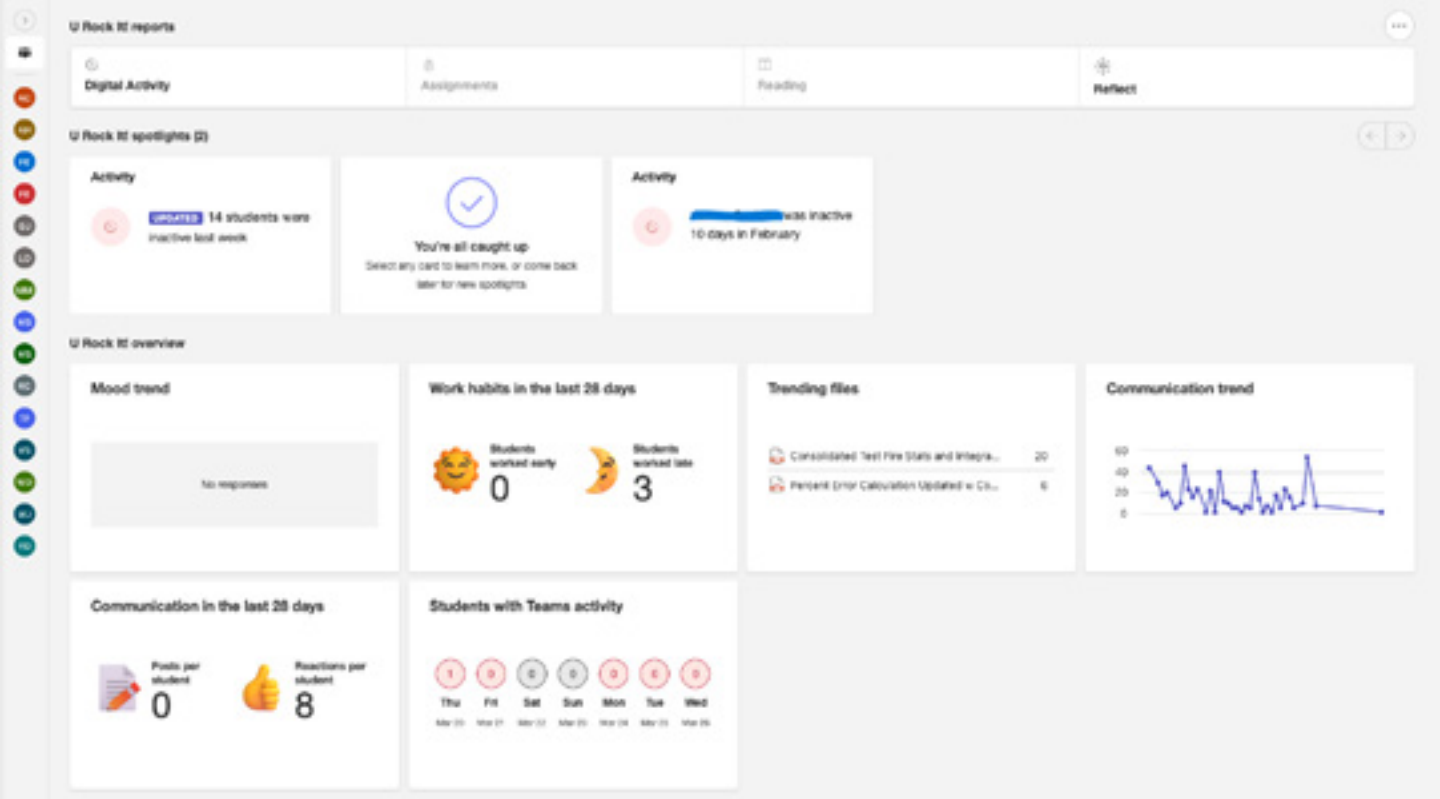
Prior to our NAR Section's first launch, I conducted pre-flight safety checks to ensure that all rocketeers' models would be green lighted for the pad by the range safety officer. During the build phase of the class, I also asked students to bring their rockets to me if they needed help. I discovered at these times unexpected construction mistakes: an unattached shock cord, disconnected parachute lines, a floating motor mount, and an engine block glued inside a nose assembly. The lesson? More frequent checks should accompany the build phase. Even better? Organize coursework, so participants can build together while I help out. MUS is in the process of changing its daily schedule, and the school will soon have a new fine arts building with lots of maker spaces. I hope to amend Basic Rocket Science to take advantage of the new schedule and studio spaces. By extension, these insights changed the lesson plans for the RockSim Challenge course too. I decided construction of the Apprentice in the first course did not provide rocketeers enough experience to build an originally designed model in the second course. There are no glued fins in the Apprentice kit, and one build iteration grants exposure to model rocket building – not experience. Without sanding and gluing fins, making and fixing mistakes, launching finished models, and observing performance characteristics, novice rocketeers cannot expect results with an original RockSim design, so I decided students would build the Apogee Avion while they learned RockSim. Then, they would open the Avion rocket file and amend both the planform of the fins and nose shape. They would add mass with an altimeter and have to run a stable simulation. Time allowing, I would also have an additional build in the eight week course.

