Field Report (1 of 2)

FIT Deployment In Support of SR 530 Washington State Mudslide & Flooding Disaster (WA-4168-DR)

Tamara Palmer, FIT Communication Strategist

Looking at the collapsed hill terrace and mudslide from WA State Road 530, and what was formerly the Steel Haven Community.

Background

The purpose of this Field Report is to identify Lessons Learned during the Field Innovation Team's (FIT) deployment in support of the Washington State Mudslide and Flooding Disaster. FIT's mission is, "Delivering real-time innovation in disasters." FIT activated a small contingent to support first-responders and help find innovative solutions to meet their needs. The first Field Report details the background of the event, FIT's mission in support of the response, and what was learned. The lessons learned and recommendations are for everyone.

Event Synopsis

On March 22, a large mudslide occurred in Snohomish County (pop. 745,913) near the town of Oso (unincorporated, pop. 180). The area had received heavy rainfall during the days leading up to the mudslide. As of the authorship of this document, there have been 37 confirmed fatalities, 7 missing/unaccounted for and presumed dead. 43 homes affected; 36 destroyed and 7 damaged (source: FEMA Daily Operations Brief, Tuesday, April 16, 2014).

FIT activated 7 personnel – 4 virtually and 3 physically, down-range. FIT members received information about the event from various social media alerts starting the evening of Saturday, March 22. As the severity of the mudslide became evident, FIT engaged. The team began working together on March 25. Based on information collected from Incident Command, FIT prioritized two projects, with the second as an extension of the first project:

1. Gather photographic images to be processed with Autodesk Recap Photo Pro photogrammetry software to will build a quick a 3D model of the mudslide and surrounding area topography. Demonstrate state of the soil to help guide search efforts and provide geologists with a tool to track and notify first responders of changing soil conditions.
1. An extension of the first mission, gather high-resolution imagery by flying Unmanned Aerial Systems (UASs) above the mudslide and surrounding area. Additional photographic imagery and existing LIDAR and laser scan point cloud data would be needed to complete the project. The plans to use the existing Lidar and laser scan point cloud data are in an effort to provide those on scene with the ability to view and measure from the data using only a web browser, utilizing Autodesk Recap technology. This would allow those on-site or remote to view the entire scene in accurate 3D data. It would also allow one to measure important areas of interest. Previously collected Lidar or laser scan data could have be compared with current date to help determine the locations of buried houses and structures.

These two disaster-specific projects and FIT's operational plan, frame the interview questions and answers.

Synopsis of FIT

The Field Innovation Team (FIT) is a disaster-response organization that redefines disaster response by delivering innovative solutions. We connect with communities "boots on the ground." FIT brings together leaders from robotics, community justice, designers, technology and beyond for impact orientated collaboration. Using innovation processes and methodology, we work with Incident Management and the affected community to understand their needs. Then we quickly get to work finding innovative solutions to help. Solutions are developed real-time during the response and recovery and are shared with the first responders and community. FIT open sources all solutions and lessons learned by sharing it on our website. FIT has deployed in support of Hurricane Sandy, the Moore, OK tornadoes, the Boston Marathon bombing, Philippines typhoon Haiyan, and the mudslide in Oso, WA.

Scope

The qualitative research collected in support of this AAR will explore 5 project objectives. FIT's efforts in a disaster are frequently project-based, therefore building best practices for FIT's projects will lead to successful future endeavors. The 5 project objectives are:

Objective 1: START-UP TIME AND TOTAL PROJECT TIME
Assess if one factor of FIT's mission success is based on the timeliness of project conception and start. Explore the average amount of volunteer hours and calendar days used towards achieving project completion, to establish workload expectations for Volunteers.

Objective 2: INTEGRATION
Describe how well FIT integrated with local officials and the affected populace. Did the depth of integration impact project completion?

Objective 3: COMMUNICATION
Identify common communication practices used by the team. Analyze if common practices support FIT's communication plan. Obtain recommendations on how to improve team communication and use of Microsoft Share Point. Explore FIT member's use of social media.

Objective 4: TRANSPARENCY
Gauge FIT's transparency by evaluating the accurate capturing and recording of processes and results.

Objective 5: INNOVATIVE SOLUTIONS
Determine if FIT will benefit by having a Guide to help identity and measure innovation in the field.

Based on these 5 project objectives, the researcher developed 20 interview questions. Phone interviews with 5 FIT members were conducted within 1 week of the end of FIT's response phase of the deployment. The interview questions are designed to capture qualitative experiences of FIT members who deployed physically and virtually. Questions seek to support research questions while allowing interviewees to express a narrative. The narrative is used to help tell the story of the deployment and provide insight to how the team used the operational plan.

Discussion

Objective 1: START-UP TIME AND TOTAL PROJECT TIME

When the mudslide occurred, the Field Innovation Team was wrapping up their final day of Boot Camp Training in Heber City, UT. One volunteer, Frank, learned about the mudslide the evening it happened via social media. Another individual, Stacy, received an alert on his phone that there was an earthquake, and upon further investigation, he discovered the event was actually the mudslide of Oso, WA. Stacy, not yet a FIT volunteer, posted on Facebook that he would be traveling to Oso to assist. Frank, a colleague, saw the post and asked to join. Both of these individuals live in the greater-Seattle area, approximately an hour away from the disaster.

Meanwhile, Frank contacted Desi regarding the severity of the event and asked if FIT would deploy to support. Desi assessed the situation and made the decision to deploy a very small contingent of personnel. She consulted FIT staff members Tamara and Rich, to brainstorm a set of micro-projects that FIT might be able to perform to aid the first-responders, and determine how FIT could assist Frank and Stacy who would be down-range. Next, Desi enlisted the help of FIT member Shaan, who would provide virtual support and expertise. FIT member, Robin, initiated contact with Desi offering her support. Robin was already aware of the event. She received a NY Times text alert and by Monday, was already blogging about the possibility of utilizing robots to help first-responders and emergency managers.

The deployed team – both virtual and physical – began working together on Tuesday morning, March 25; three days after the mudslide decimated the town below. Response operations continued until Sunday. Stacy Noland signed the Volunteer Agreement and began assisting the disaster response as an emissary from FIT.

FIT volunteers worked varying hours and number of days. Virtual volunteers helped with reach-back in conjunction with their full-time jobs. Over the course of 6 days, virtual volunteers donated 11 to 14 hours of their time. Volunteers physically deployed donated 8 to 12 hours a day for 6 days. One volunteer spent time assisting virtually at first, and then flew to Washington State, and calculates more than 83 hours of her time contributed in support of the disaster.

Lessons Learned for Objective 1

- All FIT members need to subscribe to a social media alert service. This will help FIT members be prepared to receive a FIT Warning Order, which asks for their participation in a FIT deployment.

