Accessories for Trimble Geospatial,

Transforming the way surveyors work

Kaj Niegmann

Degree Project for Master of Fine Arts in Design
Main Field of Study Industrial Design

Lund University School of Industrial Design
Department of Design Sciences

Examiner: Claus-Christian Eckhardt
Supervisors: Jasjit Singh and Thomas Bennet

ISRN: LUT-DVIDE / EX--21 / 50518-SE

2018/2021

LUND
UNIVERSITY

CONTENTS

INTRODUCTION 4
Project summary 5
Trimble Geospatial 7
Methodology 8
Limitations 9

BACKGROUND 10
History 11
What is surveying? 11
Who are surveyors? 11
Environment 12
Instruments and equipment 14

RESEARCH 24
Reports, Interviews, Observation 25

ANALYSIS AND CONCLUSIONS 34
Insights 35
Opportunity 35

INTRODUCTION

4,8m
Trimble

Methodology

I used traditional approaches i.e. reading academic papers, journals, reports, and studies during my initial research phase. I supplemented my research by participating in forums specific to surveyors, conducting field studies, creating journey maps, following their daily lives on social media, and emailing directly with practicing surveyors. While these sources may not be helpful in a quantitative sense, they were crucial to tapping into the expertise of practicing surveyors regarding current work flows, equipment, and the challenges in their field. A qualitative approach revealed surveyor's skeptical perception of emerging technology and hardware.

To understand how various concepts might work, I created micro-experiences to test different input methods and feedback systems. The prototypes were simple exercises to test and provide proof that the sensors I was recommending would work for this application. Since I didn't have access to mixed reality glasses during the project, I created proof of concept experiences by coding up simple VR environments in A-Frame (Mozilla) and tested what an augmented reality interface might feel like. All of these tests allowed me to quickly validate ideas and choose a concept direction.

My goal for the project was to propose a solution that would address Trimble's initial brief and then to push it a bit further by designing for future scenarios.

BACKGROUND

I had zero knowledge or experience in surveying before starting this project and I imagine that you do too. In this section I will give a brief history of the origins of surveying, what surveying is on a high level, who surveyors are, and the environments that they work in to give the following information context.

to be transported to and from the work site. Not all work sites are accessible by vehicle which means the gear must be carried on foot. When measuring, the surveyor is walking from point to point and needs the stamina to maintain a solid pace. Since surveying deals with property demarcations, surveyors must work with precision to deliver accurate legally binding documents (https://collegegrad.com/careers/surveyors). There is not specific 'type' of person that defines a surveyor. They can be men or women, young or old. Many surveyors enjoy the outdoors, and for some it is a part of why they have chosen this career in the first place. Freedom of work and independence are highly valued. In some markets the work is quite adventurous; field reports have shown surveyors encountering polar bears while out in the field (Propeller Report).

Environment

Surveyors work in environments all across the world: from measuring glacial movement in Antarctica to laying out pipeline corridors in the Mojave desert. These are extreme environments where the instruments are expected to work flawlessly in order to collect accurate data. More banal surveys take place in city streets, construction sites, or out in the country side measuring property lines. The work environment is extremely diverse which means the equipment has to function well no matter what the conditions are.

http://arkeologerna.com/bloggar/gullberg-och-skansen-lejonet/dokumentation-med-laserskanner/

Instruments and Equipment

Surveyors use a variety of equipment when performing surveys. The tools depend on what type of deliverables their client has asked for, the location they are surveying in, and the weather conditions. Here is overview of the instruments and tools used during a general survey.