Engage: Labs, Guests, Contests, & Communication

Success teaching pseudo-virtual rocketry to Gen Z and Gen Alpha rocketeers required regular human contact & communication. A lot of effort goes into visibility, encouragement, and affirmation. Each week I gave a schoolwide announcement during assemblies to keep the class in front of the rocketeers and school community. Every time a deadline approached, I posted a reminder in the collaboration app. When the deadline passed, I posted a late submission notice. Whenever a rocketeer did something impressive, I posted a class-wide notice and awarded a prize (see Figure 2). A quick note about posting in collaboration apps – to ensure that students continued to interact digitally, I required every rocketeer to "thumbs up" or like posts, whether it was an assignment update or general announcement (see thumbs up emoji in Figure 2), and the app provided feedback on varying metrics that helped clarify how students were staying engaged (see Figure 10).



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I found students became motivated once they discovered that working ahead and scoring well resulted in fun merchandise. Stickers are an affordable option as are T-shirts and other collectibles. I also made sure the class convened as a group each week whether that was to review a quiz, drill lecture content, do prelab tasks, attend guest lectures, or award prizes. When did I notice rocketeers having the most fun? Whenever they got to do hands on activities with one another. The more joyful experiences a rocketeer associates with the class, the more engaged and invested he or she becomes, and that happened most in the non-virtual world.

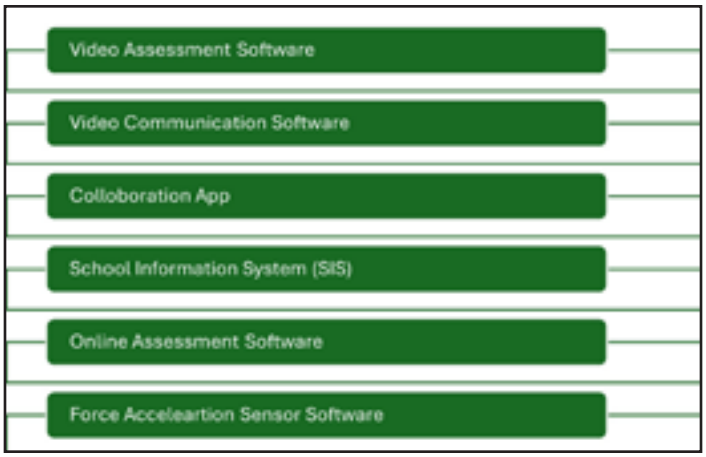
Good Luck!

Hopefully this article has given NAR section leaders and teachers some ideas of how digital tools can increase rocketeers' exposure and involvement in the science behind rocketry.

Addendum: Platform Management

I provide here a summary of the diverse applications mentioned in the article.

Figure 10: The collaboration app gives feedback on varying metrics to clarify how students are engaged with the course.





About The Author:

Patrick McCarroll teaches at Memphis University School in Memphis, Tennessee. He leads NAR Section#979, holds the narTcert certification in rocket science, and has been building rockets for 40 years.



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Article Submission Guidelines

SUBMITTING ARTICLES TO APOGEE

We are always looking for quality articles to publish in the *Peak-of-Flight* newsletter. Please submit the "idea" first before you write your article. It will need to be approved first.

When you have an idea for an article you'd like to submit, please use our contact form at **https://www.apogeerockets.com/Contact**. After review, we will be able to tell you if your article idea will be appropriate for our publication.

Always include your name, address, and contact information with all submissions. Including best contact information allows us to conduct correspondence faster. If you have questions about the current disposition of a submission, contact the editor via email or phone.

CONTENT WE ARE LOOKING FOR

We prefer articles that have at least one photo or diagram for every 500 words of text. Total article length should be between 2000-4000 words and no shorter than 1750 words. Articles of a "how-to" nature are preferred (though other types of articles will be considered) and can be on any rocketry topic: design, construction, manufacture, decoration, contest organization, etc. Both model rocket and high-power rocket articles are accepted.

CONTENT WE ARE NOT LOOKING FOR

We don't publish articles like "launch reports." They are nice to read, but if you don't learn anything new from them, then they can get boring pretty quick... Example: "Bob flew a blue rocket on a H120 motor for his certification flight." As mentioned above, we're looking for articles that have an educational component to them, which is why we like "how-to" articles.