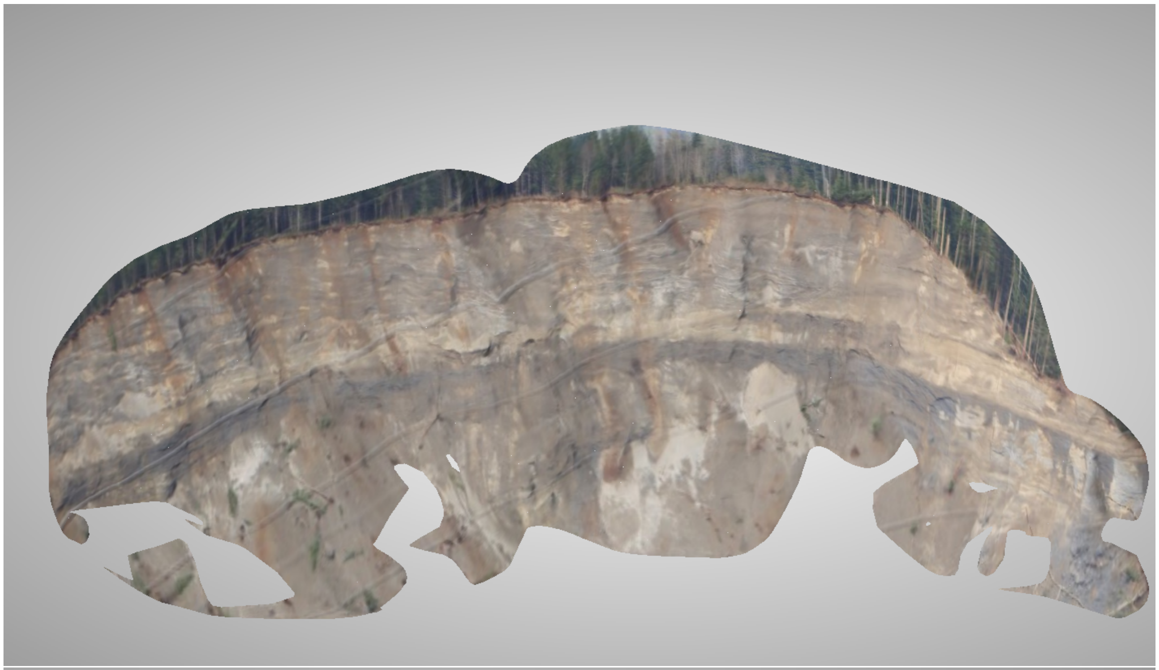
- 3-days post-event, FIT assembled. Based on the nascence of the group, this start-up time is viewed as a success. Future deployments should utilize this a metric.
- Volunteers who deploy to the site of the disaster should anticipate full workdays, and maintain a realistic sense of what they can accomplish during the deployment.
- Volunteers who work a full-time job and deploy physically should anticipate that the disaster would naturally draw their full attention for the time they are down-range.

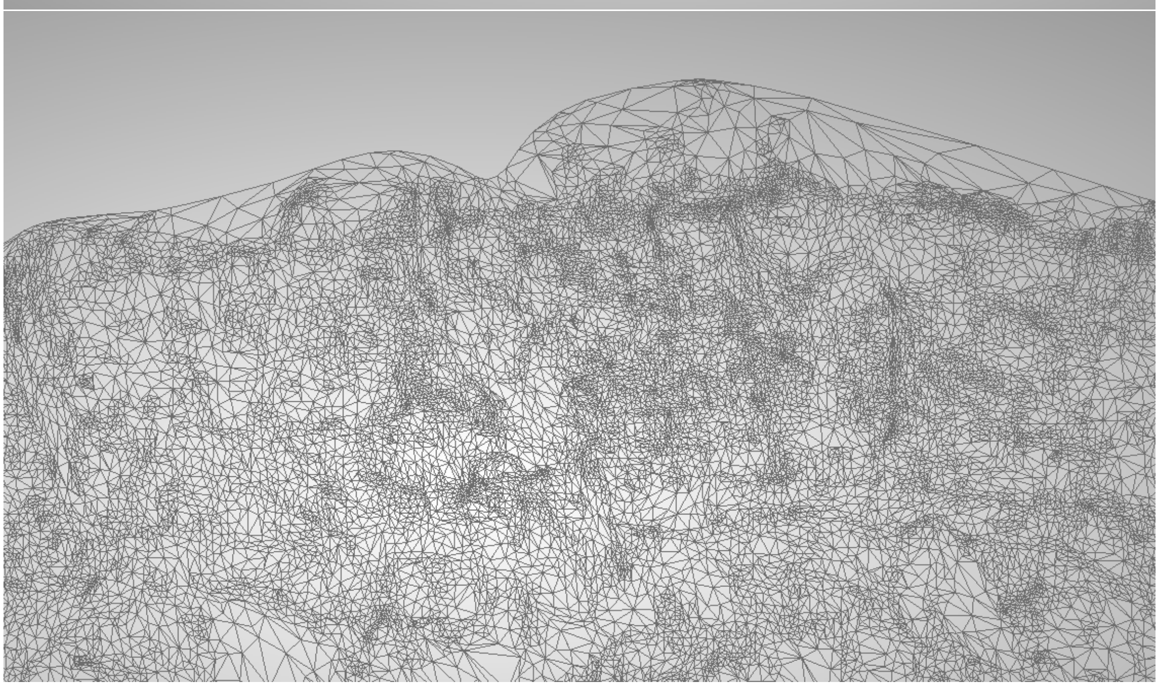
Objective 2: INTEGRATION

FIT staff and Frank and Stacy worked to establish connections that granted Frank and Stacy access to the disaster site. On the virtual side, FIT contacted the FEMA Region 10, Regional Administrator regarding FIT's presence at the site. This connection failed to produce adequate support for FIT.

Frank and Stacy traveled towards the disaster site. Their first connections were made in with Emergency Management in Arlington. Arlington officials directed them to the Oso Fire Department where they met Chief Mason, the Incident Commander. Frank and Stacy explained who they were, the mission of FIT, and that they were there to help the first responders perform their search and rescue mission with the potential of a 3D modeling system. Chief Mason connected the two to the Air National Guard and a local guide who escorted Frank and Stacy through the debris field, where they collected photographic images of the mudslide. Shaan then processed the images with Autodesk photogrammetry software to build the 3D model of the site. The photogrammetry software - Autodesk Recap Photo Pro - was to gather quick 3D models of the disaster scene to see how it changed through time. It would be up to a geologist to determine potential future slides. Unfortunately, the photographic images were not adequate and therefore a proper model could not be fully developed. Autodesk did create a test model with some of the imagery.

Here is an image of the slide:





Frank and Stacy also received situational awareness from FEMA Task Force (TF) 1, who provided maps, statistics, and other information. The two made many other connections with first-responders and affected families. They entered the site seeking out the people who were in charge, asked intelligent questions, and explained their mission of help. They developed credibility and trust by following through on the leads that were provided to them by Incident Command (IC). When given explicit instructions to follow, such as, calling and checking in with IC at the top of every hour while in the field, they followed the instructions completely. Essentially, FIT did what FIT said it would do. It did not take long for IC and the survivors to appreciate the genuineness of FIT.

These integrated relationships greatly assisted Robin. She arrived on the scene, Friday, March 28. Robin arrived representing Roboticists Without Borders and to support the first responders. Robin's project focus – obtain better imagery of the mudslide topography with LIDAR attached to Unmanned Aerial Systems (UASs), and process the imagery with Autodesk Recap Photo Pro photogrammetry software. UASs can capture high-resolution imagery and video from lower altitudes than manned vehicles. In addition, the quadrotor vehicle can gather images of debris and trees from angles not accessible with manned vehicles. The photogrammetry offers quick data acquisition, but USGS and others had Lidar and laser scanning which provided far more detailed 3D point cloud data.   However use of this technology takes more time and is expensive when compared to what most emergency management personnel have and use, such as standard digital cameras or a cameras on their phones. Also cameras are more portable and could be lifted by a UAV or many UAVs already have cameras unlike Lidar or a laser scanner which are too large to lift currently The images collected from a UAS flight have the potential to assist the recovery mission. The 3D model developed from that data could indicate changes in soil topography, and could predict unsafe terrain, as well as determine the best locations to unearth buried structures.

Obtaining permission to fly UASs is a lengthy process that requires extensive coordination and permission from the FAA, Operations, and the Air Branch. Roboticists Without Borders and FIT correctly followed all procedures. The flight was one signature away from final approval, but was denied by officials who expressed concerns over privacy issues.

Lessons Learned for Objective 2

- Identify and contact Incident Command as soon as possible. The Incident Commander, Engineering Branch, Air Operations, Liaison Officer, and Public Information Officer are primary contacts to be discovered as soon as possible.
- FIT needs to construct capabilities briefs that rapidly demonstrates how FIT can use innovation to support disaster relief (recommend categorizing the brief according to Emergency Support Functions (ESF)).
- FIT needs to incorporate visual displays and explain innovative capabilities in layman's terms. Incident Commanders are extremely busy and often overwhelmed. Therefore, they don't have the time or the bandwidth to hear lengthy explanations about highly technical or foreign concepts.
- FIT volunteers need Incident Command Structure Training.
- Emergency COAs (see Resources section for more information) need to be prepared and packaged for rapid use if UAS robots can be flown to support first-responders and survivors.