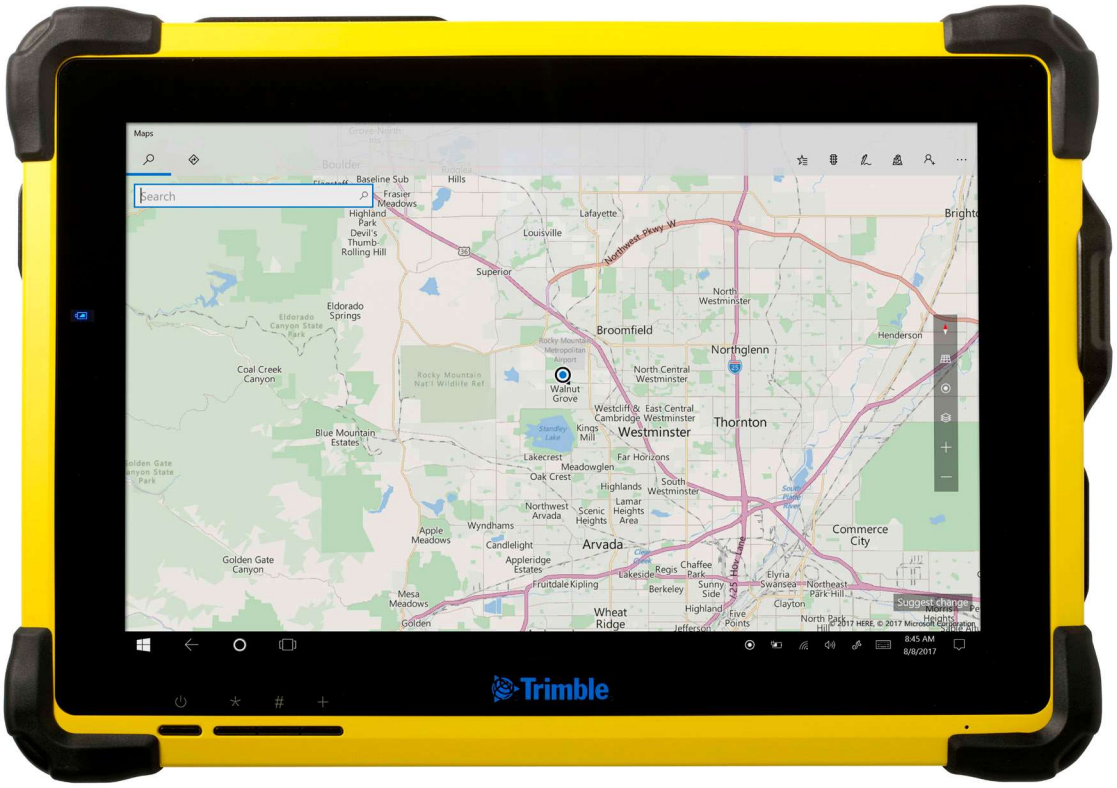
Total Stations

Trimble offers several different types of instruments that allow surveyors to conduct their jobs. In this thesis I only looked into how surveyors work with total stations and data controllers. A total station is an electronic/optical instrument that measures distances from the instrument to a particular point. Trimble has two types of robotic total stations across five models - the line up consists of the S5, S7, S9, S9HP, and the SX10.

The S series robotic total stations were first released in 2006 and have gained the trust as a top performer among surveyors worldwide. The S5, S7, S9, and S9HP have an optical eyepiece with cross hairs for viewing through the instrument. The S7, S9, and S9HP use a single camera to enable TrimbleVision which allows the surveyor to direct the survey through a live video feed on the controller. The instruments are controlled through an attached Trimble CU or data controller. There are physical controls on the S series total stations that are used to adjust where the optical site is aimed to sight-in survey markers and prisms.

The SX10 scanning total station was released in 2016 as a revolutionary new surveying instrument. It is the world's first scanning total station that truly merges high-speed 3D scanning, enhanced TrimbleVision imaging and high-accuracy total station measurements in a single instrument (Source Total station brochure). It scans at 25,600 points per second which is high compared to the S series but low when compared to dedicated laser scanners that scan 2 million or more points per second. The key difference is that the scans are already registered in a known coordinate system because its traditional total station capabilities allow it to measure its location from a back sight. The surveyor can review the data right away on the controller to see if something is missing. The instrument lacks an optical sight and is driven solely through Trimble Vision, a live video feed shown on a data controller. This is notable because the surveyor no longer interacts with the instrument after setting it up on a tripod. A fully digital system opens up opportunities for new work flows. Working with the SX10 was the focal point of my research as I moved forward.

