MAY 2019 | VOLUME 1 | ISSUE 2

AXON TCOMM
Technical Communications Newsletter

Note From Our Chief Executive Officer

WHAT DOES "PUTTING ENERGY TO WORK" MEAN?

By now, I hope it's safe to assume that we all know AXON's new Vision Statement. But, what does it mean?

"**Putting Energy to Work**" means focusing our efforts on our customers' need to get to work as quickly and safely as possible. From capital equipment to spare parts, all AXON products and services are geared towards getting our customers back to work in the oilfield. If our customers do not work, neither do we!

In addition to standard products, it is imperative that we also offer **creative solutions** (pg 4) that meet our customers' specific needs. For example, if repaired products allow them to go to work on-time and under-budget, we must focus our attention on that solution instead of our personal sales preference. Additionally, any **new products** (pg 8) should fit in our customers' work envelopes for existing equipment. Radical new versions of a "new mouse trap" can take years to adopt in this industry, and our customers do not have years to wait to go to work. AXON solutions must always be useful and relevant to our customers.

Appropriate testing and validation to the relevant **API standards** (pg 6) are also essential to ensuring AXON products, parts, and services can safely and effectively get our customers to work.

A commitment to Quality Assurance and compliance to all regulatory requirements benefit our customers as well as our people. We are reinforcing this commitment by investing in resources to reorient and strengthen our QA and HSE processes. For our customers, this verifies AXON products function as intended and work in compliance with all industry and government standards. For our people, it means synergy in programs and true alignment between facilities. It also means additional avenues for training, more facility improvements, and increased communication and visibility of our standards.

"**Putting Energy to Work**" starts from within, and I am confident that initiatives such as these will provide our people with the necessary tools to continue meeting and exceeding customer expectations.

➤ **Keith Klopfenstein, CEO**

FEATURES INSIDE THIS ISSUE:

IN EVERY ISSUE:

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TECHNICAL GROWTH SUPPORTS BUSINESS SUCCESS:

Upgrading Our Engineering Software to Abaqus FEA

➤ **David Cain, Sr. VP of Engineering**

Technical growth is regularly cited as a key driver that accelerates and sustains business success. If a proper technological infrastructure is in place, long-term operational costs are often substantially lower than cumulative, short-sighted skimping. In addition to improving operational efficiency, strategic technology investments also allow companies to competitively position themselves in the marketplace.

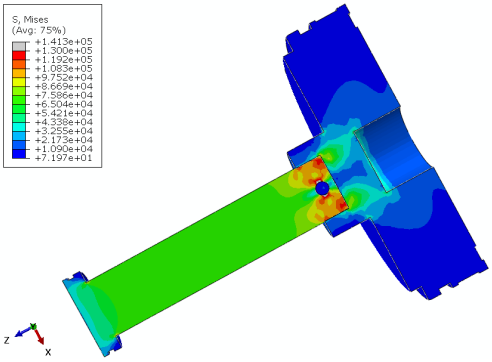
Recently, AXON demonstrated a good example of this principle. Both our NHR and JRR engineering groups develop technology in an environment within the API world where Design by Analysis is paramount. (Per **ASME**, Design by Analysis provides rules on using numerical analysis - usually Finite Element Analysis - to design a pressure vessel to Section VIII, Division 2.)

Usage of this technique supports our focus on technical communications and creates a higher level of trust with our customers, as it is a powerful tool to simulate, predict, and solve complex design issues.

Not surprisingly, company-wide technical growth requires **interdepartmental synergy** (pg 4), as well as unanimous management support once a decision is made. After discussions with IT and the Engineering leaders for each division, we collectively identified Abaqus FEA as the ideal software choice. Both Dean and Ravi agreed that the software would benefit their respective engineering groups. Compounding the advantages is Development Engineer Charles Zheng, PhD, who recently joined AXON with significant Design by Analysis experience and a high proficiency in using the Abaqus software. Charles stated he would support any AXON team member seeking to learn Abaqus.

We were ecstatic that Keith approved our funding request and supported this technology investment with enthusiasm.

Since its implementation in April, Ravi and Charles have already utilized Abaqus to tackle tough design issues involving a multifaceted anti-rotation device that needed to fit into an existing design envelope. Please join me in congratulating the whole AXON organization for recognizing the importance of technical growth in achieving business success.