Objective 3: COMMUNICATION

Communication was conducted through conference calls, text messaging, occasional GroupMe messaging, and email. FIT's collaboration platform – MS Share Point was used minimally. FIT volunteers were not able to access Share Point during the beginning of the deployment because their user accounts had not been created. Share Point was adopted as the collaboration platform only a few days before the mudslide. No one has been trained on how to use it, nor have expectations of use been established.

The lack of a collaborative platform led to inconsistent team communication. Some volunteers expressed frustration at the "flurry" of activity coming from different communication mediums. Not all FIT members had each other's contact information. Volunteers receiving text messages from unknown phone numbers led to some confusion regarding the source, which slowed response time on the issue. FIT members did not upload names and contact numbers of emergency response officials on Share Point. There was also no procedure or pre-established location for uploading the digital photos taken of the mudslide. A Drop Box account was established and shared for this purpose, but a procedure for handing large data transfers is also needed.

FIT did successfully implement the daily stand-up brief, and end-of-day de-brief communication procedure. Additionally, all daily activity was summarized into a report and shared with deployed members via email. FIT does appreciate that there was not enough time to establish many of these procedures and socialize them with the team before the disaster happened. Valuable lessons learned will be addressed.

Lessons Learned for Objective 3

- Provide training and set expectations for use of MS Share Point.
- Socialize the use of MS Share Point during times of lull, so that FIT members are not expected to learn a new system during disaster response.
- Develop a complete internal communication plan, including a final decision on how to use additional tools (for example, use SMS text, GroupMe, something else?).

Objective 4: TRANSPARENCY

Transparency, or the capturing and recording of work, real-time in the disaster, are largely dependent upon the ability of people to use MS Share Point. MS Share Point is designed to house the team's tasks, efforts, important documents, and other information relevant to a disaster. The discussion from Objective 3 illustrates that MS Share Point was not frequently used by FIT. However, Desi did provide a daily summary of the team's activities, a very helpful exercise, which has established a record of the deployment. Additionally, the element of FIT that was not deployed was given a report in the early phase of the engagement. This report briefs on the event and details the efforts undertaken by the deployed part of the team. The team was given more information about response efforts a week later during the FIT monthly conference call.

FIT members employ many methods for capturing and recording data. While FIT does not endorse one method over another, the end-state of transparency should be that data, reports, contact information, etc are documented and shared on MS Share Point, or in the case of solutions, established as Open Source. All FIT personnel in every disaster must satisfy these metrics. The practice of conducting interviews and writing After Action Reports is one example of successfully meeting a transparency measurement.

Lessons Learned for Objective 4

- Provide guidance on how to capture and record individual efforts, which is important for transparency among the team.
- Encourage the daily upload of information to MS Share Point.
- Establish transparency metrics.

Objective 5: INNOVATIVE SOLUTIONS

Due to time constraints, FIT has not established how to measure project or mission success through the lens of using innovation to assist and find solutions. Each FIT Task Force Unit is responsible for constructing its own metrics and FIT continues to explore the definition of success within our mission space. All interviewed personnel agree that mission of FIT was satisfied. All agree that FIT performed admirably in its support of first-responders and the survivors. Solutions recommended were innovative and not considered by incident commanders until FIT presented them with the ideas. All agree that the projects demonstrated success, especially given the restraints and difficulties that exist outside the control of FIT.

Additionally, all concur that some form of an Innovation Guide needs to be in place for use by FIT. The Innovation Guide will help FIT explain available innovation, and demonstrate similar use-cases of innovations that can be applied to the current disaster. Eventually, the Guide may be able to help measure innovation. Innovation articulated as a practice is to be shared with the Whole Community.

Lessons Learned for Objective 5

- Develop Innovation Guide. Allow for the Guide to change and be reflective of FIT's capabilities learned over-time.
- Expand the contents of FIT's current Field Guide to explain FIT's capabilities and/or existing innovations that could benefit Incident Command and the survivors they serve.

Recommendations

Recommendations specific to this deployment:

- FIT Research Project: Have FIT member research "Approach of Engagement." Research the ICS practices used in all 50 states, how law determines application of innovation during a response in all 50 states, and compile a list of emergency management offices/titles (not people) that FIT should immediately contact during disaster response, in all 50 states. Develop this document for dissemination among the team.
- For Integration into Washington State's Incident Command Structure:
    - Innovation Officer – Develop this position based on the structure initiated by Desi during her time with FEMA (FEMA is adding Innovation Officers to Emergency Operations Centers). This individual will be an officer that supports the Incident Commander by helping advise on innovation and will liaise with innovation response and recovery organizations who support disaster relief. Responsibilities include maintaining situational awareness, keeping an open-mind, and staying abreast of the evolving situation, with the purpose of understanding how any recommended innovations could be applied to assist disaster response and relief efforts.
    - Community Liaison Officer – This individual will be responsible for communicating and connecting with community leaders in disaster-affected locations. Responsibilities include organizing Town-Hall type events where the needs of affected community members can be heard, recorded, shared with the Incident Commander, with subsequent actions/decisions/follow-up shared with the affected community. The Community Liaison Officer helps empower affected communities.
- Refine FIT's Operations Plan: Conducting Operations by Objectives to reinforce the survivor-centric nature of FIT's operations in support of a disaster. Clarify the organizational structure, including defined roles and responsibilities for FIT full-time staff and the volunteers. Layer communication processes and procedures within the refined Operations Plan.
- FIT needs training on the technology available for use by its partners.
- Roboticists Without Borders hosts webinar training for FIT to:
    - Transfer the lessons learned about the types of missions, the constraints on the UAS, and the constraints/opportunities for post-processing, such as with Autodesk.
    - Review the emergency COA process and the template for air space deconfliction with manned aircraft.

Resources

Emergency COA
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCcQFjAA&url=http%3A%2F%2Fairspacecoordination.org%2Fcoord%2Fem_coa_process.ppt&ei=n6xFU9CtG8zy2gWP44DoDg&usg=AFQjCNGPyiB0SW0xBKsm6WjjYEM02p_1Wg&sig2=DYFMNriTdsJuvBfeWSUIPg&bvm=bv.64507335,d.b2I

https://www.youtube.com/watch?v=V244qPNz_4k&feature=youtu.be&app=desktop

Field Report (2 of 2)

FIT Deployment In Support of SR 530 Washington State Mudslide & Flooding Disaster (WA-4168-DR)

Tamara Palmer, FIT Communication Strategist

Looking at the collapsed hill terrace and mudslide debris field from State Road 530.

Background

The purposes of this Field Report are to identify lessons learned and identify capability gaps that can be closed with the Field Innovation Team (FIT) and collaborator's proposed solutions. This report discusses FIT's deployment in support of the Washington State Mudslide and Flooding Disaster of 2014. FIT's mission is, "Delivering real-time innovation in disasters." FIT activated a small contingent of volunteers to support first-responders and help find innovative solutions to meet their needs.

This second Field Report discusses FIT's operational period from mid-April to late June of 2014. It discusses two projects completed by FIT and its collaborators. Project A focuses on the flight of an Unmanned Aerial System (UAS) over a section of the mudslide commonly called the "moonscape" and the use of two technologies, which occurred after the flight for post-processing: Computer generated 3D reconstructions and 3D printing of a portion of the moonscape. The capability gaps and proposed solutions for each technology are organized and examined in 3 Phases. Project A's discussion concludes with commentary on operational considerations and parameters.

Project B focuses on a social media fraud-tracking app designed to help the community maintain a record of who raised funds in the name of Oso. Project B's discussion concludes with recommendations for how to catalog tracking information and the app's spectrum of utility. For more information on the event, the complete background on FIT's mission to support the response, and the operational period covering March 22 to mid-April, please read Field Report_SR530 Mudslide_Oso_WA_1of2.

