nobel labs

Product Development

Product Review

JANUARY 11, 2018

Agenda : Product Development Review

1. **2017 Product recap**
   A general review the product team’s progress across all workstreams at the end of 2017.

2. **Testing & Research findings**
   Review of the latest usability testing and research findings.

3. **What’s next...**
   Brief overview of the current planned features, priorities, and potential next products post Athos/Hermes V1 launch.

2017 product recap

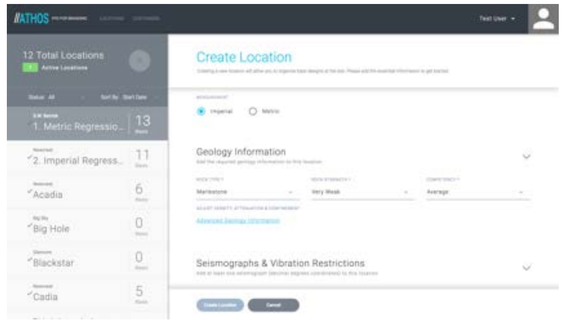
Athos

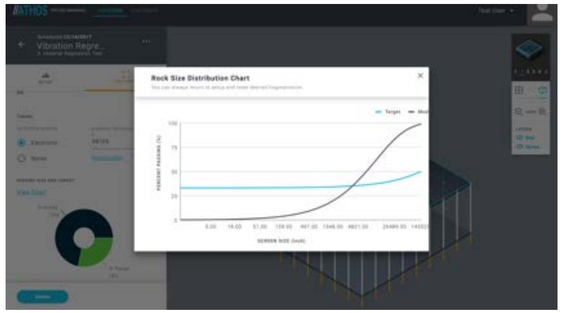
2017

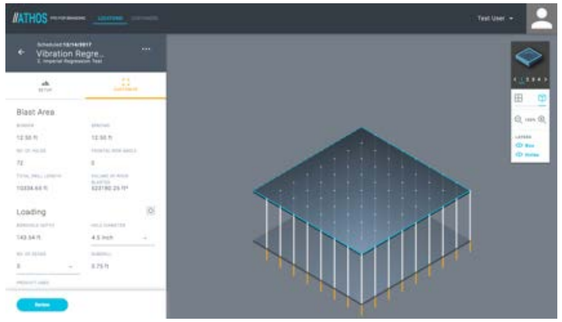
2018

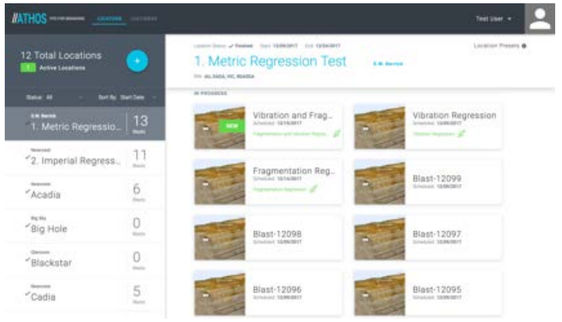
Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar

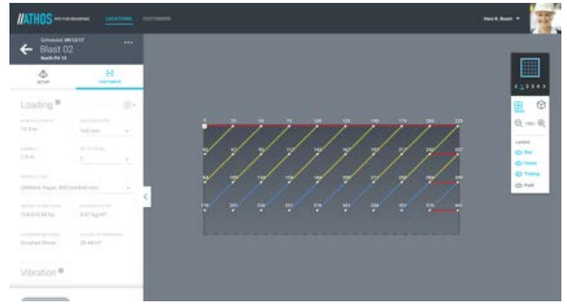
- Imperial Metric Conversion & Location Presets
- Interactive Modeling & Interactive Blast Planning
- Fragmentation Modeling & Visualisation
- Regression Engine & Blast Reporting
- Nonel Timing & Irregular Shapes
- Borehole Manipulation & Electronic Timing
- 3D Mesh integration (Hermes)