PROACTIVE THINKING

TOYODA BM-1600 VMC
NHR MACHINE SHOP

In many CNC machines, telescopic way covers are used to protect the guide ways from ball screws, chip loads, etc. Overlapping steel sections with wipers at the joints function by sliding to extend or compress as needed.

Last month, production halted on our CNC vertical mill due to wear/damage on these metal segments. We have 14 CNC machines and 3 manual machines at NHR. However, the machine that broke down happened to be our only vertical mill.

Rather than defaulting to a service technician for repair or purchasing a replacement, the machine shop team took matters into their own hands – literally.

Our skilled machinists are highly versed in how these machines operate. If it's something they can effectively fix in-house, we take the initiative first to minimize costs and get back online as soon as possible.

Thanks to the resourcefulness of two AXON employees, the vertical mill was back to work in only two days. They successfully repaired the segments and replaced minor parts on the way cover, avoiding a $5,000 expense and 6-week downtime.

➤ **Tu Le, Manufacturing Manager**

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The purpose of this reoccurring section is to showcase details about technological roles at AXON, including in departments outside of Engineering. In this issue, we learn about CNC (Computer Numerical Control) programming with Thong Tran, Sr. CNC Programmer.

A DAY IN THE LIFE OF... CNC PROGRAMMERS

Although Thong has 20 years of experience specific to CNC programming, his involvement in precision machining spans over 3 decades. His immersion in the oil and gas industry began in 2005 upon moving his family from New Orleans to Houston in Hurricane Katrina's aftermath. In his free time, Thong enjoys relaxing with his wife and three daughters, listening to classical music, and working on cars.

What is CNC Programming?

CNC programming entails writing detailed instructions to run machinery that precisely shapes and cuts raw materials into specific parts, such bonnets for our ram BOPs.

We analyze design specifications to plot out each step required to machine the parts, then convert the instructions into a code that the machines can read. In a nutshell, our job is to determine the WHAT, HOW, and WHEN needed to make each part.

How does everything begin?

It starts when Engineering provides a CAD drawing of the part to be machined. The first step is processing the specifications into precise machining steps needed to make the concept design into a physical reality. We make calculations based on raw materials and physical production requirements, such as material type, machine speeds, feed rates, etc. We then translate the calculations into sequential programming code for the machine to follow.

The first thing I think when looking at the print is, "What is the best way to process this? What is the easiest, cheapest, and most efficient way to achieve these design requirements?"

How do you figure that out?

In the machine shop world, it is important to thoroughly understand a combination of five different things: tooling, fixturing, how the machine works, cutting methods, and materials involved. The key is to constantly think about how these elements relate to each other, while also maintaining a very adaptive mentality. Things don't always go as planned, and we need to adapt accordingly.

Experience is also vital. Believe me, I've messed up many, many times over the years. Some things look effortless for me today because I've learned from my mistakes. One of the first things new CNC programmers learn is that reality is very different from the virtual design world. That's why it is a huge advantage to know how to both program and operate the machinery. Cross-training is extremely useful in this field because it helps us understand multiple perspectives while assessing solution options.

What is the most critical aspect of CNC programming?

In my opinion, the actual component machined is not special in any industry. There are many different methods to arrive at the same physical result. The real challenge is figuring out the most efficient process to get there. It's not just about programming the machine; sequence and positioning are huge factors in determining the time/cost invested into making a part.

Speed is important, especially in our industry, but obviously it isn't everything. In fact, speed is nothing if quality and safety are compromised.

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FROM OEM TO CEM
Generating Creative, Workable Solutions

➤ **Eric Crochet, Operations Manager**

We are currently collaborating closely with the NHR team to complete our customer's order for an 18-10M BOP stack. To fulfill their request for a cost-effective solution and quick turnaround time, the AXON team assessed existing equipment to find opportunities in which repairs/rebranding would meet specifications. We concluded that a combination of new and rebranded equipment was optimal for their BOP stack.

On the new equipment side, Okan and his team are supporting us by manufacturing Type 50 bodies for the stack's double and single ram BOPs. They are also providing machining support when necessary.