Trimble Access
1:54
Tap here to log in
General Survey
Roads
Tunnels
Mines
Land Seismic
Sync
Settings
GNSS Forecast
Internet Setup
Files
Internet
OK
Fn
F1
F2
F3
Trimble


Maps
Search
Trimble

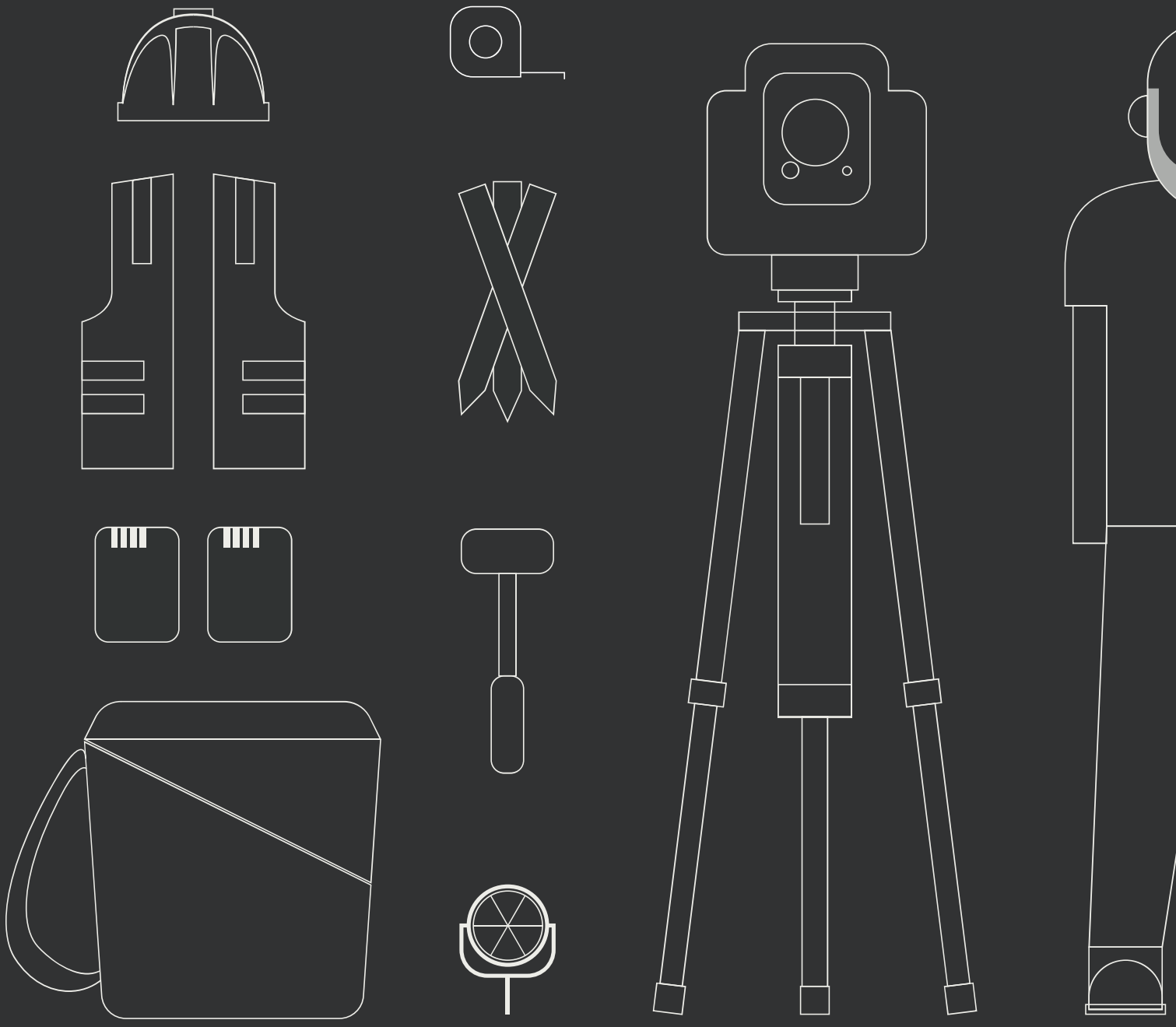
Trimble Access Field Software

Trimble Access is the leading field software professional surveyors use around the world (source, website). It is designed to support surveyors in various routines in mining, roads, corridors, land seismic monitoring, general surveys, and more.