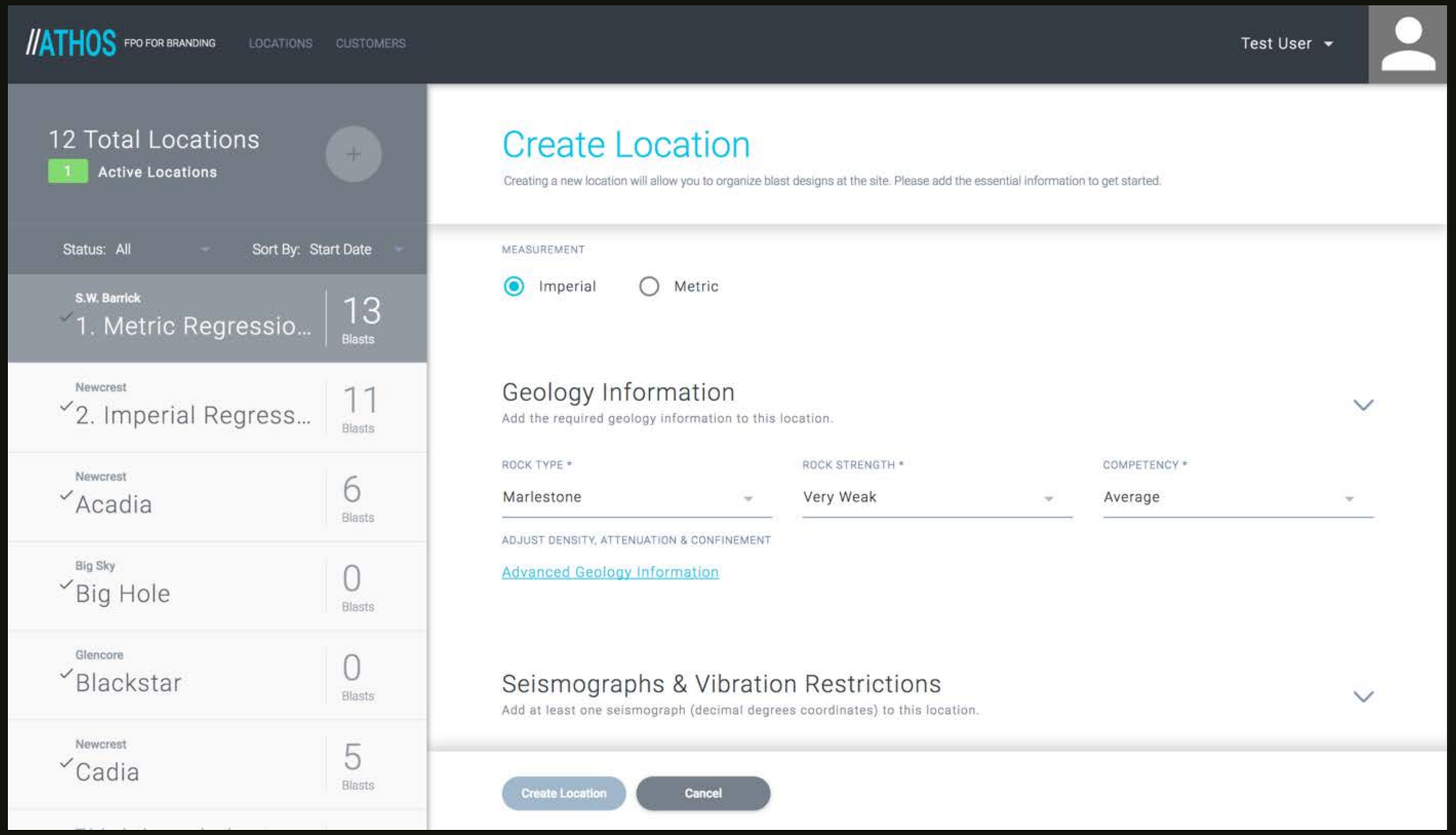




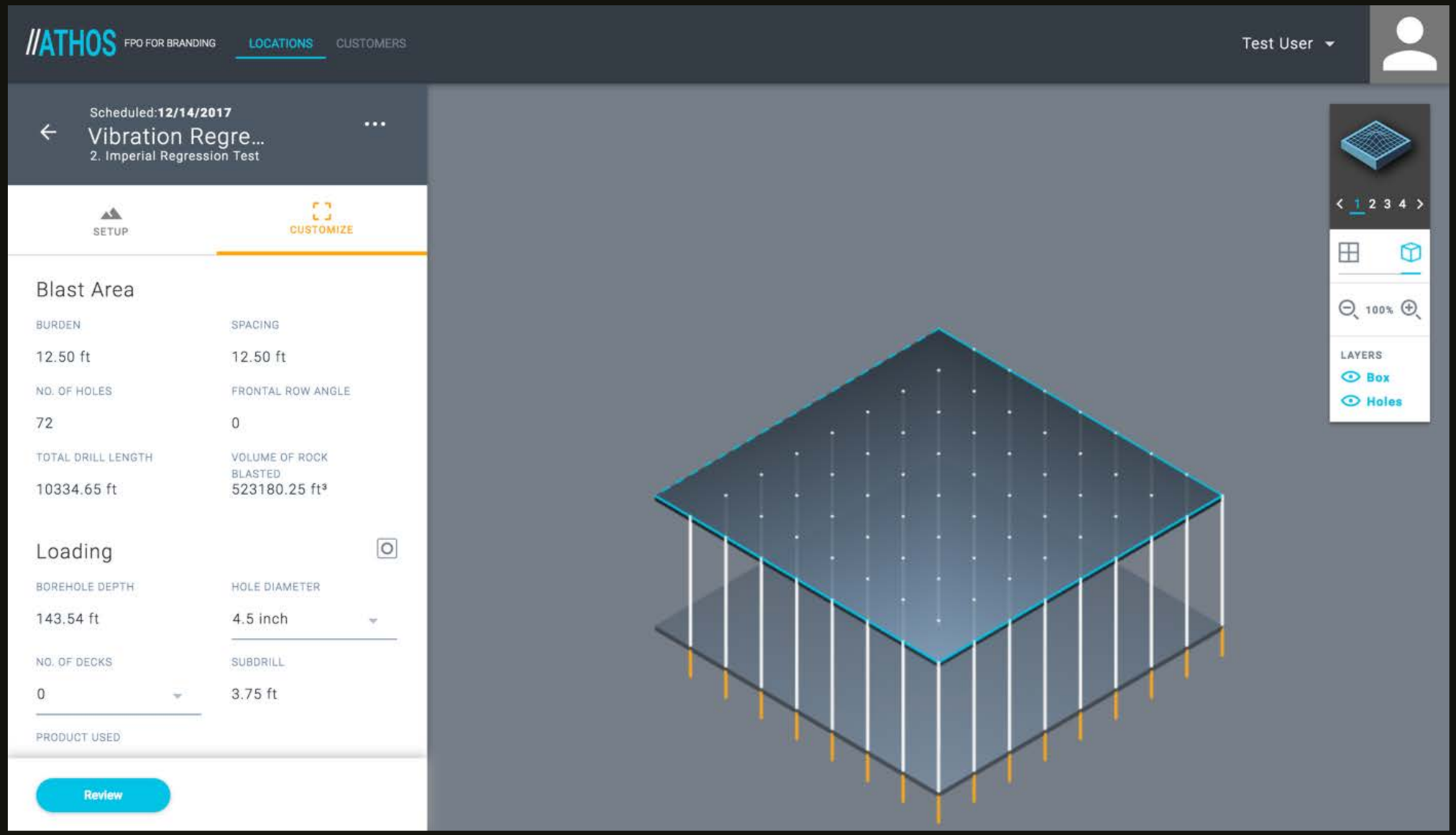




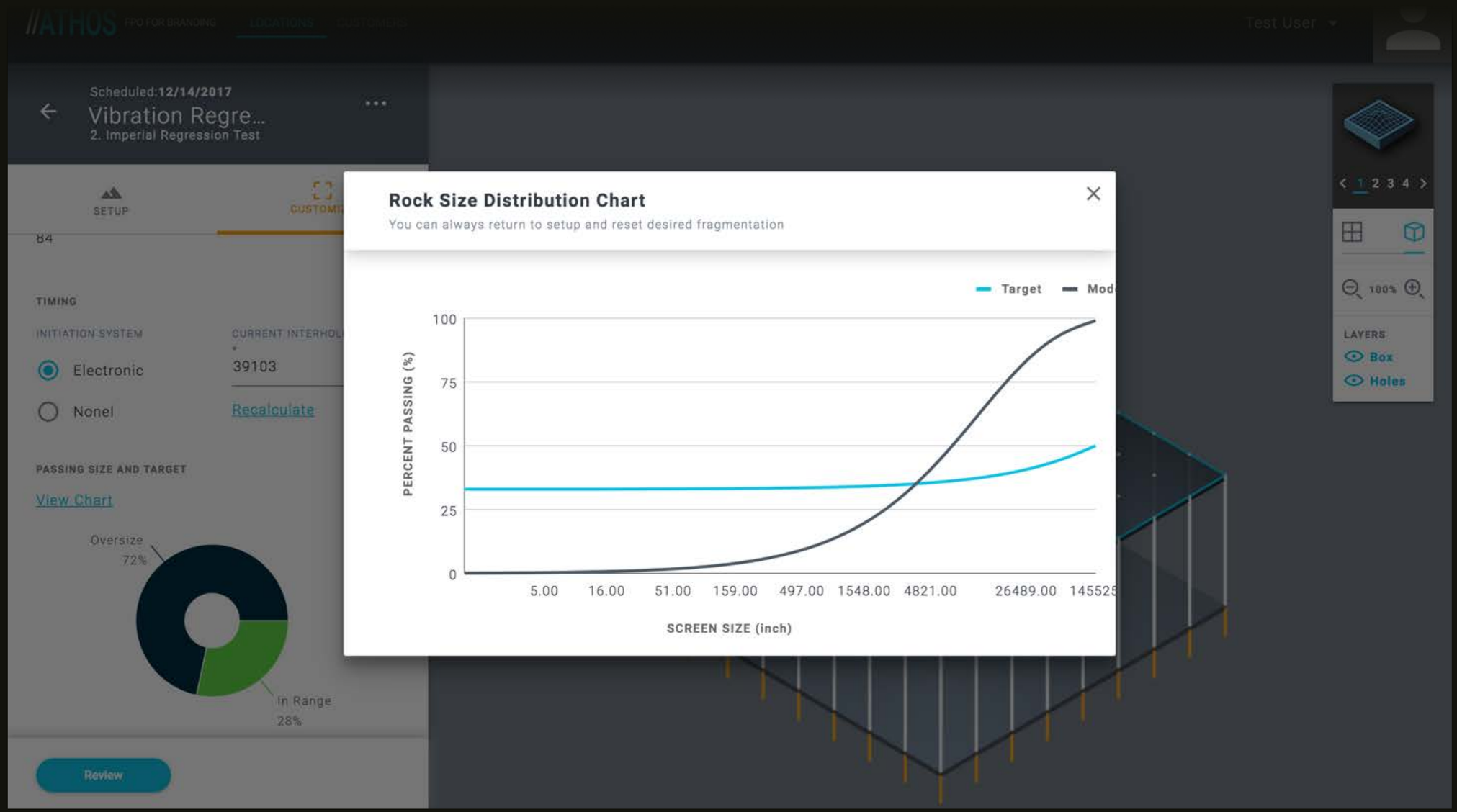
July 2017: Imperial Metric Conversion & Location Presets



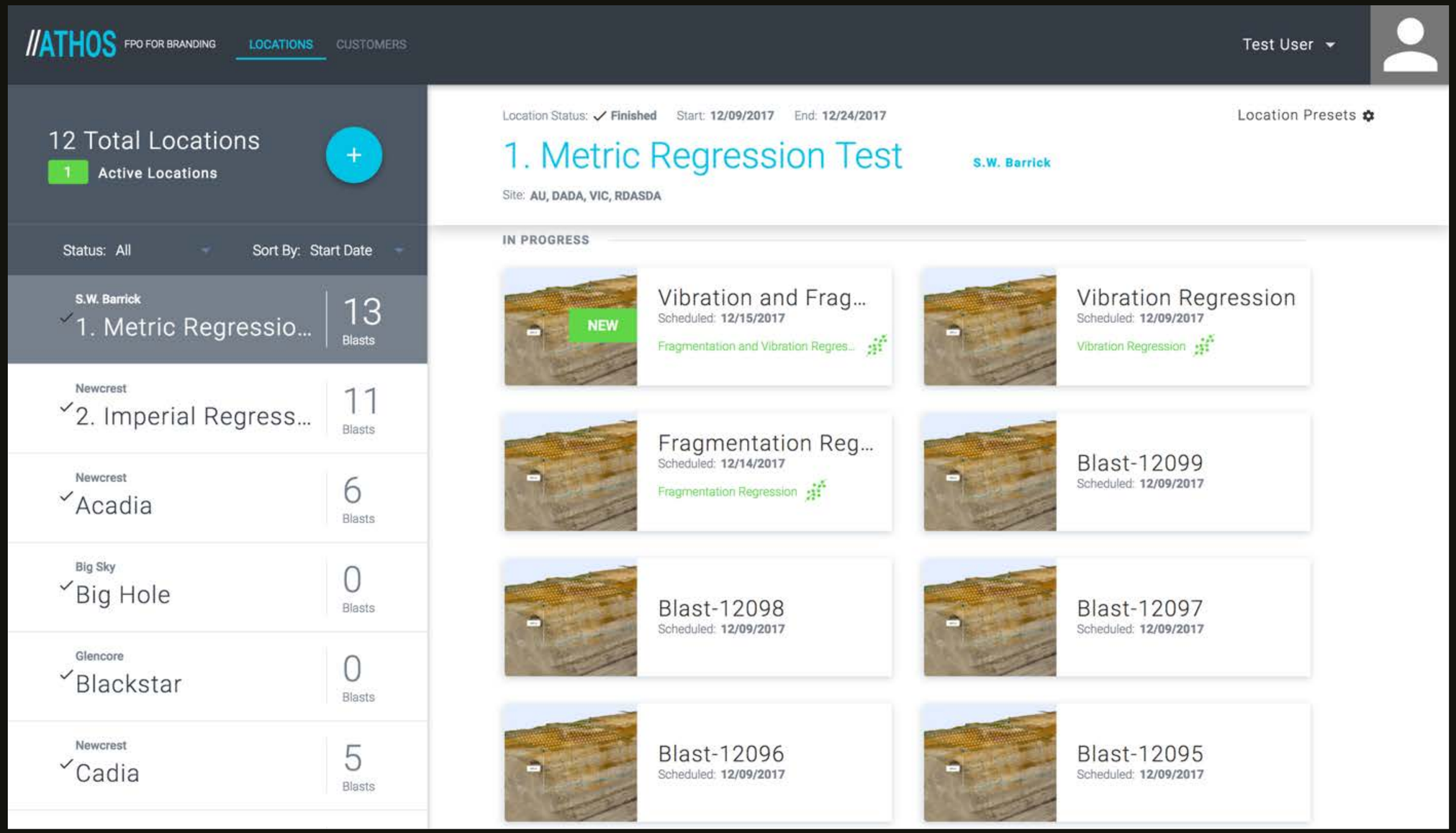
September 2017: Interactive Modeling & Interactive Blast Planning



November 2017: Fragmentation Modeling & Visualisation



December 2017: Regression Engine & Blast Reporting



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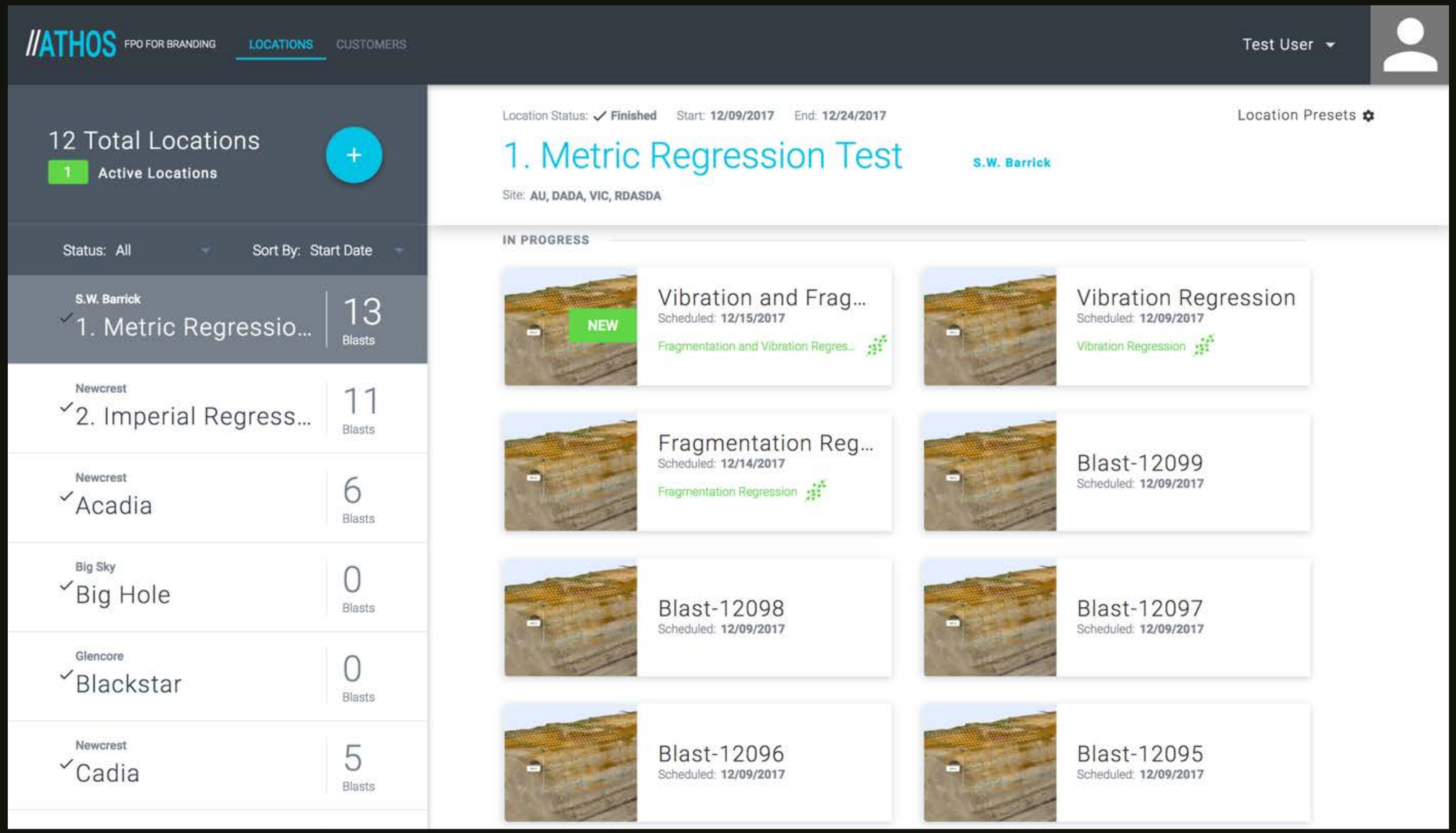