Overall Mission Description

FIT member Frank Sanborn traveled to the Arlington Incident Command Post to discuss response and recovery needs and offer assistance for technology shortfalls. Incident Management expressed the need for enhanced situational awareness of the mudslide terrain, which was still partially inaccessible due unstable soil, debris piles, and flooding from the Stillaguamish River. When the 800 ft. high terrace collapsed, it damned the River causing flooding on the north and south forks of the river, and deposited ossified mud across the valley more than a mile wide, and in several places, more than 20 feet deep. The assistance of FIT and its collaborators was requested by Incident Command to empower them with the tools they needed to achieve their mission objectives.

FIT and its collaborators have identified and are working on 2 projects that support the needs of Incident Command. Project A directly involves the technical and material assistance of the Center for Robot-Assisted Search and Rescue, Roboticists Without Borders Program, PrecisionHawk's PrecisionMapper software, and Autodesk. Project B directly involves the technical expertise and proprietary data of Splunk4Good. It is these projects that are discussed.

Project A: Obtain Enhanced Situational Awareness of Mudslide Terrain

Phase 1 – Unmanned Aerial Systems (UAS) Flights

Capability Gap

Recovery and reconstruction of the valley and dammed river was slow due to the difficult terrain. Some of the ground was passable by foot. The first responders had formed foot traffic pathways with packed pieces of debris (trees, branches, and rocks) in places where the river water had been drained. Aerial imagery of the valley was possible with manned helicopter flights and LIDAR data provided by the U.S. Geological Survey (USGS). However, these options did not offer a complete solution to problem. Manned helicopter flights are expensive. Operating costs vary and can be anywhere between $300 to $1,000 dollars per hour. Helicopters must also maintain a higher altitude because flying below 150 feet can endanger the machine, the pilot and passengers, and people below. USGS LIDAR data is valuable, but during the Oso response and recovery, the time between data collection and transfer to incident management was approximately 2 to 4 days, impacting operations because they lacked up-to-date imagery information. In any case, the site was not safe. Additional situational awareness was needed and the safety of first responders and engineers was the primary concern.

Sheriff's Department canvassing over the Oso mudslide site with their helicopter.

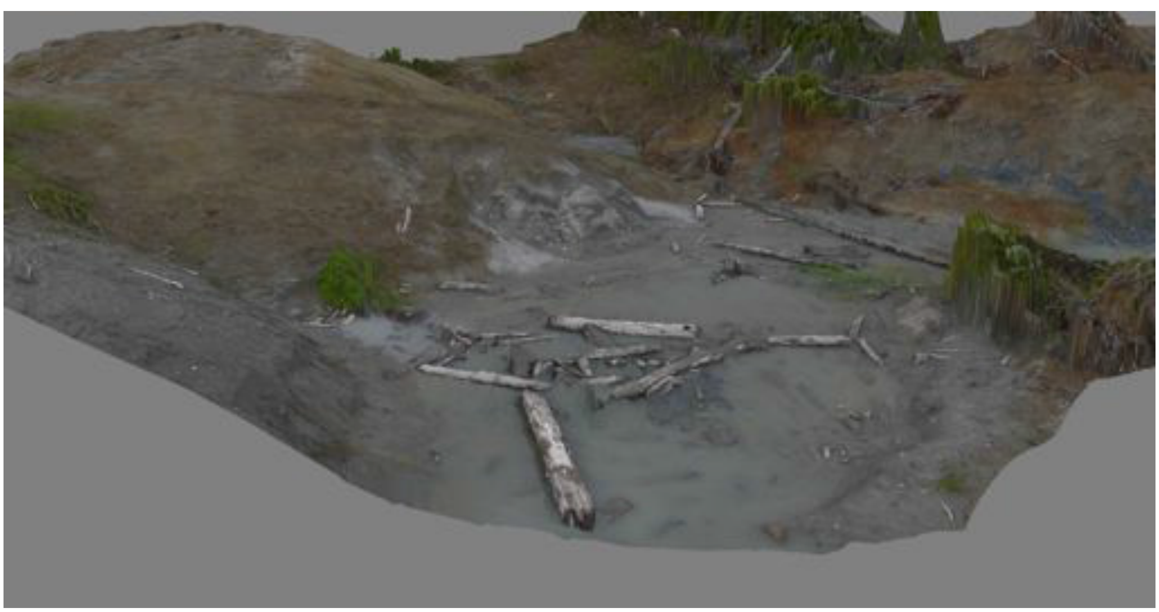
Description of the Proposed Solution

A solution was proposed to help alleviate the lack of situational awareness. FIT worked with Incident Management to invite the Center for Robot-Assisted Search and Rescue through the Roboticists Without Borders program at the Texas A&M Engineering Experiment Station Center back to Oso to perform UAS flights. Previously, FIT arranged the invitation for UAS teams from Roboticists Without Borders (RWB) PrecisionHawk, and Insitu to perform UAS flights at Oso. The flights were to take place during the period of March 28 to 30, but due to inaccurate perceptions about the purpose of the mission and data collection process, the Incident Commander at the time would not allow the flights to take place. The UAS teams demobilized.

RWB and PrecisionHawk returned to Oso on April 22, 2014. FIT member Tamara Palmer also arrived to assist and support the mission. RWB brought their portable UAS platform the CRASAR AirRobot AR 100B rotorcraft. PrecisionHawk brought their UAS platform, the Lancaster, a portable fixed wing device. FIT members Frank Sanborn and Tamara Palmer captured video and photographs of the mission.

The AirRobot AR 100B UAS flew at the direction of the Incident Management team under an emergency COA from the Federal Aviation Administration. 40 acres of the mudslide “moonscape” was captured with 7 flights during 48 minutes of flight time with a Canon digital camera fixed to the AirRobot UAS. The visual data was then shared with the PrecisionHawk team who began processing it with their software. The first computer generated interactive 3D reconstruction was available in only 30 minutes using PrecisionHawk’s PrecisionMapper software, running on a laptop. The model was produced using 22 photos collected during the initial flights. A higher resolution reconstruction was completed in 3 hours later that day, with additional images collected from more flights. The PrecisionHawk Lancaster platform did not fly because no emergency COA was granted for it. Had it been able to fly, additional geo-spatial sensing would have been available, enhancing the post-processing outcome of the interactive 3D reconstruction.

The image below shows the 3D interactive reconstruction that was generated to enhance situational awareness of a portion of the mudslide.



PrecisionHawk’s PrecisionMapper software generated this 3D scan of a portion of the mudslide.

Mission The Proposed Solution Will Accomplish

At the end of the day, the team returned to the Incident Command Post. All photo and video data was transferred to the engineers, including access to the interactive 3D scan. The engineer's response to the delivered product was highly positive. They found value in the interactive 3D reconstruction, and were impressed by the rapid start to finish execution provided by the UAS flights and post-processing capabilities. They intended to use the 3D reconstruction to make decisions on where to place excavating equipment. Several days later, a copy of the same data was delivered directly to the Washington State Hydrologist Engineer at the Washington State Department of Transportation, who immediately recognized other ways to use this type of technology to support their hydrology projects.

FIT, RWB, and PrecisionHawk demonstrate to the engineers the interactive 3D computer generated scan.

Additional AirRobot AR 100B flights were scheduled to take place the following day on April 23, 2014, but windy conditions grounded the mission. FIT member Frank Sanborn traversed the area and took several hundred photos of the mudslide with a high powered digital camera, collecting as many different angles as possible. More imagery was needed to inform more comprehensive 3D reconstructive scans, which will be discussed in the next section.

Phase 2 – Generate Comprehensive 3D Reconstructions

Frank Sanborn transferred the additional photographic images he collected on April 23, 2014 to Tyler Collins from PrecisionHawk. While Tyler worked to process the new photos through PrecisionMapper software, a second 3D model was being generated by FIT's collaborator, Autodesk, in San Francisco, CA. Autodesk is a technology company specializing in 3D design, engineering, and entertainment software and services.