The SX10 is a fully digital total station and relies on TrimbleVision to show where the instrument is aimed. TrimbleVision is a feature in Trimble Access that streams video from the perspective of the instrument to the controller display. Trimble Access can overlay survey data like points and lines on the streaming video which enhances the surveyor's field productivity when operating the instrument robotically (TrimbleVision Whitepaper). This form of augmented reality helps surveyors visually validate collected data on the fly.

The software runs on any Windows environment. The software registers click, mouse, and touch, and gesture events. Common interactions like multi-touch, gesture control, pinch and zoom from our screen-centric lifestyles are just now entering the data controller space (xhyt article)". Text can be input either through a physical keyboard or an onboard digital keyboard. The most common events are tapping to select a box and then inputting a value, using gestures to move the camera view, and pressing the measure button.

P
Infarts-
parkering



RESEARCH

S9 Training Session

I met with Christian Gässer, an R&D engineer at Trimble, to go through the basics of setting up and operating the S9 robotic total station with a Trimble CU (See appendix for CU description). The most important factor to an accurate survey is the station setup. Accuracy can be comprised with the instrument height is not measured correctly or if temperature corrections are not input correctly. These are seemingly simple tasks, like using a tape measure to check how high the instrument is off of the ground and to check the local temperature on weather app on your phone, but they are also some of the most common situations for human error.

We ran through a series of direct reflex measurements on the building across the street as well as fixed prism measurements. The S9 has an optical sight that requires manual focusing using dials on the side of the instrument. I noted that looking through the sight could lead to awkward postures if the instrument height was low or the tripod legs were in the way.

Propeller Reports

My supervisor, Thomas Bennet, provided a series of reports conducted by Propeller in 2008. The reports were part of a brand reactivation project that was to set the stage for future development of total stations, data controllers, equipment, and software. The reports were generated based on interviews and field research conducted in Australia, the UK, Sweden, the United States of America, and Canada. The actual reports are not available for public distribution but I will summarize the main points that were relevant to my project here. You may be wondering if the reports themselves are still up-to-date since they were conducted in 2008, the answer is yes. The surveyors were using S series equipment and the previous generation TSC2 data collector. Surveying instruments have a long development cycle and change does not happen quickly. For example, the development of the SX10 scanning total station began in 2007 and it took almost a decade for the technology to be perfected and released (xhyt article the big eye). This leads into one of the biggest insights from the Propeller reports.

“A portion of the users are conservative, and skeptical towards new technologies. These are often however of the older generation. There is a generation shift happening in the business today, and the younger users are generally more positive towards new technology.”

These conservative users become used to working with the equipment over several years and don’t want to change to something new that might affect the accuracy of their work. Even if the routines and work flows are improved,

Most surveyors interviewed said that Trimble as a brand is associated with quality and reliability (Propeller). It is important then that any accessories developed also convey these qualities. Trimble’s main strengths are the advanced technical capabilities, R&D focus, and usability. Their products are in the premium category and focus on delivering the most precise instruments and going to great lengths to gain an edge. They spare no expense to get the best

complete office work in the field instead of only collecting data. Lee D appreciates the ability to interface with scanners, printers, create PDF files and spreadsheets, e-mail, receive and open attachments, etc. while member Jalbrz enjoyed using the tablet to surf the net and watch YouTube videos on long drives to sites. The larger screen also has benefits when working with TrimbleVision capable total stations. “I enjoy being able to sit in an air conditioned vehicle in Louisiana in August while I shoot direct reflex topo to power lines, etc. I’ve operated the SX10 from the comfort of my vehicle more than once” (Lee D). Other members commented that working inside a vehicle with the heater on would also improve winter direct reflex work flows (Totalsurv, RPLS).

Working in Cold Weather

I contacted Ann-Christine Krooks who works as a surveyor in Jakobstad, Finland. She shared photos from various past winter surveying jobs that show that extreme weather does not stop a surveyor from working. The commonalities between these three situations are cold weather below 0° to -13° Celsius, surveying instruments and controllers, high vis apparel, a warm hat, and thick gloves.

The first photo shows the surveyor operating an S Series total station with very thick gloves and holding a TSC3 controller. The sun is rising which creates glare on the controller screen and makes it more difficult to see what the screen is displaying.