You can see what articles and topics we've published before at: **https://www.apogeerockets.com/Peak-of-Flight?pof_list=archives&m=education**. You might use this list to give you an idea or two for your topic.

Here are some of the common articles that we reject all the time, because we've published on these topics before:

- How to get a L1, L2, or L3 Cert
- Building cheap rockets and equipment (pads & controllers)
- How to 3D print parts, or a Rocket Kit
- How to Build a cheap Rocket Kit
- Getting Back Into Rocketry After a Long Hiatus

ARTICLE & IMAGES SUBMISSION

Articles may be submitted by emailing them to the editor. Article text can be provided in any standard word processor format, or as plain-text. Graphics should be sent in either a vector format (Adobe Illustrator, SVG, etc.) or a raster format (such as jpg or png) with a width of at least 600 pixels for single column images or 1200 pixels for two-column images. It is preferable for images to be simple enough to be readable in a two-column layout, but special layouts can be used.

Send the images separately via email as well as show where they go by placing them in the word processor document.

ACCEPTANCE

Submitted articles will be evaluated against a rubric (available here on our website). All articles will be evaluated and the results will be sent to the author. In the evaluation process, our goal is to ensure the quality of the content in *Peak-of-Flight*, but we want to publish your article! Resubmission of articles that do not meet the required standard are heavily encouraged.

ORIGINALITY

All articles submitted to Peak-of-Flight must not run in another publication before inclusion in the *POF* newsletter, but it may be based on another work such as a prior article, R&D report, etc. After we have published and paid for an article, you are free to submit them to other publications.

RATES

Apogee Components offers **$300** for a quality-written article over 2,000 words in length. Payment is pro-rated for shorter articles.

WHERE WILL IT APPEAR?

These articles will mainly be published in our free newsletter, *Peak-of-Flight*. Occasionally some of the higher-quality articles could potentially appear in one of Tim Van Milligan's books that he publishes from time to time.



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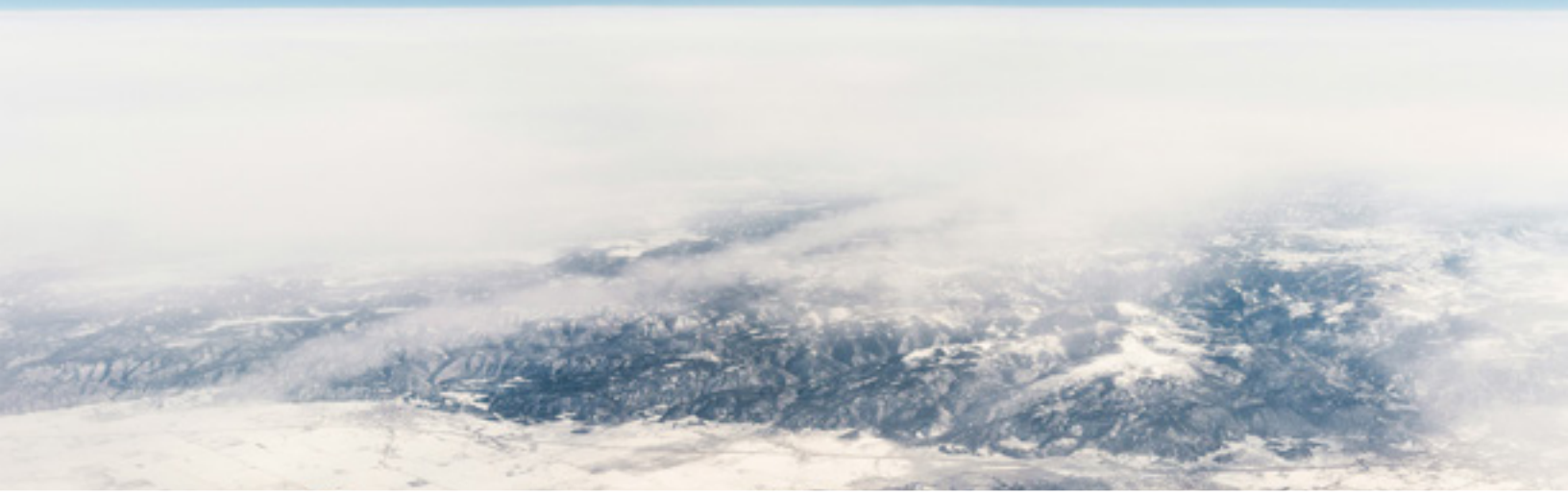
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