Hermes

2017 accomplishments

After kicking off the Hermes workstream in October, the team closed out the year with several key accomplishments:

1) Started **development** work on the iOS mobile flight planning application and laid the initial technical groundwork to build upon in future sprints

2) Conducted **user research** with blast engineers from both quarries and coal mines to understand end user needs, pain points, and how that information can influence the product roadmap

3) Designed a **functional prototype** of Hermes flight planning and model generation functionality to help drive user research and development efforts going forward

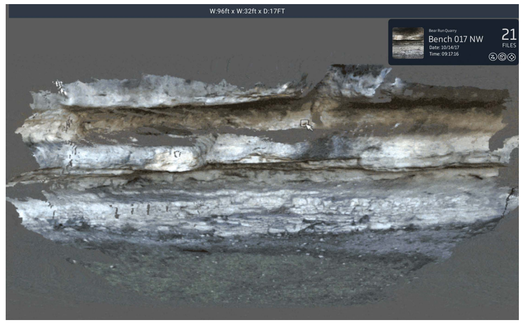
4) Investigated the potential application of **new emerging technologies** for model generation and blasting needs

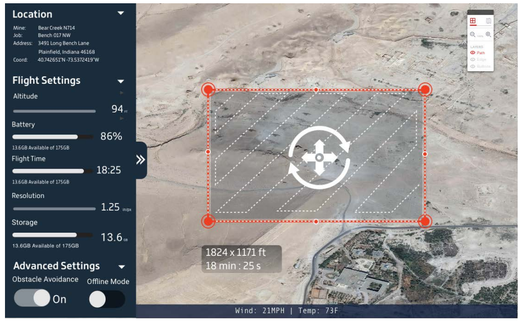
2017

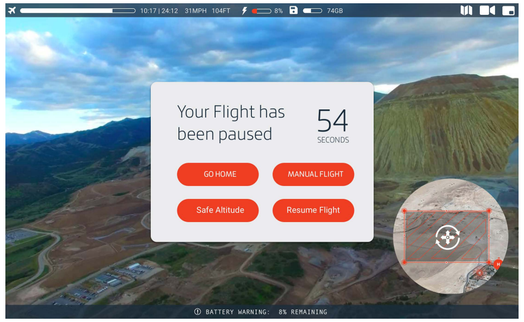
2018

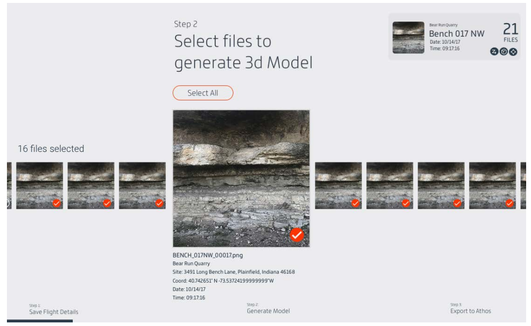
Oct | **Nov** | **Dec** | **Jan** | **Feb** | **Mar**

- Drone flight research
- Drone flight control prototyping
- Base iOS technical groundwork & start of flight control development
- Flight planning & 3D model previewer
- Flight planning & model generation
- 3D model generation & integration with Athos

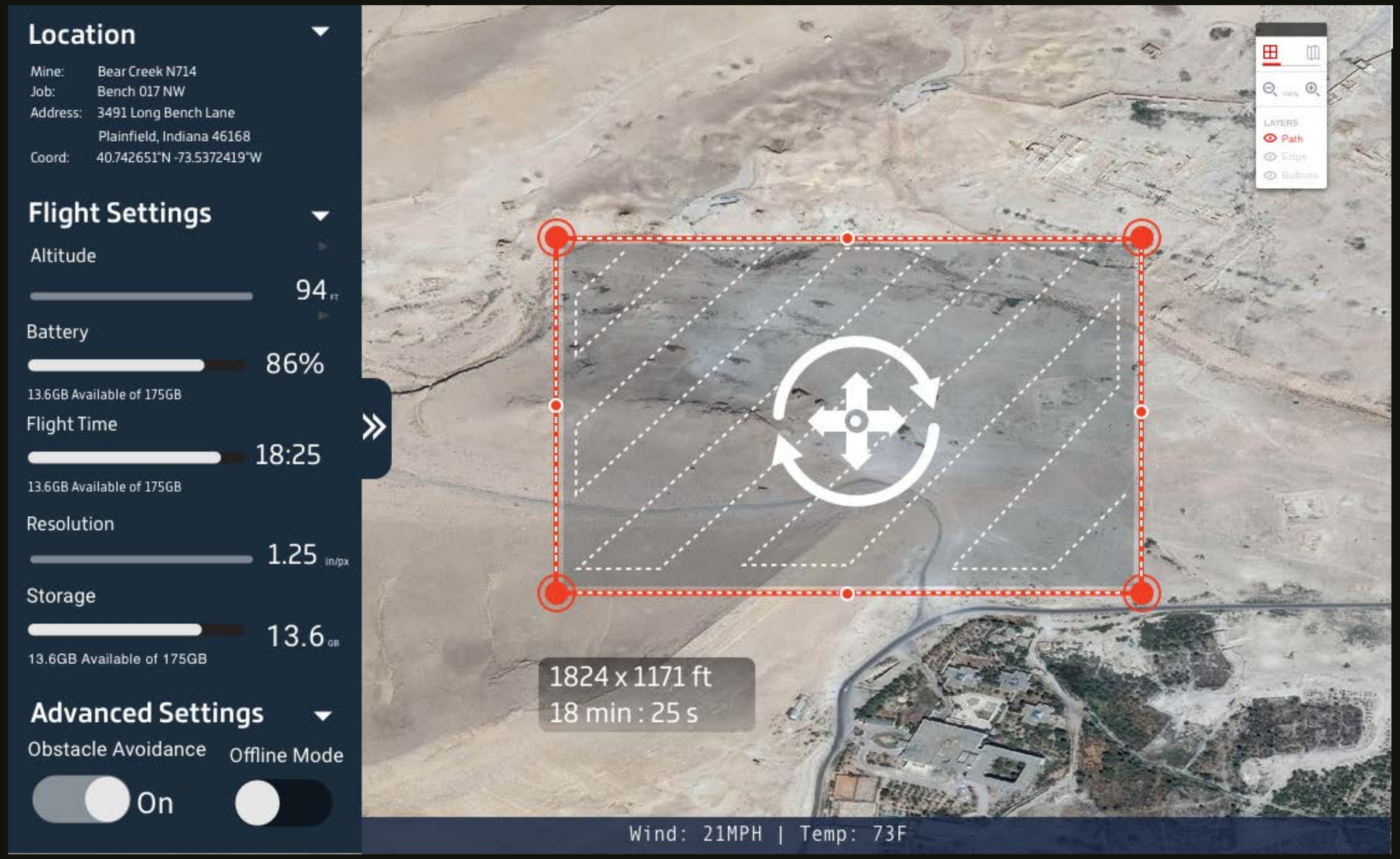




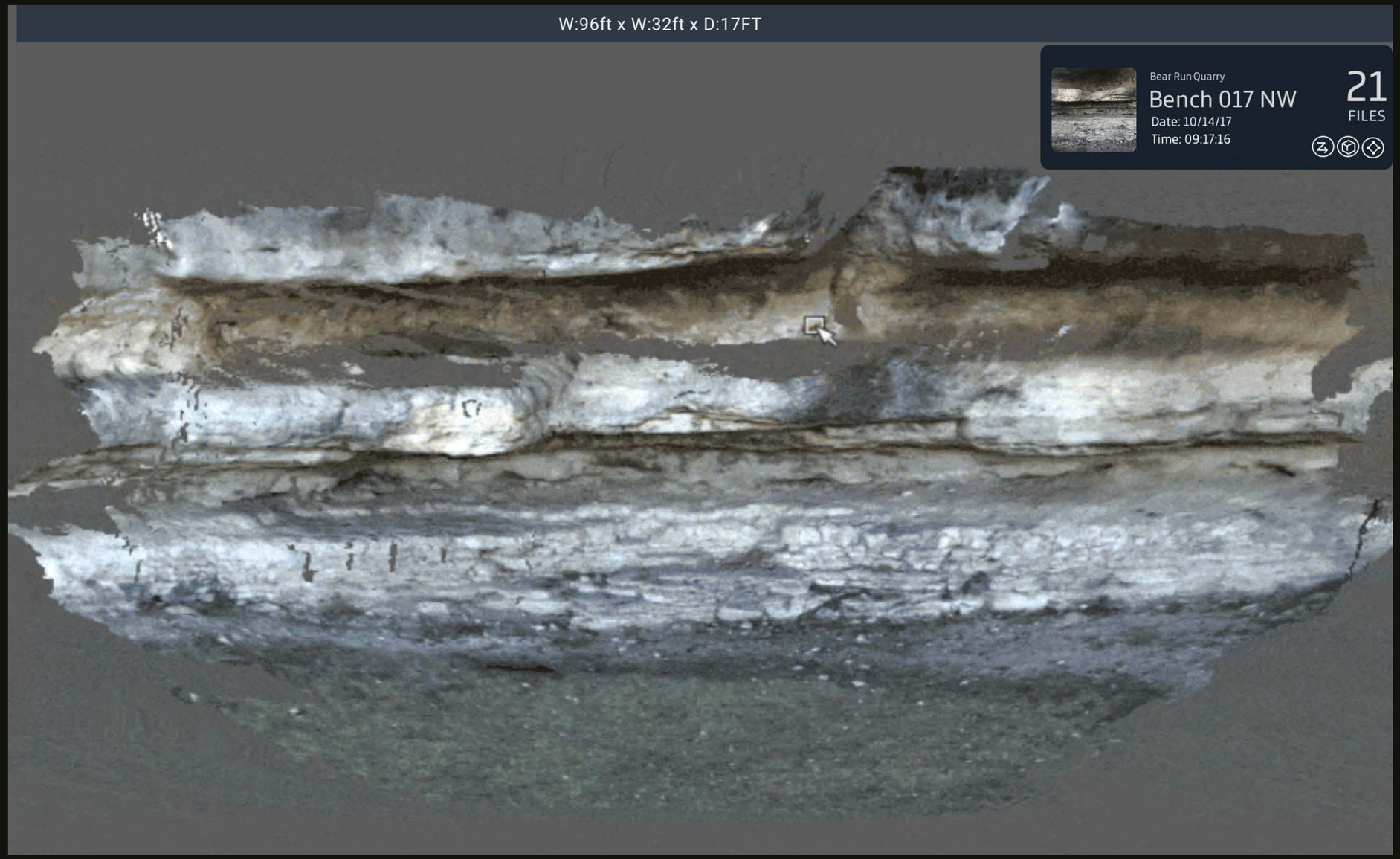




November 2017: Drone flight control prototyping



November 2017: Base iOS technical groundwork



Testing & Research

Usability Testing

(Athos)

What we did.

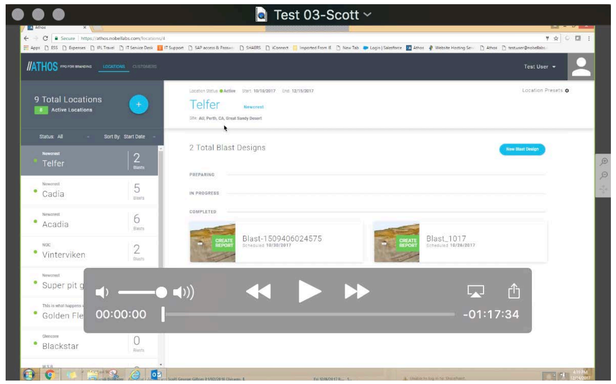
We ran 3 user testing sessions of 1.5 hours duration each, with representative ATHOS users.