Capability Gap

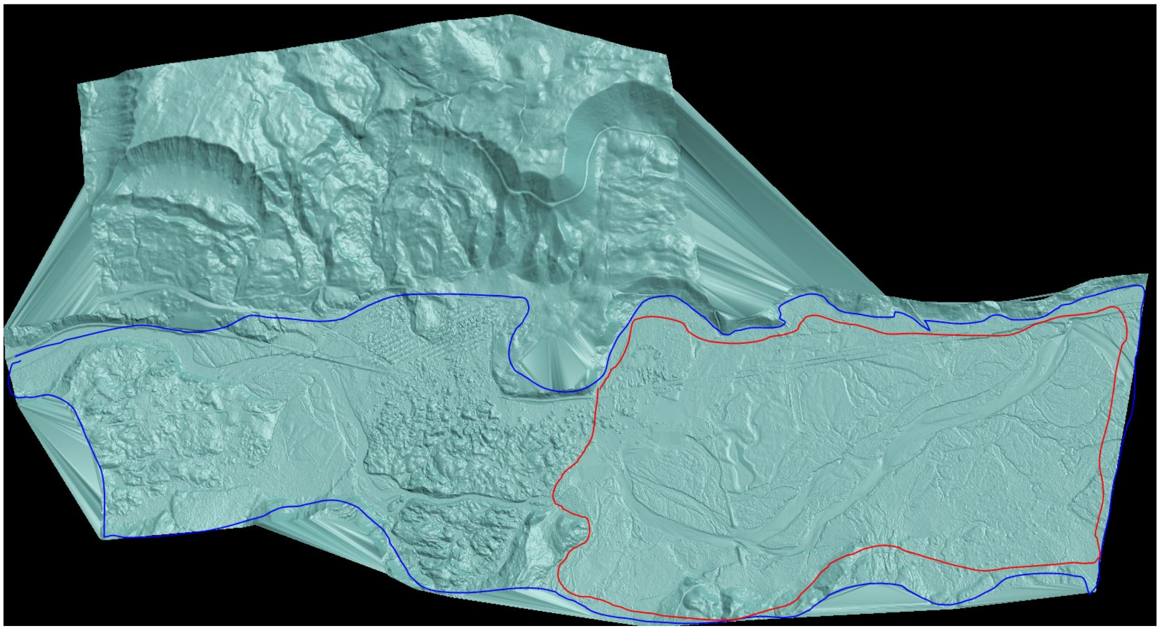
The first 3D computer reconstruction that was produced did not include geotagging for geospatial reference. Also, the first reconstruction was of a lower 5cm per pixel resolution because of the type of video and photo imagery collected with the AirRobot AR 100B. The utility of the AR 100B has been proven in this situation, but the camera fixed to the device is not capable of obtaining high-resolution photogrammetry. Essentially, the imagery collected with the AR 100B and the PrecisionMapper software was not capable of producing the workflow for the 3D print requested by the engineers. Had PrecisionHawk's Lancaster fixed wing device been granted permission to fly, 3cm per pixel resolution, geotagging, and a more detailed 3D reconstruction would have been available to the engineers, and may have provided the geo-spatial data necessary for post-processing a 3D print. The difference between 5cm and 3cm per pixel resolution may not seem like a big deal, but think of it this way. The 5cm pixel resolution will show you a rock on the ground. The 3cm pixel resolution will show you the colors and textures of the rock and ground surrounding it.

Description of the Proposed Solution

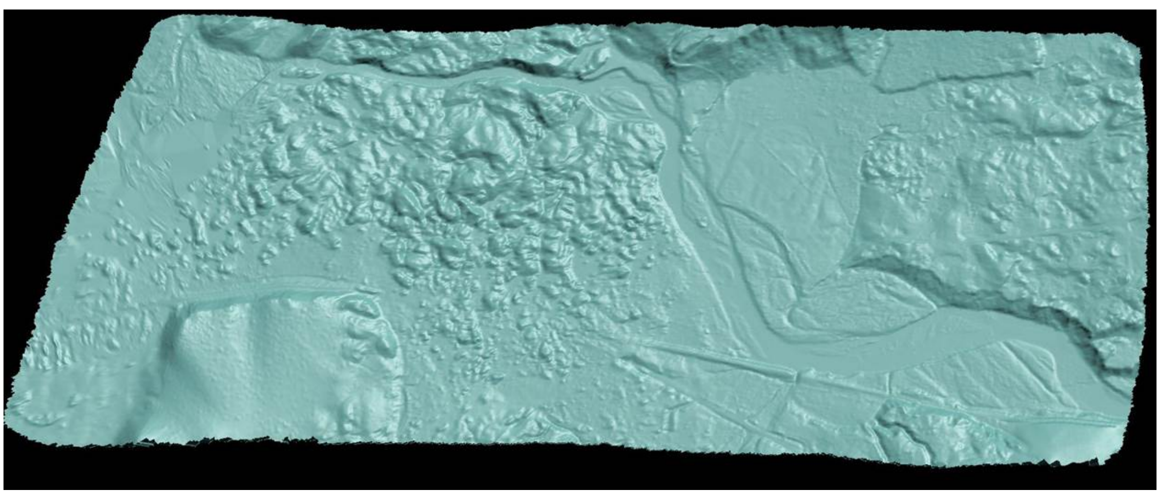
Build a comprehensive and detailed 3D reconstructive model of the surveyed portion of the mudslide. This experiment was performed through 2 separate systems. The first experiment was performed with UAS data processed through PrecisionHawk's PrecisionMapper software (the first iteration of this experiment was discussed in the previous section).

The second experiment was performed with LIDAR data processed through Autodesk's Recap reality capture, a cloud-point image-based 3D modeling software. The computer-generated scan data was converted into a 12 million triangles mesh model. This high level resolution displayed detailed topographic features of the surveyed area and established the workflow for 3D printing.

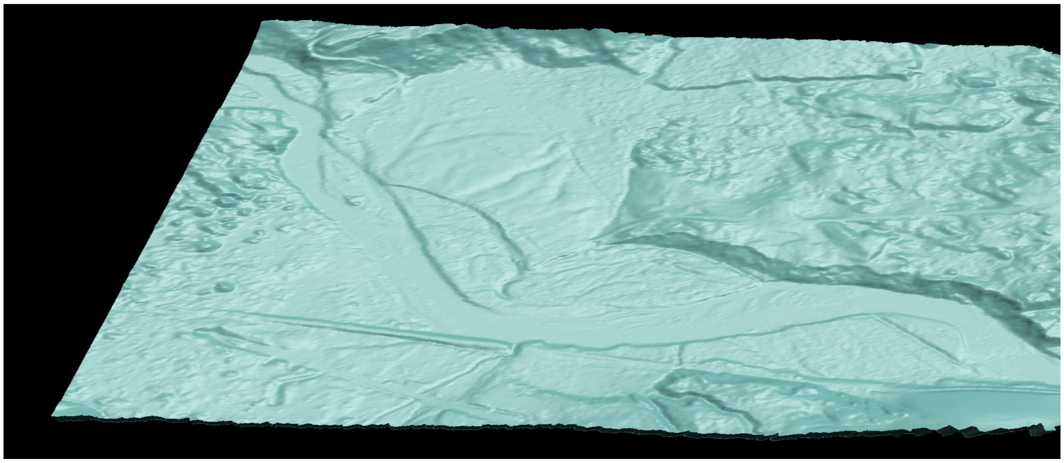
The image below displays the output of the Recap software. In the image you can see the remains of the hill terrace that broke away as well as the spread of the mudslide across the valley. The area marked by blue outline represents the left side, or western portion of the mudslide, while the red outline represents the right, or eastern portion of the mudslide.



Autodesk's Recap software generates a 3D reconstruction of the mudslide.



Above: A closer view of the left side of the mudslide. *Below:* A closer view of the right side.