On the rebranded equipment side, we acquired existing bonnet assemblies from customer property, as well as an 18-5M annular BOP. Ravi and his group are an integral part in this time-sensitive rebranding project, as they have been quickly providing engineering design support as needed to ensure compliance with API 16AR.

Once again, our facilities did an excellent job joining forces to combine AXON OEM and CEM equipment for this order. Thanks to the outstanding teamwork, we are on track to deliver the completed BOP stack in Q3/2019.

TOP: 18-5M Type 52 BOP Lower Housing; weld prep completed to mount weld neck flange

BOTTOM: 18-10M Type 50 Double BOP Body; getting milled on Toshiba 1 HBM

THE IMPORTANCE OF
Interdepartmental Synergy

➤ **Ravi Velamarthy, Sr. Engineering Manager**

In the last two months, we have had many technological wins, such as our patent pending Low Force Shear Rams (LFSR) design and adoption of **Abaqus for FEA analysis** (pg 2).

However, I'd like to focus this article on a topic not confined to Engineering. Something that we have been doing a lot more lately at AXON is increasing interdepartmental communication. For example, Paul Tasson joined the NHR Engineering Team in April and spearheaded the conceptualization of our **7-15M LFSR design** (pg 8).

Paul has nearly four decades of significant annular and ram BOP experience, with a specialization in ram development. However, rather than limiting discussions to Engineering, we scheduled a Sales Review and Alignment Meeting that also included Manufacturing, Sales, and Marketing. The purpose was to introduce the design, discuss features, and collectively agree upon next steps.

Although Paul was undeniably the subject matter expert, we benefited greatly from sharing information and asking/answering questions during the meeting. Engineering obtained valuable input from different departments in the beginning design stage, thereby reducing the risk of wasted time down the road (e.g., discovering a feature is not feasible in a manufacturing standpoint or leaving out a feature that customers really want).

This collaboration has been helpful in the case of the LFSR development, as well as many other instances. In addition to a more efficient flow of information, the focus on interdepartmental communication has also kept us from losing sight of the other moving parts within our company.

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CONTROL SYSTEMS FOR DRILLING WELL CONTROL + DIVERTER EQUIPMENT

Our Journey from 16D-001 to Now and Beyond

The first edition of API Specification 16D was published and took effect on March 1, 1993. Less than two months later, API issued the world's first 16D certificate (16D-0001).

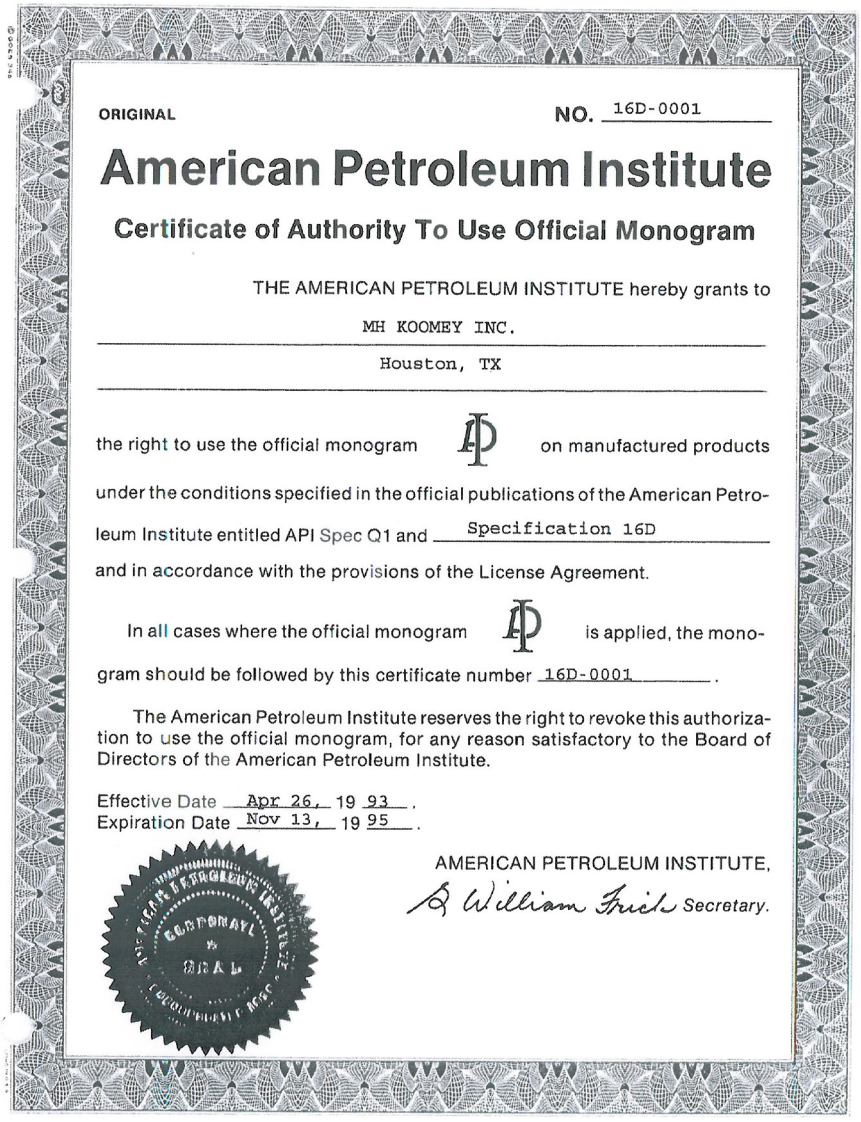
Our JRR facility, operating as MH Koomey Inc. at the time, holds this honor of literally being the **first company approved to monogram 16D equipment**. We produced our first monogrammed unit in April of the following year. Since then, the JRR facility has monogrammed roughly 250 control systems.