Our main **goals** were to:

- Learn if users are able to complete specified tasks successfully
- Ensure Athos addresses the right user needs in the right and most efficient way
- Identify changes required to improve user performance and satisfaction

Joe Nawrocki, Sr. – Tech Team Mgr
Has 45 yrs blasting experience

Joe Nawrocki, III – Technical Sales
Has 20 yrs blasting experience



Scott Giltner – Senior project engineer
Has experience in troubleshooting and blast optimization since 1985

Key observations and takeaways:

What works well

Ease of use

Users with various computer skill levels were able to navigate the Athos interface easily and without assistance.

Product progress

2 out of 3 users have seen an earlier version of Athos and mentioned the product has significantly improved since the previous version.

Understanding the workflow

Users found it easy to understand the relationship between customers, locations and blasts.

New Blast Design

Creating a new blast was straightforward using the enhanced 3D canvas and left pane navigation.

User efficiency

Users found it very helpful to be able to create location presets and re-use the entered data, avoiding the need to enter the same values multiple times.

Data Visualisation

The fragmentation graphs were a desired feature, enabling users understand fragmentation results in an easy way.

Upcoming features

Users' reaction to future designs for Nonel timing and irregular shapes was positive. They were keen to see them in the next release.

Key observations and takeaways:

What needs improvement

Error messages

Some Athos error messages are not intuitive and clear. Error messages should not use jargon and instead give users options to remedy the situation.

Call to action buttons

Some of the hyperlink styled buttons (such as Add Product) were not apparent to the user, so they would miss-out clicking on them.

Option to enter data later

Users wanted to have the option to enter some of the blast data (such as seismographs values) later as all those values might not be known to them at the time of location creation.

Modifying blast data

Once in the customize mode, users wanted to be able to modify the blast data in the setup section (right now this is not possible).

Viewing relevant fields

Not all values are relevant for all sites. Athos should be smart and ask for relevant data based on site type (e.g. Youngs Modulus is not used in quarries).

More features

Users wanted some additional features such as adding multiple freefaces, blast shape presets etc. which will be added to the product backlog.

Sharing blast reports

Users wanted an easy way to send/email blast reports to colleagues/others.

Key observations and takeaways:

Next Steps

1) Enhance current ATHOS designs based on received feedback

2) Add enhancements into the product backlog and priorities for future releases

3) Continue the user testing sessions either remotely or in person (6 more users to be confirmed for Jan-Feb timeline)

Field Research

(Athos & Hermes)

What we did.

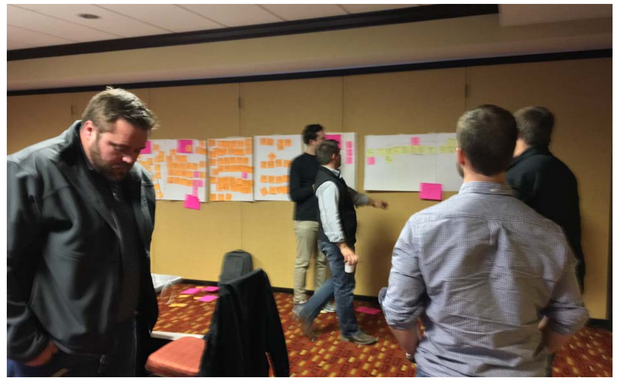
In the month of December, team members from both the Hermes and Athos product teams traveled to visit with end users in both Maryland and Indiana.

The goal of these sessions was to:
a) Gain a better understanding of the **way our end users work**, what their **pain points** are and potential **opportunities**
b) Gather **usability feedback** on some of the tools/prototypes we've developed thus far

In our first set of sessions we met with DNA team members working in the Mid Atlantic (Maryland) to understand how they interact with the **quarry operations** in the area and gather feedback on Athos.

Our second session was with a group of Dyno Consult team members working with one of DNA's largest clients in Indiana to understand how **mine operations** work, how they are looking to optimize those operations, and how they are using drones.

Quarry Operations
Various locations in Maryland, Virginia, and West Virginia



Drone SME Meeting
Undisclosed location in Indiana

Key observations and takeaways:

Discoveries & Observations

Speed is King

Every part of the quarry is on-demand. Data and tools need to be fast and reliable or it throws off entire production.

Extreme Conditions

Hardware needs to be reliable, durable, and hold up to extreme conditions. Its frequently cold, dirty & wet.

Offline Mode

The transfer of information is primitive but works. There is generally no signal so people resort to USB and photocopied paper.

New Blast Design

The right data at the right time is critical to the process. The right data is high value but more data than necessary has no immediate value.

Skill Shortage

Blast engineers service multiple quarries, large geographic regions and are in high demand.

Orchestration

Sites are well oiled on-demand machines that depend on collaboration and timely data. People need to be flexible and problems disrupt entire flow.

Technophobia

People are often distrustful of new technology.

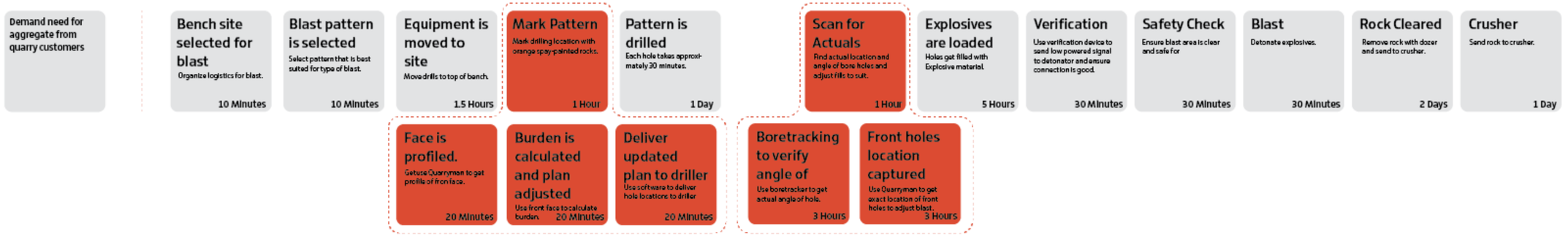
Safety First

Safety is a constant concern. Quarries will pay a premium for products that reduce risk to people and expensive machines.

Quarries - The Blast Process

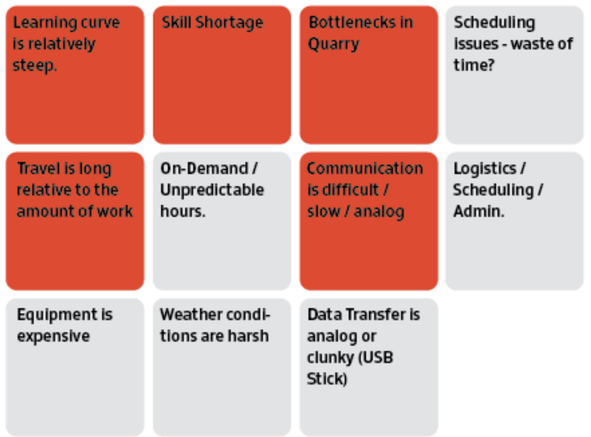
The following is a complete top level view of the blast process.

Blast Process



Pain Points of a Blast

Current pain points of a blast mapped to a product offering.



High Value

Mines - The Blast Process

The following is a complete top level view of the blast process.

Blast Process

Prior to blast

- Create standard blast patterns for entire site.

1 Day

- Set deadline for blast. — Organize logistics for blast. — .5 Hours
- Bench Preparation — Ensure bench is in good condition and ready for blasting. — 3-5 Hours
- Move Drills to bench. — Move drills to top of bench. — 1.5 Hours
- Pattern layout — Mark drilling location with orange spay-painted rocks. — 1 Hour

2 Days

- Drill Holes — Each hole takes approximately 30 minutes — 2 Days
- Fill Holes — Holes get filled with Explosive material. — 2 Days
- Tag Holes — Holes get filled with Explosive material. — 1-2 Hours

2 Hours

- Wire Holes — Connect holes to electronic detonator. — 1-2 Hours
- Verification — Use verification device to send low powered signal to detonator and ensure connection is good. — .5 Hours
- Blast — Detonate. — 5 Minutes

2 Days

- Burm Top & Safety check. — Check area for hazards. — .5 Hours
- Clear with dozer — Remove material from blast site. — 2 Days

Drone Scanning Process

- Pre-Blast Scan — Scan bench before blast. — 3 Hours
- Audit — Verify that what was drilled is correct — Optional - 3 hours
- Post-Blast Scan — Analyze results of blast. — .5 Hours
- Cast Analysis — Get 3D & calculate blast efficacy. — 1-3 DAYS

***Most pain points in this stage.**

Pain Points of a Blast

Current pain points of a blast mapped to a product offering.

● High Value

ATHOS

Satisfied or Partially Satisfied

- Communication is slow, manual, and prone to error
- Data exchange is slow, difficult & analog
- Data is de-centralized
- Information is lost from blast design to drillers & fillers.

Potentially Satisfied

- No feedback loop to improve blast performance.
- Staff is not outcome driven / no incentive to improve performance.
- Manual Data Entry
- Equipment& logistics bottlenecks.
- No KPI

UNADDRESSED

Not Satisfied

- No WiFi or LTE Service.
- Don't know what to do with data.
- Variety of different tools used.
- No long term planning solution
- Fragmentation is inconsistent
- No way to use old data.
- Hardware readings for filling trucks are inconsistent

HERMES

Satisfied or Partially Satisfied

- Post scan is too laborious.

Potentially Satisfied

- Actual Holes vs. Athos Holes are different
- Markings vs. Athos Holes are different
- Only front holes are measured.
- Too much travel and driving for blast engineers.

Key observations and takeaways:

Next Steps

1) Identify research needs to investigate key questions and validate hypothesis

2) Define key KPIs and conduct value estimates for product and features

3) Define personas and align on target persona(s) for MVP/V1 releases

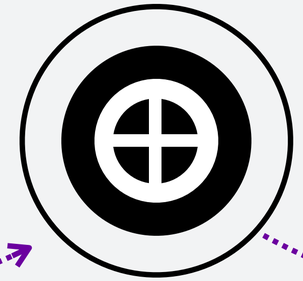
4) Update product roadmaps to reflect learnings from field research

5) Research common tools and data leveraged for blasting operations

What’s Next…

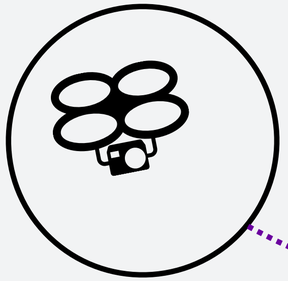
Athos + Hermes work flow

1. Plan a Flight
Select area to scan in app or on desktop using a map interface, then plan the flight and save.

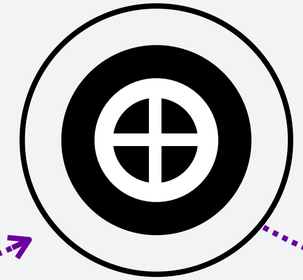


2. Place GCPs
Drive to the site and place 1 to 4 ground control points around the scan area. Then take accurate RTK GPS surveys of each ground control point and record for later.