Mission the Proposed Solution Will Accomplish

This solution has been developed to build color, interactive, 3D reconstructive models of the mudslide area to demonstrate the topography, better understand soil conditions, placement of debris piles, and for hydrologists to understand river flow and flood patterns of the Stillaguamish River, which dammed and flooded the valley as a result of the mudslide. 3D interactive reconstructions will have uses in other types of disasters and are currently used in the private sector for agriculture, mining, insurance estimates, infrastructure surveying and more.

The 3D reconstruction created with PrecisionMapper displayed the mudslide survey with multiple colors and showed fallen trees and other debris items. The reconstruction created with the LIDAR data is one solid color, but demonstrates a wider area with extrusions, bulges, dips, and cuts. The Autodesk software has the added bonus of establishing the workflow for 3D printing, which will be discussed in Phase 3. The utility of these tools and speed of production, as demonstrated by FIT and its collaborators, will empower first responders in the response phase of a disaster as well as engineers in charge of reconstruction during long-term disaster recovery.

Phase 3 – Produce 3D Printed Model of the 3D Reconstruction

The potential for FIT and its collaborators to produce a 3D printed model of the surveyed mudslide was mentioned early in discussions with the engineers handling the mudslide and river reconstruction. Engineers were keenly interested in obtaining the 3D print. 3D printing technology is fast becoming more available, more advanced, and less expensive. FIT has been closely monitoring the evolution of 3D printing and performed a field experiment with Scott Summit to pilot the 3D reconstructive scan with 3D printed product during the Joint Interagency Field Exploration (JIFX) event in August of 2013.

Capability Gap

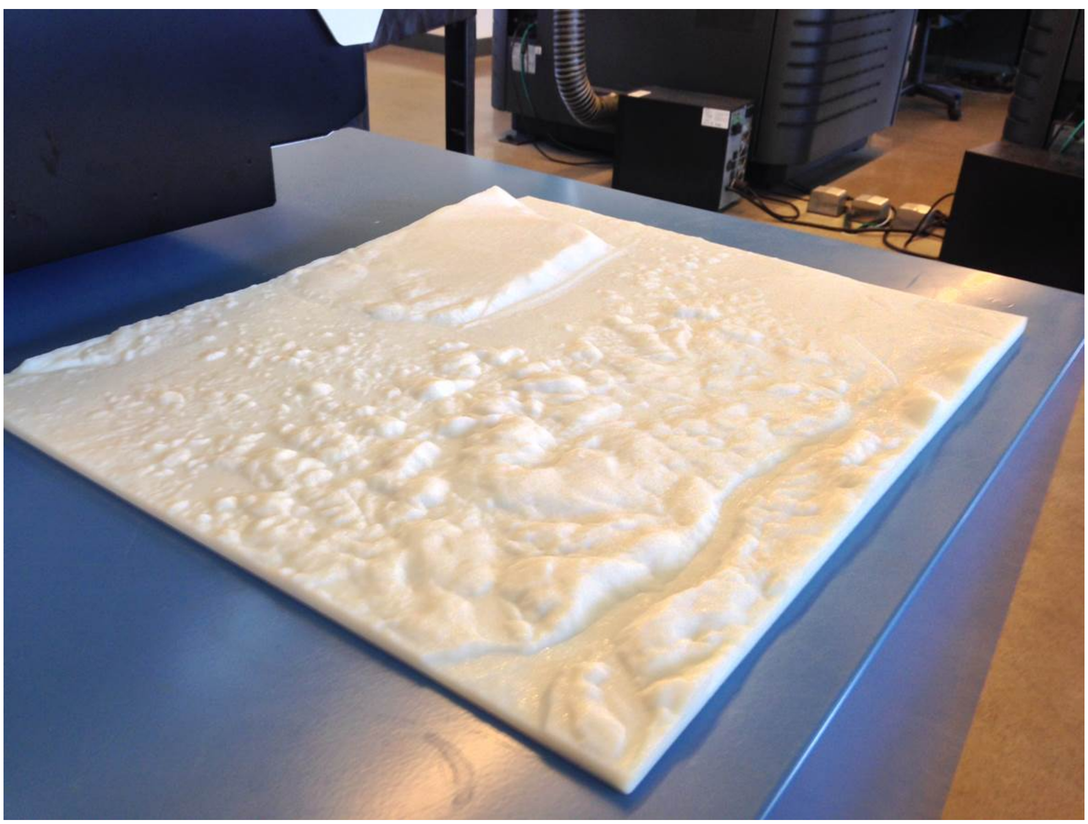
The Oso mudslide was more than a mile in length and width. The sheer scale of the damage, the unstable soil conditions, and the lack of roads available to access the site compounded the challenges faced by incident management. Enhanced situational awareness was needed. The safety of first responders and engineers could not be compromised for the sake of understanding the terrain and topography.

Description of the Proposed Solution

The First 3D Print

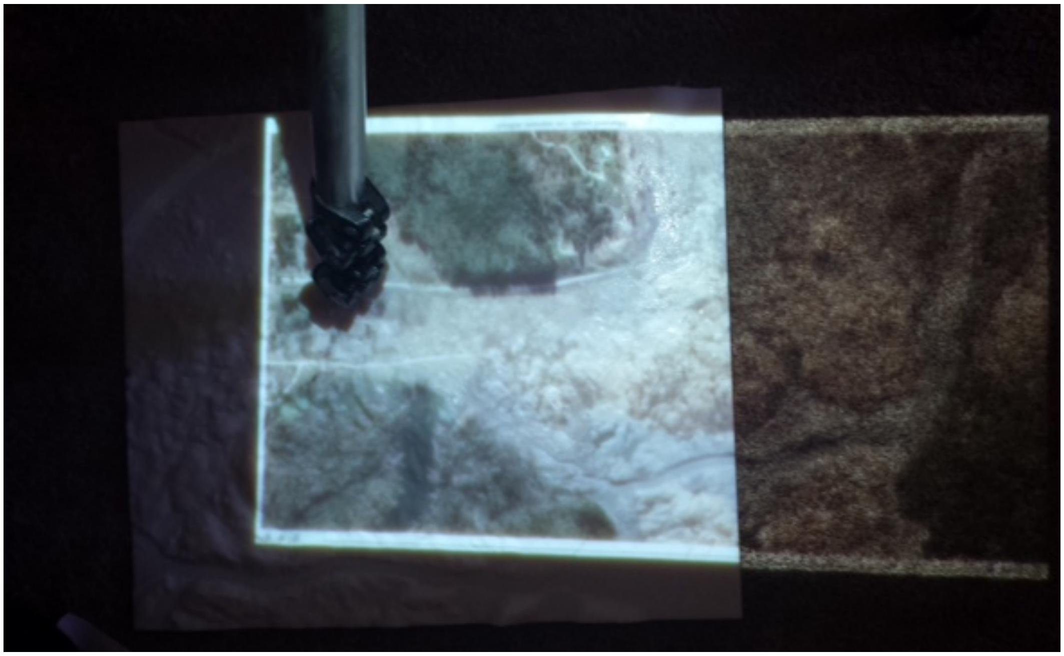
The workflow for the 3D print was established with Autodesk's Recap reality capture, a cloud-point image-based 3D modeling software. The model was printed with Autodesk's Objet 500 Connex 3D printer. The 3D design is entered into the machine and hot polymers are layered until the shape is complete. The model was to be printed in two sections. Only half of the total model (the left side) was printed because the Objet 500 Connex bed is 50x40cm or 20" inches, and the total model exceeds that size. Due to the experimental nature of this endeavor, it was decided that one side would be made available for the engineers to view before printing the other side. The print was completed on May 15, 2014. It was shipped to FIT member Frank Sanborn in Seattle who handed it over to Owen Carter, Deputy Director/County Engineer for Snohomish County Department of Public Works.

The model has been printed white, as shown in the image below.