With the release of API 16D, 3rd Edition, in November 2018 (effective May 2019), the JRR Engineering Team performed a gap analysis between the 2nd and 3rd Editions to address any **design changes** (pg 6) needed to meet the new edition requirements.

I would like to commend the group, **with a special thank you to Bhavin Patel**, for completing this task. All updated design requirements have been successfully addressed for each of the five product licenses we have under our API 16D certificate.

The first AXON units to be monogrammed per the 3rd Edition will be completed and delivered to our customer this summer.

➤ **Dean Ueckert, Chief Engineer**



ORIGINAL NO. 16D-0001

American Petroleum Institute

Certificate of Authority To Use Official Monogram

THE AMERICAN PETROLEUM INSTITUTE hereby grants to

MH KOOMEY INC.

Houston, TX

the right to use the official monogram API on manufactured products under the conditions specified in the official publications of the American Petroleum Institute entitled API Spec Q1 and Specification 16D and in accordance with the provisions of the License Agreement.

In all cases where the official monogram API is applied, the monogram should be followed by this certificate number 16D-0001.

The American Petroleum Institute reserves the right to revoke this authorization to use the official monogram, for any reason satisfactory to the Board of Directors of the American Petroleum Institute.

Effective Date Apr 26, 19 93.
Expiration Date Nov 13, 19 95.

AMERICAN PETROLEUM INSTITUTE,
R. William Fritch Secretary.

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API 16D Updates: Changes in Accumulator Sizing Requirements

API 16D Edition	Functional Operation	System	Min. Operating Pressure (psi)	Optimum Precharge (psi)	Bottles Required (11 gal)
2nd Edition	No Shearing	Main	1,500	1,200	12
	Shearing	Main	2,100	1,840	16
3rd Edition	No Shearing	Main	1,500	1,540	16
	Shearing & Sealing (No Dedicated Shear Bottles)	Main	2,100	2,127	41
	Shearing & Sealing with Dedicated Shear Bottles (3k Supply)	Main	1,500	1,540	16
		Dedicated Shear	2,100	2,263	7

The new API 16D edition resulted in substantial changes to accumulator sizing requirements for many land rigs. As a result, we have received many requests from customers for help in understanding the changes.

This example is part of a technical document we created to aid others in navigating the updates. The calculations illustrate differences in accumulator sizing requirements between the 2nd and 3rd Editions.