3. Preflight
Unpack the drone and controller. Place the drone on level ground for takeoff. Dock a mobile device with the controller and launch DJI Go plus the Athos app.



4. Fly Drone
Locate your flight plan in the Athos app and launch the drone on that mission. The drone flies autonomously and returns home once the mission is complete.



5. Post Flight
Pack up the drone and controller, removing the SD card from the drone. Drive and pick up all of the ground control points placed in Step 2.

6. Import into Athos
Back at the office, copy images off of the SD card from the drone to a PC and then upload them to Athos for photogrammetry processing of images, model rendering, and blast planning on the models.

7. Blast Planning
Blast Design is done in Athos using the 3D model for planning.

8. Print/Distribute Blast Plan
Once the Blast has been designed, the plan can be printed for distribution to various parties or exported as a PDF for electronic distrubution.

Athos

Athos : Feature Roadmap (1/10/18)

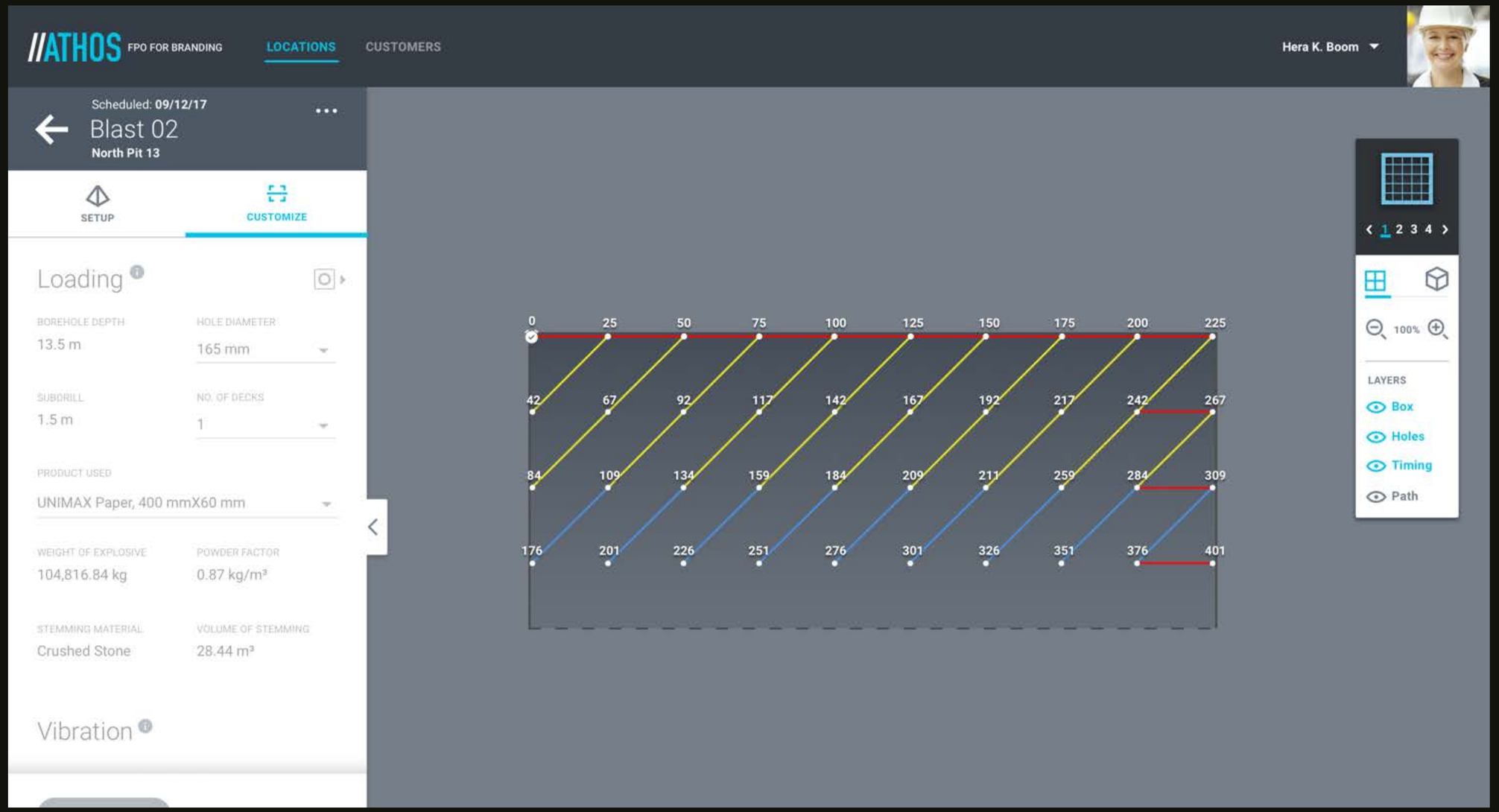
Dev in progress
Research in progress , pending decisions
Stretch Goal

Phase	MVP1-June2017	MVP2-October2017	FASBLAST Parity- December2017	V1.0	V2x
Description	Optimized Blast Calculator that uses 20 formulas & 3 algorithms to generate thousands of potential solutions then recommends the best solution from a valid subset to the user.	Blast planning application with an interactive 3D work space and simplified user inputs for blast calculations.	End-to-end blast planning application for small to medium sized mines. Has fragmentation modeling and regression analysis.	End-to-end blast planning application for small to medium sized mines. Has integrated drone scanning.	End-to-end blast planning application. Very frequent releases allow Athos to grow the user base quickly with new features.

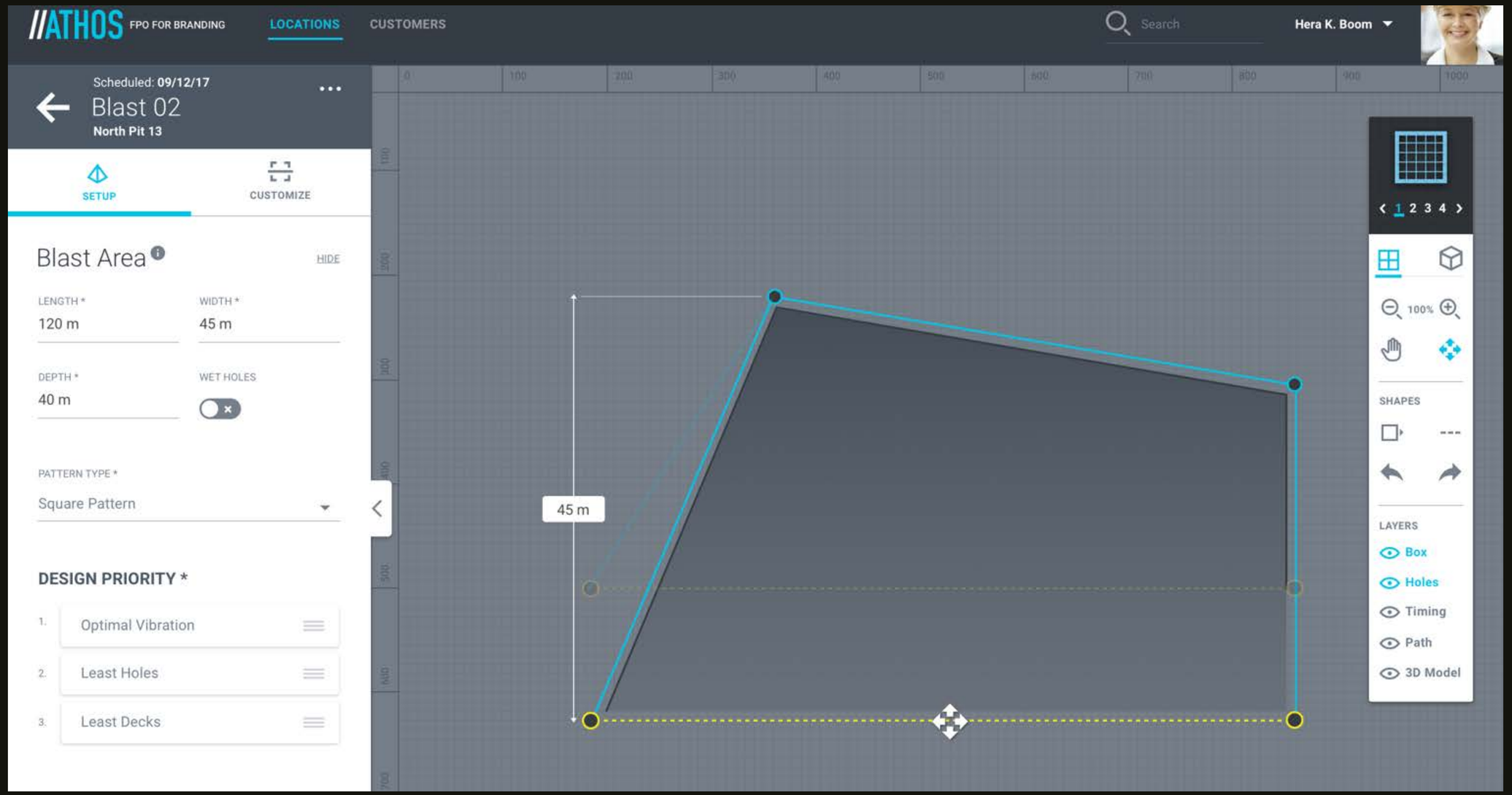
Features	• **Geology** - entry per blast
	• **Product -** entry per blast
	• **Location** - entry per blast
	• **Timing** - entry per blast
	• **Drill bit sizes** - entry per blast
	• **Vibration req's/location** - entry per blast
	• **Blast calculation**
	• **Vibration calculation**
	• **Blast Plan:**
	  ◦ Explosives used
	  ◦ Actual blast outcomes
		• **Geology** - preset
		• **Product** - preset
		• **Location** - preset
		• **Drill bit sizes** - preset
		• **Vibration req's/location** - preset
		• **Blast box**
		• **Blast calculation -** optimized
		• **Vibration calculation**
		• **Canvas Workspace:**
		  ◦ Free face selection
		  ◦ Products - preset
		• **Blast Plan:**
		  ◦ Explosives used
			• **Fragmentation Calculation:**
			  ◦ Modified Kuz Ram modeling
			  ◦ Visualization of frag modeling
			  ◦ Manual input of outcome
			  ◦ Regression analysis
			• **Vibration Calculation:**
			  ◦ Manual input of outcome
			  ◦ Regression analysis
			• **Drill and Blast Report**
				• **Timing :**
				  ◦ Nonel in blast box
				  ◦ EL in blast box
				  ◦ Detonators/boosters used
				• **Drone:**
				  ◦ Drone Flight planning
				  ◦ Autonomous Drone flight control
				  ◦ Photogrammetry service
				• **3D model generator/import**
				  ◦ Include LIDAR data
				• **Canvas Workspace:**
				  ◦ Auto free face detection
				  ◦ Staggered Pattern
				  ◦ Irregular Shape
				  ◦ Add/Edit Product selection
				  ◦ Borehole Manipulation
				• **Blast cost estimate (Blast only)**
				• **Blast design by rows/column**
					• **Fragmentation calculation with AI**
					• **Vibration calculation with AI**
					• **Fragmentation analysis**
					  ◦ Post blast
					  ◦ Drone Image capture & analysis
					• **Explosive energy distribution**
					• **NonEL Scatter Simulation**
					• **Fly rock prediction**
					• **Scaled depth of burial (for fly rock modeling)**
					• **Drill and Blast Report**
					• **Airblast modeling**
					• **Dig rate modeling**
					• **Blast cost estimate**
					  ◦ Drilling + Explosives (BID Tool)
					• **Post blast area (mutual)**
					  ◦ Reconciliation of Design vs Blasted
					• **Dig rates (actual)**
					• **Actual blast costs**
					  ◦ Full drill and blast cost model
					• **Throw modeling**
					• **Extra products per hole (blending)**
					• **Regulatory agency submittal**
					• **Drone: Post Drill Scan**
					• **Enhanced drone flight/time**
					• **Enhanced Shot Report**