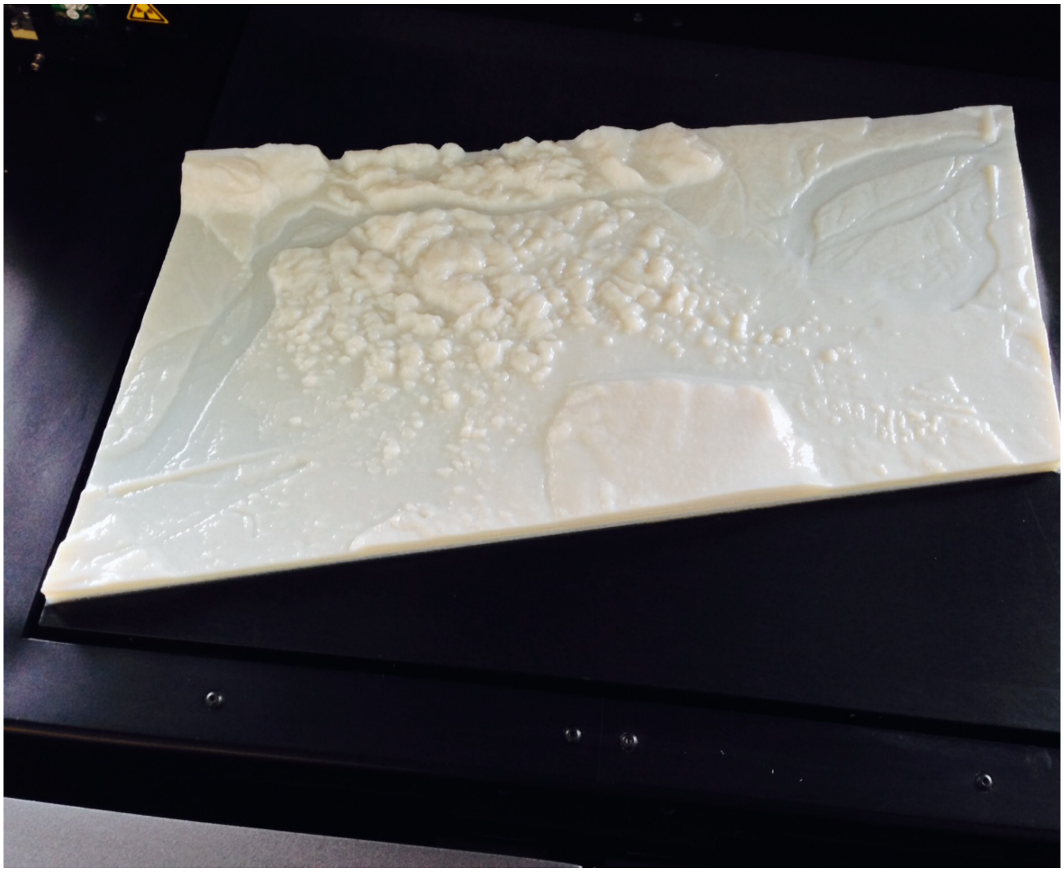
Close up view of the first 3D print's terrain features: Deposited mud and debris piles on the left; river on the right.

A serendipitous moment occurred at the end of the first printing experiment. FIT member Frank Sanborn discovered an elegant solution to compensate for the Vero white filament color of the 3D print. Frank suspended a portable Pico project above the 3D print and projected the color 3D computer reconstruction onto the printed model, as seen in the photo below. The combined mediums allowed viewers to discern the landscape traits of the printed mudslide model.


3D print and 3D computer reconstruction combined.

The Second 3D Print

After delivering the 3D printed model to Snohomish County Department of Public Works, the engineers identified an error with the 3D printed model. The model was inverted, or a mirror image of the terrain. This error was due to the wrong reading of the coordinates from the scan files in AutoCAD Civil 3D. The issue was corrected and a second 3D printed model of the mudslide was produced by Autodesk (see image below). The correct model was shipped to FIT member, Frank, who delivered it to August 1, 2014, to Steven Thomsen and Owen Carter. The correct model was well received. Engineers immediately began discussing placement of excavating equipment and how current terrain features may affect future flooding events.


The second 3D print – the corrected model.

Mission the Proposed Solution Will Accomplish

The interactive 3D reconstructive computer models demonstrate high value. Utilizing an interactive 3D computer model provides immediate discernment and familiarity of the affected area. Creating a 3D printed model provides another visual aid and planning tool. It can be taken to any location and does not require technical skills to use it. Engineers can use the model to demonstrate changes overtime, which is best accomplished with the projected 3D computer reconstruction overlay method. We recommend additional UAS flights or LIDAR data from same surveyed area, with post-processing of the data to demonstrate reconstruction alterations.

Engineers can use these tools to assist with operational decision-making. The combination of topographic map with the ability to change the images projected onto it will show change over time, help plan the reconstructive effort, and offers a comprehensive birds-eye view for accurate visual display that can be shared limitlessly, as determined by incident management in charge of long-term recovery. This powerful tool will benefit from further advances in additive manufacturing, which will improve the technology, lower prices, and become accessible to a wider audience.

Autodesk employee, Mitko Vidanovski volunteered more than 40 hours of his time on the project, and Autodesk donated the use of all software and materials.

Project A: Operational Considerations & Parameters

Operating Period – End Goal

FIT is working to operationalize this process to rapidly deploy this technology within a matter of hours for use in future disasters. In future disasters, FIT seeks to reduce the post-processing and production time. Ideally, the UAS flights would collect the required photogrammetric data in one day over 4 to 8 hours. Post-processing would be completed in 2 to 3 hours. 3D printing would be accomplished in 4 to 8 hours, depending on the size of the print and printing method used to accomplish the task.

Logistics & System Affordability

Autodesk's Objet 500 Connex 3D printer finished the 20-inch print of the Oso mudslide in 8 hours. This powerful machine is large, making transport to a disaster site nearly impossible. The machine and its materials are expensive, impacting the frequency of printing. In the case of the Oso mudslide print, the LIDAR data was transferred to Mitko of Autodesk via Dropbox. When Mitko finished the processing and 3D printing, he mailed it to Frank of FIT, who then hand delivered it to officials in Oso. It took approximately 2 weeks from print completion to hand-off, and coordination through email, rather than face-to-face slowed the process. Therefore FIT recommends that a 3D printing system be deployed to the incident. Being on site with the tools will significantly decrease the time needed to complete the project, getting the product into the hands of those who need it within hours.

An alternative printing solution is to deploy several MakerBots to an incident, and then, print smaller sections of a model, which would be joined together like puzzle pieces. MakerBots are smaller, making them easier to transport. Operating 2 to 4 MakerBots to print sections of a model at the same time could significantly reduce total printing time and get the finished product out faster. This solution has not yet been tested. For this method to be viable, the sections would need to be tested for correct scale. When the printed sections are joined, the small space between them could significantly impact the accuracy of the model. What may look like a cm of space between sections could be in reality, a gap of several hundred feet.

The logistics of this process are feasible. First, select the preferred type of MakerBot that will satisfy a wide range of operational requirements. Second, decide how many will be needed on average, per disaster. Third, determine transportation, maintenance, and materials costs. Fourth, resolve storage procedures and identify the person(s) responsible for tracking and storage of the system. This person should be experienced with the MakerBot system, otherwise additional training will be required. Knowledge of these factors will help inform the Operational Period – End Goal. Long-term costs of this system also need to be estimated. For additional information, please see FIT & Autodesk's SOP on 3D Computer Modeling and 3D Printing.

Project B: Social Media Fraud Tracking App

Immediately after the mudslide and flooding incident occurred on March 22, 2014, people were moved to raise monetary funds to help the victim's families and survivors. The response and the large number of volunteers who descended to the area overwhelmed the communities of Oso and Darrington. Local officials had no way to track or manage the fundraising. Many had concerns about fraud. Incident Management asked FIT for assistance.

Capability Gap

A system to track potential or active fraudulent fundraising activities is a current gap in disaster management. Tracking fraud is not the same as donations management. Multiple platforms and organizations exist to assist with donations management. Tracking fraud is a niche, but critical component of a successful disaster response and recovery for any community.