A typical 13-5/8" 10M BOP stack (components below) is used for the control unit calculations:

- (1) 5M Type 52 annular BOP - 23.58 gallons to close
- (2) 10M Type 50 pipe rams - 5.8 gallons to close
- (1) 10M Type 50 shear ram with large bore shear bonnets - 10.9 gallons to close
- (1) HCR valve - 1 gallon to close

This configuration requires a FVR of 47.08 gallons to operate and uses 11-gallon accumulator bottles.

CALCULATION EXPLANATION

2nd Edition, No Shearing

Per the 2nd Edition, a MOP (minimum operating pressure) of 1,500 psi would typically be used. Optimum precharge for this system is calculated at 1,200 psi (1,000 psi has been the standard precharge since accumulator units were first used). Utilizing this precharge and MOP gives a requirement of 10.3 bottles. To meet 25% isolation requirements per 16D, this typicallys net a 12-bottle unit.

2nd Edition, Shearing

Still using Method A, sizing the same unit to shear results in a 2,100 psi MOP. The unit's optimum precharge is now 1,840 psi, resulting in a requirement of 13.4 bottles. This is rounded up to yield a 16-bottle unit.

3rd Edition, No Shearing

Now, moving to 3rd edition, using the same volume stack but without shearing equipment, requirements increase again. The unit needs to be able to close the annular and a pipe ram using Method C -or- do the drawdown test using Method B. The ACR (with the same precharge pressure) shall be the greater of the two. This leads to a system with 1,540 psi precharge and 16 bottles.

3rd Edition, Shearing and Sealing (no dedicated shear bottles)

Sizing the unit for shearing and sealing in the wellbore without dedicated shear bottles leads to the most bottles required. The unit needs to be able to close the annular and shear/seal using Method C -or- do the drawdown test using Method B. The ACR (with the same precharge pressure) shall be the greater of the two. Again, using a shear pressure of 2,100 psi, the system now requires a precharge of 2,127 psi and requires 41 bottles.

3rd Edition, Shearing and Sealing w/ Dedicated Shear Bottles

Conversely, sizing the equipment with a set of dedicated accumulator bottles (3,000 psi supply) that are fed off of the main system has different requirements. 16 bottles precharged to 1,540 psi are needed to operate the annular, pipe rams, and HCR. 7 bottles precharged to 2,263 psi are needed that are dedicated to shear only.

➤ continued on page 7

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A DAY IN THE LIFE OF...

➤ continued from page 3

For instance, let's say Person A can machine a part in 10 hours, whereas Person B can do it in 7 hours. Even if Person B is quicker, if design specifications are not met, the total cost may be three times the anticipated amount due to having to fix/scrap the part and start over.

Once you figure out a process, is that it?

No. As mentioned above, things don't always go as planned. CNC machining is an automated process, but computers have their limitations. Unforeseen issues may arise, and the process may need adjustments. Sometimes we may discover that the part requires a special fixture that is not available on the market. Then the challenge is figuring out the most efficient way to design and make it, if time and resources permit. I regularly work with our Machinists, Engineers, and other team members to troubleshoot the process to ensure specifications are met or exceeded.

Please tell us about a process improvement that exceeded expectations.

Previously, a typical AXON Type 50 bonnet required five or six operations (~33 hours) for its machining process. By reprocessing the existing sequence and methodology, including machinery used, our team reduced the process down to three operations (~13 hours). This process improvement proved to be very cost and time effective (~60% reduction in machining hours), without negatively affecting quality.

Besides the skills you described above, what else has driven your success?

Dedication. Passion. Motivation to constantly seek improvement, if time permits. Being aware that – yes, improvement is great, but not if you're creating a bottleneck for others in the process. Think outside the box and put yourself in other people's shoes. That will drive your success and hopefully contribute to theirs as well.

➤ **Thong Tran, Sr. CNC Programmer**

DID YOU KNOW?

• Did you know… **after June 30th you can no longer 'borrow' PTO time?** (ref. 2/22/19 HR email on Revised PTO Policy)

• Did you know… **safety shoes (steel or composite toe) must be worn in the shop areas when outside the yellow lines?** (AXON has a reimbursement program; contact QHSE for details)

• Did you know… **three lives are saved with each blood donation?** (Next blood drive is at NHR on Tuesday, June 4th)

Need more info? Have something you want to feature? Let me know!