In V1

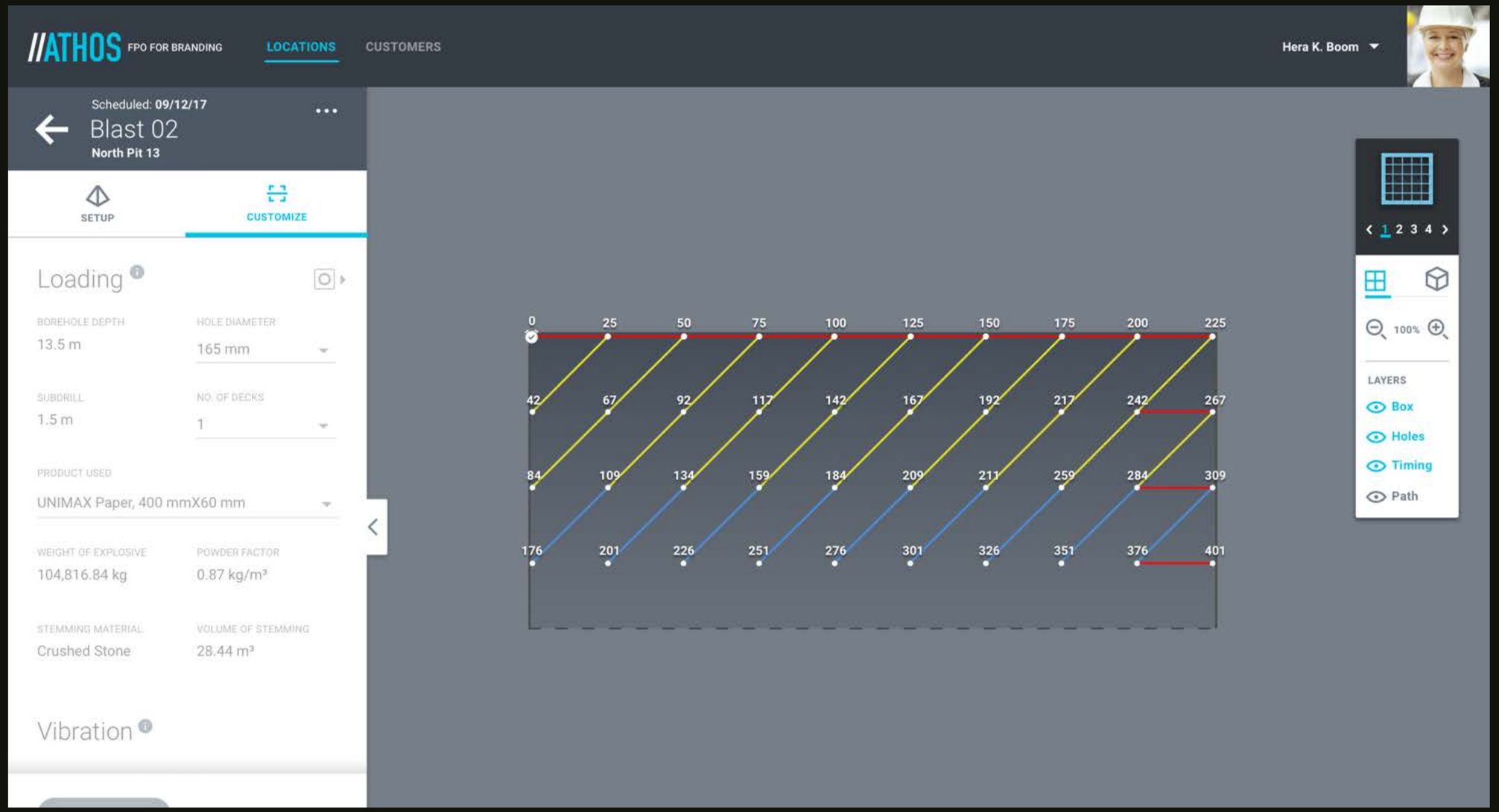
January 2018: Nonel Timing



January 2018: Nonel Timing



January 2018: Nonel Timing



Hermes

Development priorities for V1

Drone flight planning/control (mobile iOS)

- Identity management integration with Athos
- Create new, edit, or duplicate existing flight plans
- Assign flight plans to specific geographic locations or blast plans
- Sync plans to DJI drones and monitor flights in real time
- '3D' flight planning to capture additional photos of free faces (stretch goal)

3D model processing (web)

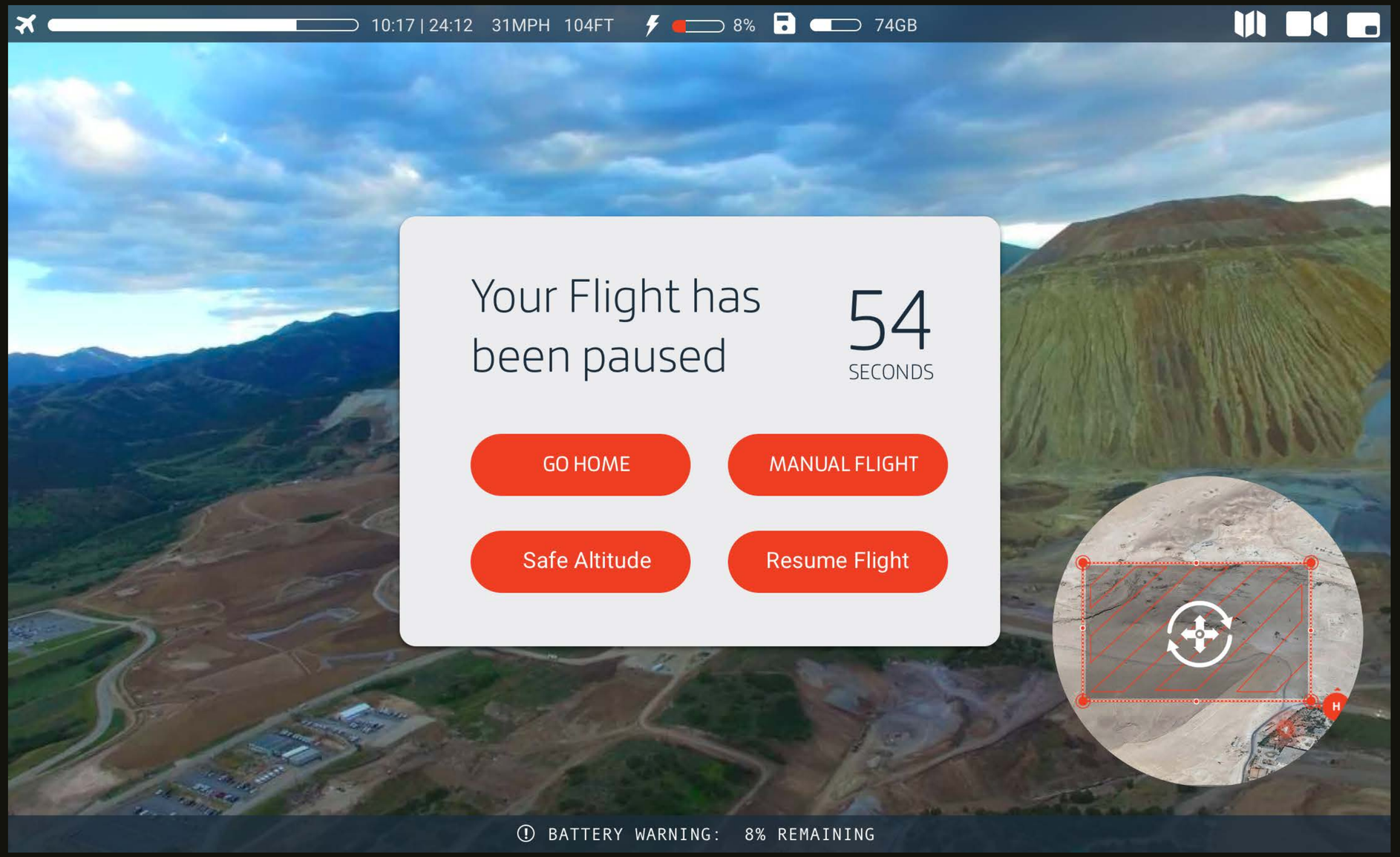
- Upload photos drone flight images for processing
- Cloud based photogrammetry processing to generate 3D models
- Model preview to see results prior to blast planning
- Integration with Athos to transfer 3D model to blast plan
- Incorporate ground control points for improved accuracy (stretch goal)

Path forward for 2018

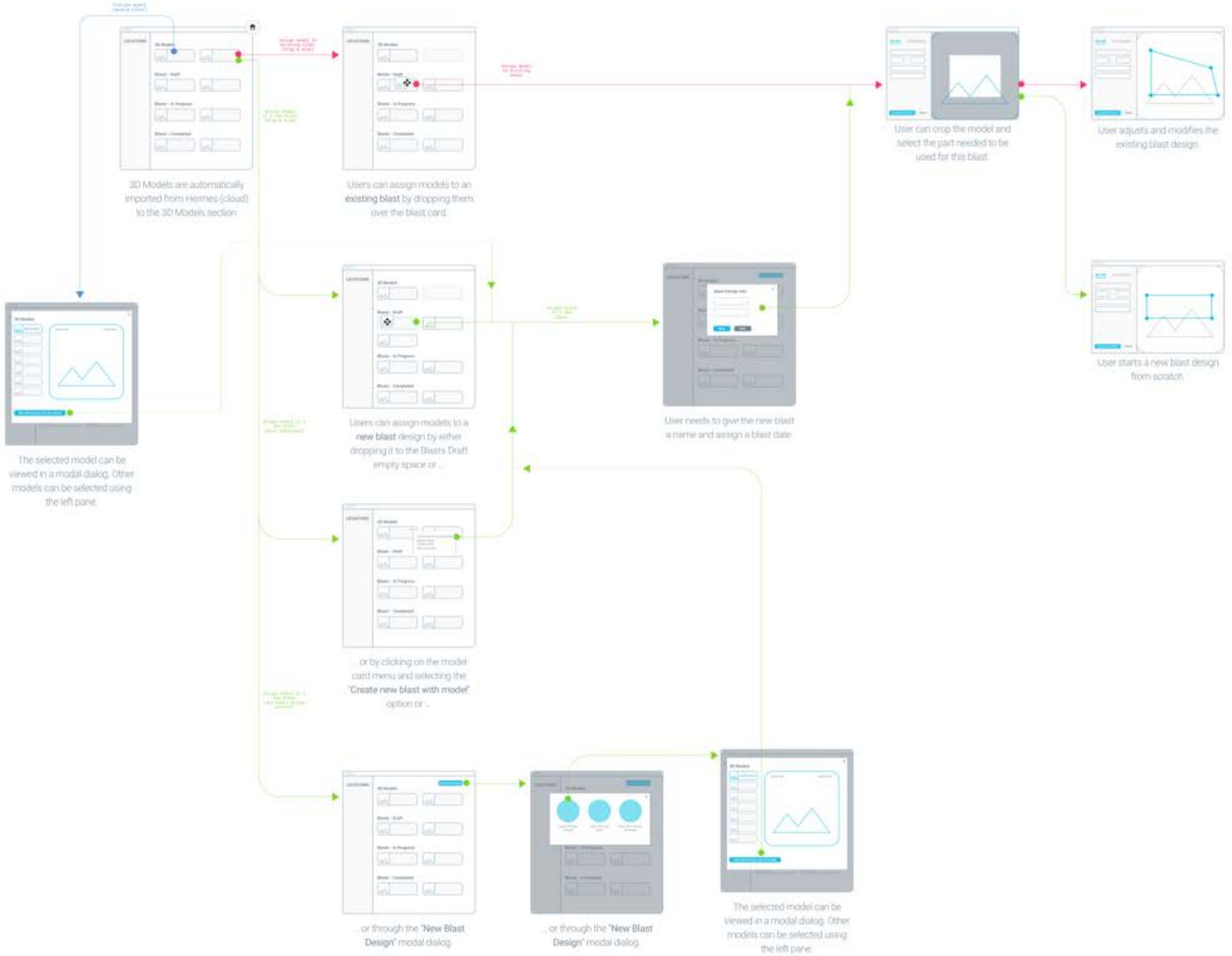
In the coming weeks, the team is currently focused on:

1) Finalizing MVP functionality, workflows, and screens for the first release early this year
2) Ramping up the development effort by bringing on an additional iOS developer and identifying a drone flight/photogrammetry SME
3) Conducting end user research to inform our product roadmap and help guide MVP development and roll out decisions
4) Identifying the first set of target user personas to focus on for MVP release
5) Developing a roll out/onboarding strategy to help these users get up to speed with the product

January 2018: Flight planning & 3D model previewer

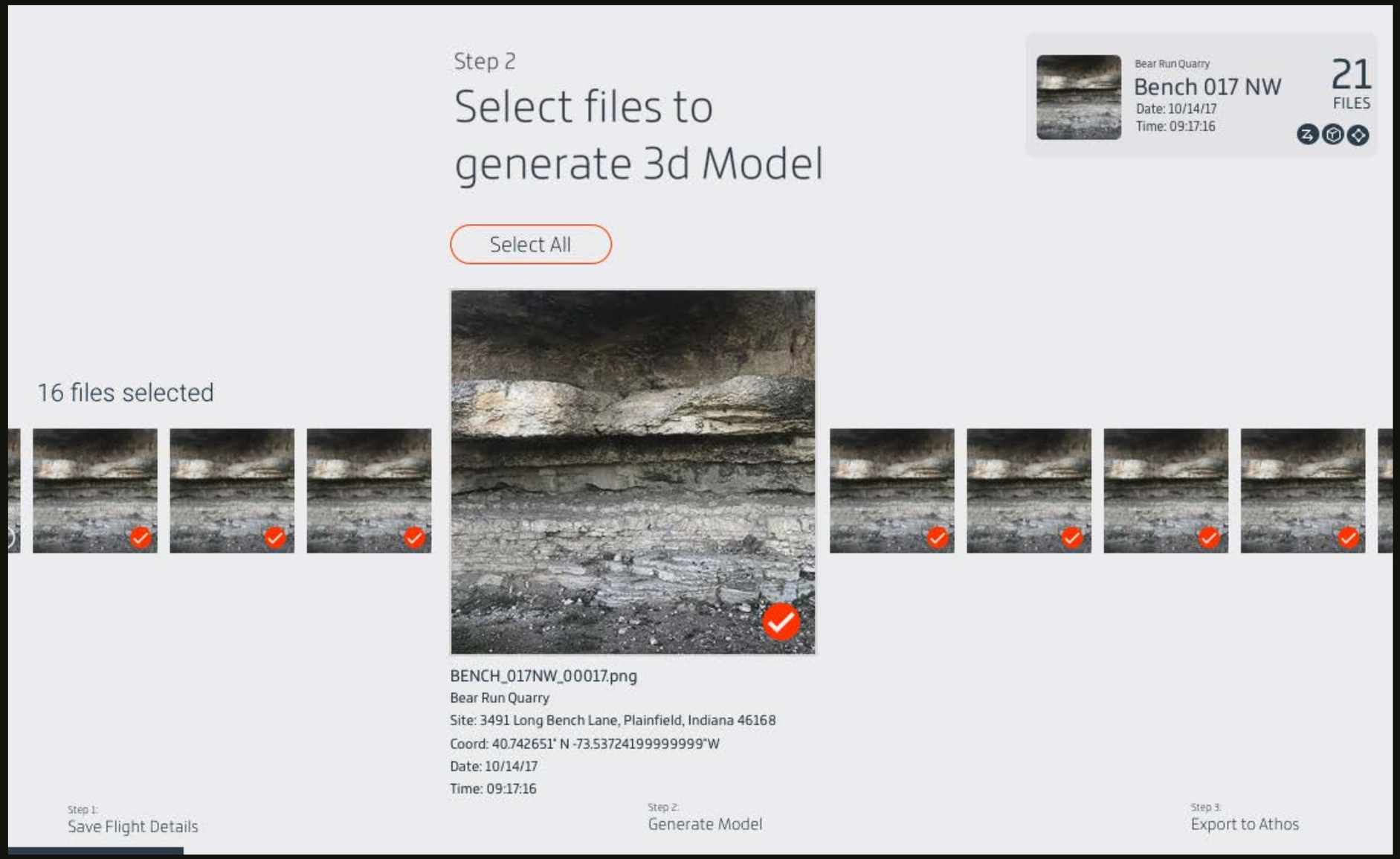


February 2018: Athos + Hermes 3D Mesh Integration



Click here to access the InVision Prototype

February - March 2018: Flight planning & 3D model previewer



New Opportunities

Product opportunities

Streamline Communication

Different users leverage similar information, but in different ways, resulting in handwritten notes and work arounds

Improve the flow of information to simplify tasks, prevent miscommunication, and reduce wasted time

Lower Technology Barrier

A small subset of individuals with specialized knowledge perform key tasks for blast operations (face profiling and bore tracking) across the region

Simplify field processes to enable more generalized team members to take on more tasks

Expand Capabilities

Expert engineers are spread across large geographic areas resulting in large amounts of time on the road

Provide the ability for Dyno Consult experts to scan and plan blasts from off site to allow them serve more clients

Alfred Nobel

Nobel Labs | San Francisco, California

Product Development Overview 11/14/17

PROGRESS

DISCOVERY

In Progress - Usability Testing of MVP 2 (Oct build)

DESIGN & DEVELOPMENT

In Progress - Athos - Application QA & bug bashes
In Progress - Athos - Workflow documentation for Dev Team
In Progress - Athos FasBlast parity, Dec. 15th deadline
In Progress - Athos - fragmentation calculation
In Progress - Athos - fragmentation regression PSS
In Progress - Athos - timing PSS
In Progress - Athos - UI refinements
In Progress - Athos + Hermes UX workflow
Complete - Hermes - flight tests & discovery
In Progress - Hermes - Initial PoC with emerging tech (zed camera)
In Progress - Hermes two app prototypes for tech stack evaluation

OTHER

Complete - Onboarding new team members
In Progress - Commercialization team alignment

PRIORITIES

- Athos - Co-locating with symphony in Sarajevo this week to push for Dec. milestone.
- Initial site visit and research on location in Maryland
- Product strategy alignment with new findings with entire team
- Hermes - Define product architecture based on vision/roadmap
- Hermes - Identify team skill needs and staff accordingly
- Continued refinement and design on Athos and Hermes UI
- Design impact assessment to UIs from branding work stream
- Product ecosystem naming/branding

KEY DECISIONS

1). Can the team plan on potentially spend time in Europe in the week or two prior to the holidays to help accelerate development?
2). To what extent should we pursue new/emerging technologies as longer term solutions vs. focusing on the near term goals?
3). Do we have access to provious “beta testing” subjects for a second round of testing with Athos MVP 2 (aka MVP+, Hera, Oct. build)?

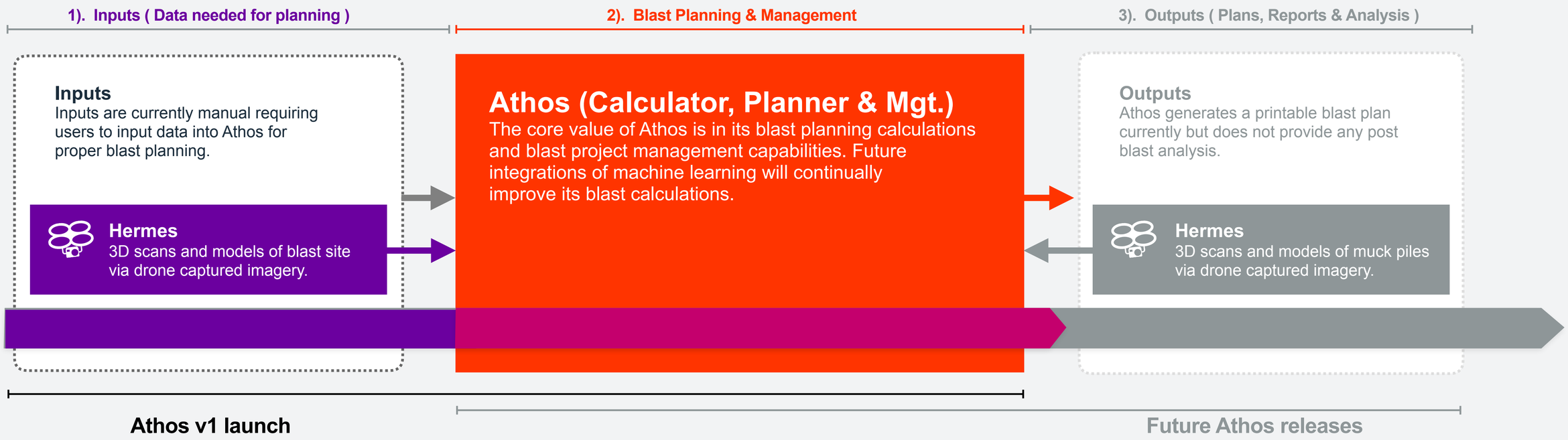
BLOCKERS

- **Access to SMEs for product design, development & testing**

Hermes near term focus

Hermes is an end to end solution for rapidly scanning blast sites and generating accurate 3D models for use in pre and post blasting scenarios via aerial drones. Hermes impacts data capture within Athos on both the inputs and outputs with the application. The near term focus for the Hermes work stream will be on the data “inputs” to Athos - capturing scan and importing 3D data into Athos for surface blast planning. Future releases will go beyond this initial push.

Near term focus for Athos v1 - integrated drone flight planning, flight control, and 3D model capture via photogrammetry within Athos using the Hermes software module/plug-in. This allows us to build base capabilities of drone control and imaging that we can further build on as base technologies for more advanced drone uses. Post Athos v1 launch and with more advanced imaging options, the Hermes software could become a stand alone product within the Nobel Labs product ecosystem.



Existing drone scanning work flow

This is the drone workflow used by Blast Engineers with Dyno Consult currently in the field. They are flying DJI Phantom 4 Pros and DJI Inspires at present via Dronedeploy.

TOTAL TIME:

2 - 6 hours

(depending on connection speeds)

1. Plan a Flight

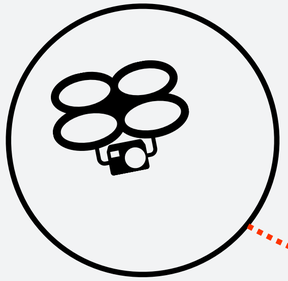
Select area to scan in app or on desktop using a map interface, then plan the flight and save.