Description of the Proposed Solution

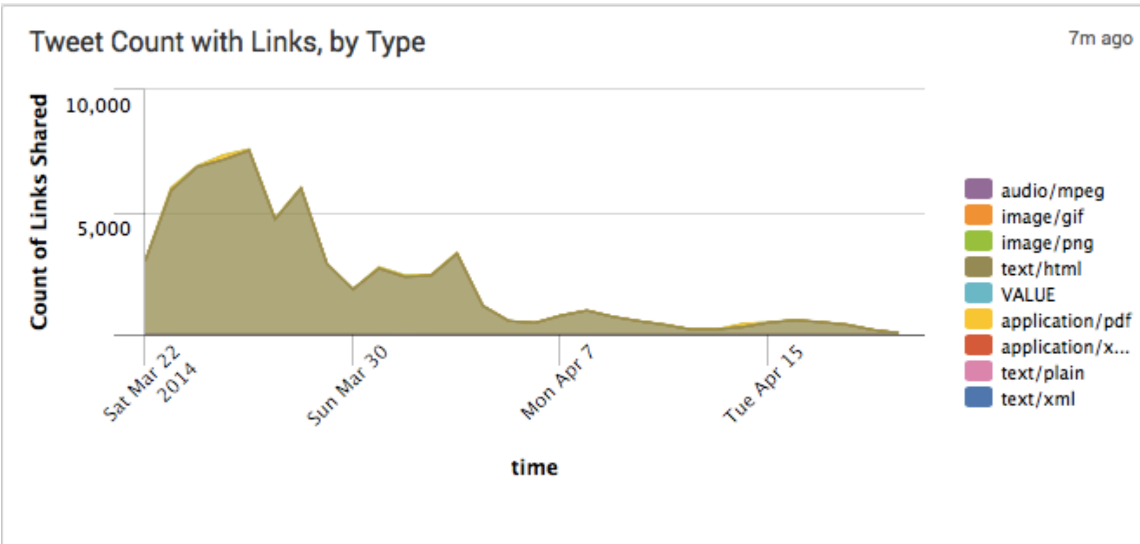
After Incident Management expressed a need to track potential fraudulent fundraising activities, FIT contacted Corey Marshall from Splunk's corporate and social responsibility program, Splunk4Good. FIT and Splunk4Good collaborated In a previous endeavor using Twitter feeds to track how fear changed as Hurricane Sandy approached; How many people asked for help over time and what the sentiment analysis showed; Critical Supplies over time and what the sentiment analysis showed, and; Rate of people evacuating the area over time.

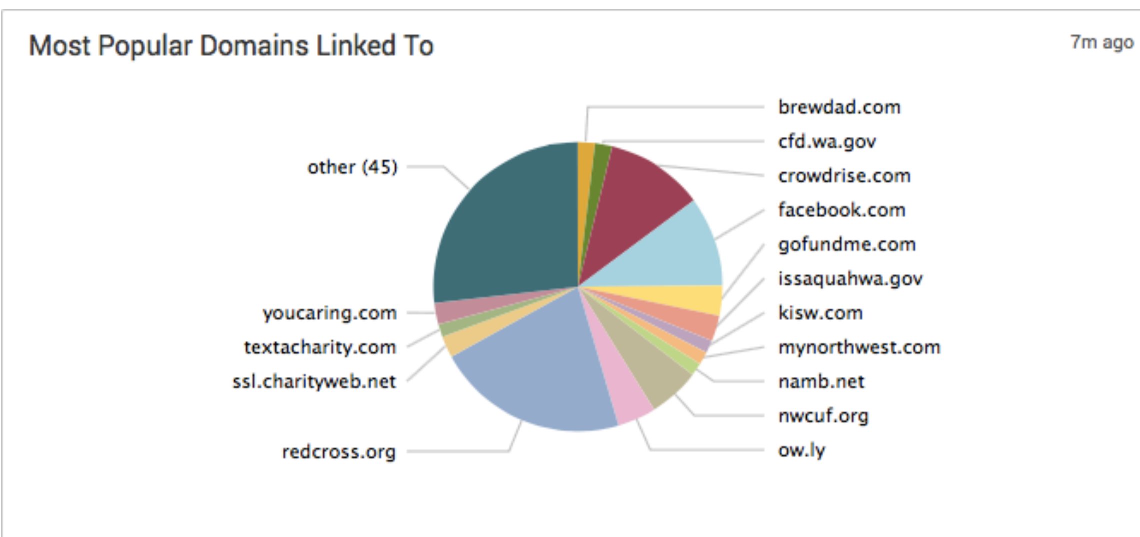
Desi Matel-Anderson, Tamara Palmer, and Frank Sanborn asked Splunk4Good if they could perform an in-depth, exhaustive data analysis of social media platforms to develop an internal-use only, easy interface system that identifies all groups, organizations, and people who are fundraising on behalf of the SR530 Mudslide Incident. The Oso Fire Station and Snohomish County used the system to track fundraising activities and identify potentially fraudulent activities connected with SR530 Mudslide fundraising. Selected personnel from Snohomish County used the information to follow-up with suspicious persons or organizations and inquire about the status of donations.

The team from Splunk volunteered their time and powerful data analysis tools to develop a report for Oso personnel. The dashboard is also intended for use in future disasters and for any community. Any disaster-stricken community can download the app and use the tool to gather information.

FIT provided a list of key words and comment text phrases relevant to the event to help filter the search. Examples of key words include, “Oso,” “mudslide,” “SR530.” Examples of comment text phrases include, "donate to Oso mudslide victims," "Oso relief fund," and "Oso strong."

The Oso dashboard report summarizes Twitter activity from March 22 to April 21. 67,430 tweets were analyzed. After eliminating retweets (RT), identifying tweets containing web sites, and normalizing web sites to eliminate duplication, Splunk identified 103 unique tweets that indicate fundraising activity. The methodology also captures activity on Facebook and other social media that have been broadcast via Twitter. The following images illustrate the user-friendly dashboard.





Access to the report is password protected. The report can be exported into a Comma Separated Value (CSV) report. This allows officials to build and maintain a tracking system to best suit their needs. FIT recommends the following categories be considered when building tracking spreadsheet after the report has been downloaded:

- Name of group or person making (or made in the past) donation request.
- Name of group or person hosting (or hosted in the past) a fundraising event.
- Contact email.
- Contact phone.
- Link to site where request is being advertised.
- ‘First Contact Made’ check box & name of official who made contact.
- ‘Second Contact Made’ check box & name of official who made contact.
- ‘Follow-Up’ box.
- ‘Flag for Fraud’ box.
- ‘Tracking Complete’ box.
- ‘Notes’ section.

Mission the Proposed Solution Will Accomplish

Oso officials can maintain tracking information, and maintain accountability of those working on the project. The information is kept safe and for internal use only with the secure log in. Additionally, Oso officials have a way catalog their efforts on the project. Officials and volunteers will have a tool to empower the community and alleviate the stresses of wondering about where the donations end up. This is important when communities are overwhelmed and dealing with the stages of grief. Empowerment occurs when officials and volunteers handle the reach-back and vetting of the people and organizations that are earmarked on the spreadsheet.

A second iteration of this solution was developed for the Volunteer Coordinator in charge of the Volunteer Response for the Pilger, Nebraska twin tornado disaster of June 2014. ITDRC created the tracking spreadsheet based on information provided by the app. Pilger volunteers used it and a script to conduct tracking activities. If you are interested in learning more about the app, please contact the Field Innovation Team or Corey Marshall from Splunk.

Conclusion

The goals of this Field Report are three-fold. First, FIT catalogs the response and recovery for this event to prevent loss of knowledge and make record of the important efforts of those involved. Second, this report seeks to illustrate existing response disparities and how FIT and collaborators worked to couple solutions to those who needed them. Finally, FIT entreats readers to use this information to inform and empower themselves and others. Please use the recommendations and plans laid out here, to improve your solutions and further advance innovative disaster response and recovery. Let’s Innovate!