➤ Rachel Chalfant, Sr. Sales Assistant

API 16D Updates: Changes in Accumulator Sizing Requirements

➤ continued from page 6

CONCLUSION

Why does 3rd Edition require such a substantial increase in bottles?

API 16D set new standards to ensure equipment capability. Not having enough bottle capacity/pressure is a huge risk, and API addresses this in the new edition by stipulating a more conservative calculation method. This is especially true as we drill deeper at higher pressures; accumulator units must compensate by providing more pressure (compared to the past) to safely control the BOPs.

Also, the difference in bottle counts only becomes more drastic as required shear pressure increases. For example, for 2,200 psi shear pressure, a unit without dedicated shear requires 51 bottles precharged to 2,261 psi. For 2,300 psi shear pressure, a unit requires 64 bottles, etc.

➤ **Chris Robertson, Mechanical Engineer**

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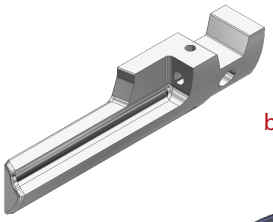
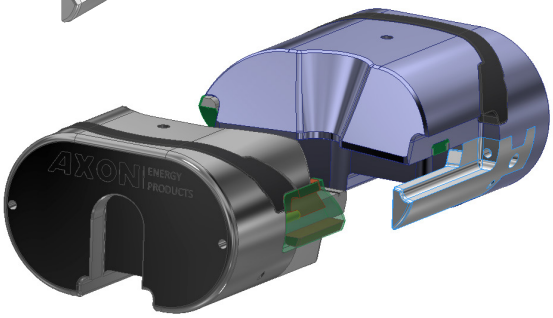
NEW DESIGN HIGHLIGHT | KEY FEATURES

7-15M Low Force Shear Rams

- Optimized to shear wireline in harsh environments - rated to 15,000 psi with temperature range of 30°F - 250°F; optional acid compatible seals available
- Large bore, low force shear blades allow for larger bore coverage while reducing required shear pressure (shear calculations available upon request)
- Replaceable linear locking feature results in superior shearing/sealing (locking mechanisms engaged at both beginning and end of stroke)
- Top seal and blade seal geometry designed for enhanced rubber flow
- Debris catcher gathers excess debris during shearing process



linear locking mechanism features bolt-on design for ease of ram maintenance



Individuals play the game, but teams beat the odds. -NAVY SEALS

Each employee plays an active role not only for their personal success, but also for the success our company and our customers. Please join us in recognizing new members, promotions, and anniversaries in our AXON team.

THANK YOU!

- Dean Ueckert, 32 years
- Josh Casteblanco, 14 years
- Michael Melek, 13 years
- Adael Martinez, 13 years
- Danny Parsons, 11 years
- Ravi Velamarthy, 10 years
- Aaron Gravis, 8 years
- Ramon Miramontes, 8 years
- Kenneth Stevens, 7 years
- Jimmie Billiot, 7 years
- Thai Duc Vu, 7 years
- Bhavin Patel, 6 years
- Tong Nguyen, 5 years
- Michael Doty, 3 years
- Harrison Weber, 2 years
- Jason Knight, 1 year
- Ernest Martinez, 1 year
- Thai Trinh, 1 year
- Saul Zamarron, 1 year
- Thong Tran, 1 year

CONGRATS!

- Tina Rys
- Nihan Sengul
- Adael Martinez
- Michael Maury
- Joe Ramirez
- Oscar Garcia Shelly
- Dean Crow
- Angelicia Davis

WELCOME!

- Jerraile Ivery
- Charles Zheng
- Judy de Jong
- Larry Falcon
- Darlene Ritchie
- Paul Tasson
- James McMullan

HELP SOMEONE WIN A $150 GIFT CARD!

REMINDER | AXON Achiever Appreciation Program: Each month, you can help in recognizing fellow employees who have demonstrated our mission, vision, and values through their performance, safety, and community involvement.

Per the schedule you received, the highlighted facility for June is **NHR**. Please send your AXON Achiever Nomination Form to me by June 25th! Thanks!

➤ **Kari Leafe, Human Resources Director**

Got questions, comments, or contribution ideas?

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