2. Place GCPs

Drive to the site and place four ground control points around the scan area. Then take accurate RTK GPS surveys of each ground control point and record for later.

3. Preflight

Unpack the drone and controller. Place the drone on level ground for takeoff. Dock a mobile device with the controller and launch DJI Go plus surveying app.



4. Fly Drone

Locate your flight plan in the survey app and launch the drone on that mission. The drone flies autonomously and returns home once the mission is complete.

5. Post Flight

Pack up the drone and controller, removing the SD card from the drone. Drive and pick up all of the ground control points placed in Step 2.

6. Upload Images

Back at the office, copy images off of the SD card from the drone to a PC and then upload them to the cloud for photogrammetry.

7. Render Model

Once all of the images are uploaded and validated, they can begin the photogrammetry process to turn images into 3D models.

8. Download & Import Model

Once the 3D model has processed, it can be downloaded from the cloud and imported into a CAD program.

9. Blast Planning

With sections from CAD to determine the burden on the front wall, other software is used for blast planning.

Hermes **drone** work flow

The Hermes work stream will attempt to eliminate barriers to entry, optimize existing photogrammetry processes, and eliminate user experience pain points. By controlling the drones directly from Athos, we are able to streamline the entire photogrammetry process for users. The team is constraining on optimizing image uploads times and eliminating the need for ground control points (GCPs) if possible.

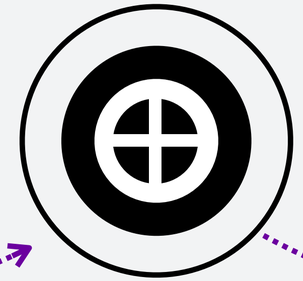
TOTAL TIME:

1 - 3 hours

(depending on connection speeds)

1. Plan a Flight

Select area to scan in app or on desktop using a map interface, then plan the flight and save.

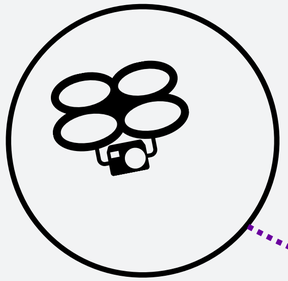


2. Place GCPs

Drive to the site and place 1 to 4 ground control points around the scan area. Then take accurate RTK GPS surveys of each ground control point and record for later.

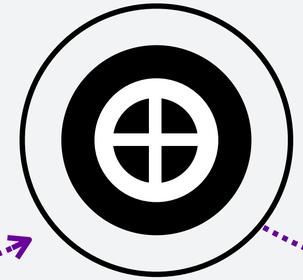
3. Preflight

Unpack the drone and controller. Place the drone on level ground for takeoff. Dock a mobile device with the controller and launch DJI Go plus the Athos app.



4. Fly Drone

Locate your flight plan in the Athos app and launch the drone on that mission. The drone flies autonomously and returns home once the mission is complete.



5. Post Flight

Pack up the drone and controller, removing the SD card from the drone. Drive and pick up all of the ground control points placed in Step 2.

6. Import into Athos

Back at the office, copy images off of the SD card from the drone to a PC and then upload them to Athos for photogrammetry processing of images, model rendering, and blast planning on the models.

Ideal Hermes drone work flow

The Hermes work stream will attempt to eliminate barriers to entry, optimize existing photogrammetry processes, and eliminate user experience pain points. By controlling the drones directly from Athos, we are able to streamline the entire photogrammetry process for users. The team is constraining on optimizing image uploads times and eliminating the need for ground control points (GCPs) if possible.

TOTAL TIME:

1 - 2 hours

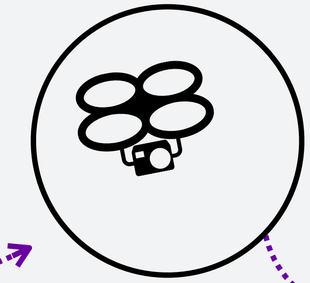
(depending on connection speeds)

1. Plan a Flight

Drive to site for scanning. Select area to scan in app, then plan the flight and save.

2. Preflight

Unpack the drone and controller. Place the drone on level ground for takeoff. Dock a mobile device with the controller and launch DJI Go plus the Athos app.



3. Fly Drone

Locate your flight plan in the Athos app and launch the drone on that mission. The drone flies autonomously and returns home once the mission is complete.

4. Post Flight

Pack up the drone and controller after the drone wirelessly transmits its images to the mobile device/controller where images are optimized.

5. Import into Athos

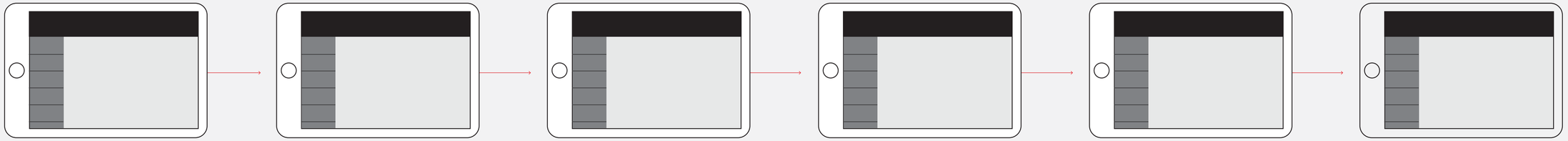
Once near a PC, the mobile device sends the optimized images to a local version of Athos on the PC for photogrammetry processing and model rendering. Blast planning on the 3D model uses cloud based processing within Athos instead of local processing used for photogrammetry.

Hermes **drone** work flow in screens

From these Hermes workflows, the “hero” use case would go across these types of screens.

H

Launch app



H1 — Flight plan selection

- Create a new flight plan
- Select a plan to fly
- Clone/duplicate a flight plan
- Add/edit blast plan assoication to a flight plan

H2 — Flight planning

- Review a plan details before flight
- Select an area to fly
- Draw out the area to scan
- Adjust scan/flight perimeters
- Save/export flight plan for mobile use
- Cancel / Go back to Athos home screen

H3 — Pre-flight check

- Review pre-flight checklist
- Launch drone for autonmous flight
- Check local flight restrictions?
- Check local weather?

H4 — Inflight control

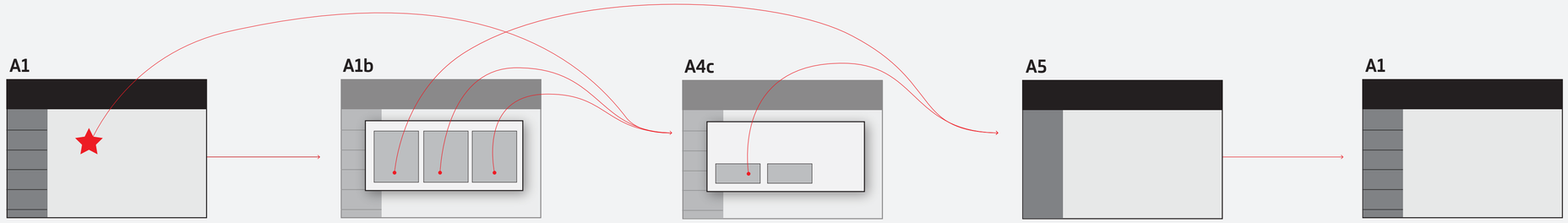
- Live view from drone’s camera
- Progress of scan according to the plan
- Return the drone to take off point
- Convert to manual flight mode
- Abort / “Freeze” / Safe space button
- Turn on/off various DJI functionality?

H4 — Post flight summary / data transfer

- Flight summary
- Image verification before uploading/processing
- Data tranfer / uploading
- Model processing on device
- Generated model transfer / upload

H1 — Flight plan selection

- Create a new flight plan
- Select a plan to fly
- Clone/duplicate a flight plan
- Add/edit blast plan assoication to a flight plan



A1 — Athos home (blast list)

- View blast per location
- Create a new location
- Create a new blast
- Create/Import 3D models

A1b — Athos home w/ “Start Blast design” modal

- Select a starting point for blast planning
  - Import a 3D model
  - Import images from drone
  - Start with a basic design
- Go back to Athos home screen

A4c — File Browser / Import options

- Import / Attach model to a blast
- Go back to Athos blast details screen

A5 — Blast planning

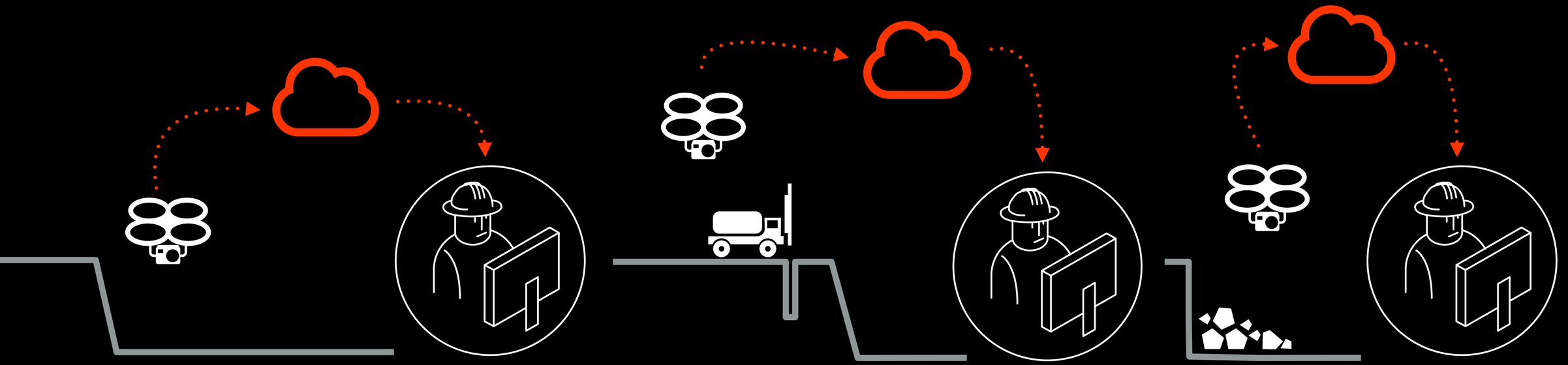
- Create / edit blast designs
- Turn visability on/off for various functions
- Generate blast plans
- Generate drill & blast reports

A1 — Athos home (blast list)

- View blast per location
- Create a new location
- Create a new blast
- Create/Import 3D models

Hermes overview

At the center of Athos is blast planning; however, it doesn't comprehensively address user's pain point to generate the most possible value. By streamlining the data inputs to Athos via drone generated 3D modeling, Athos instantly becomes MUCH more valuable to end customers by allowing fast analysis for blasting.



1. Survey

Inexpensive drones capture wall and bench as images on several quick flight paths. Images are uploaded by the Blast Engineer to Athos. Athos sends images to the cloud for processing.

2. Blast planning

Athos receives a 3D model from the cloud based on drone's image capture. The 3D model is used for blast planning.

3. Drilling, Loading & Blasting

Based on the blast plan, the shot is drilled and loaded as normal. Drones fly again to validate drilling is to plan.

Future opportunities include having Athos integrated with ESR, inventory management systems and smart drills to ensure the plan is executed as precisely as possible. Vibration data can also be captured during blasting.

4. Post blast survey

In future phases of work with input from the Artemis work stream, the initial drone image survey capabilities are expanded for post blast surveys of the muck pile. These surveys generate new 3D models for post blast analysis. Machine learning crunches numerous blasts to continually improve Athos' planning algorithms. The more blasts it is fed, the smarter it gets over time.

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