The second photo is taking at 9:00 am. The winters are long, cold, and dark in Finland and this surveyor is working by moonlight. This limits long range visibility. The glove makes his hands lose pointing precision and he removes one glove to operate the controllers buttons. This is a notable usability issue that makes working in the cold uncomfortable and potentially dangerous.

The third photo shows the surveyor covered head to toe in high visibility winter apparel. This work wear is provided by his employer to ensure a warm and safe working environment.

The job can require low tech, analog tools, like hammers, stakes, and spray paint, to mark where points are located in the physical world. This is done by hammering stakes into the ground after a point is located with a total station or GNSS receiver.

During cold months, the ground may freeze and a power drill is required to create a pilot hole for the stake. Typically this requires a two person crew. One person runs the rod and marks the points with a spray painted dot while the other follows behind, drills the hole, and sets the stake.

Most of Ann-Christine’s comments related to technical problems like bad connectivity to satellites and base stations. She noted that there is a lot of gear that surveyors have to carry into the field. Less would be better because everything you bring adds to the total weight carried to and from the site which becomes very tiring day after day. Her employer is the city of Jakobstad and the surveying instruments and data controllers are rarely replaced. She is still working with the Trimble S6, Trimble CU, and

Systems engineer field observation

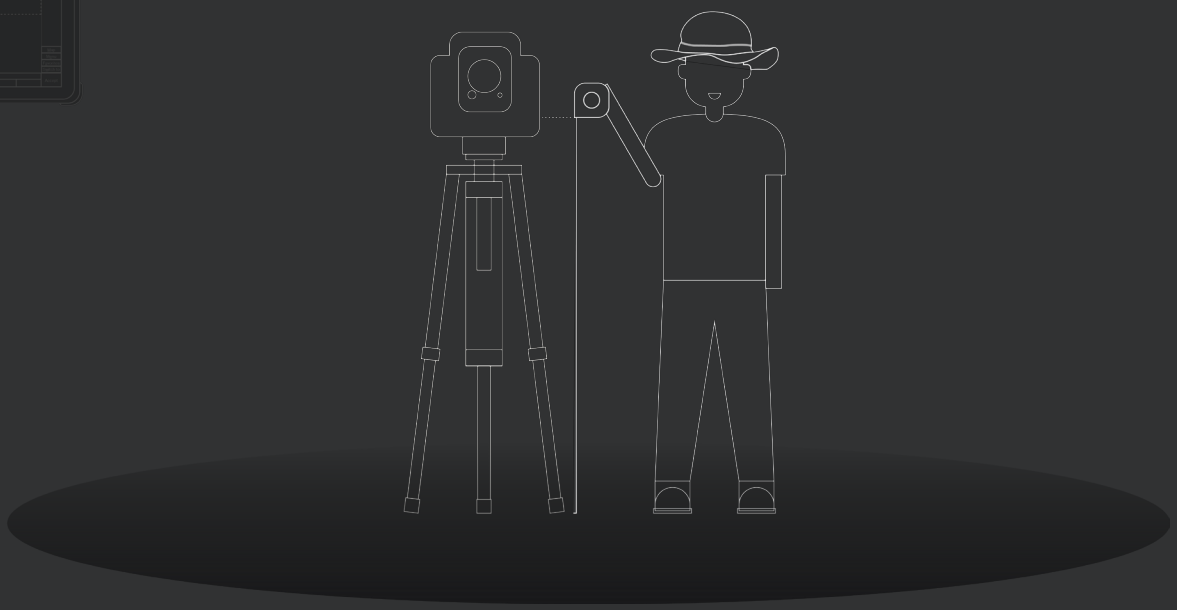
I observed a systems engineer from Trimble while he conducted field testing of a component for the SX10. The aim of the study was to understand a typical workflow while using the SX10 scanning total station and Trimble tablet for data collection. The main goal was to see what kind of tasks take place when transporting, setting up, operating the instrument during a field survey.

Torsten is a systems engineer in the research and development division for Trimble's total station platforms, Torsten is the go-to expert for how all of the equipment works together. He tests functionality of firmware, software, hardware, and peripherals. He has a master's of engineering in geodesy and geoinformatics. He spends time in the office as well as in the field working with the instruments in their intended work flows. He enjoys working at Trimble due the balance of technical in-office work and practical field work.

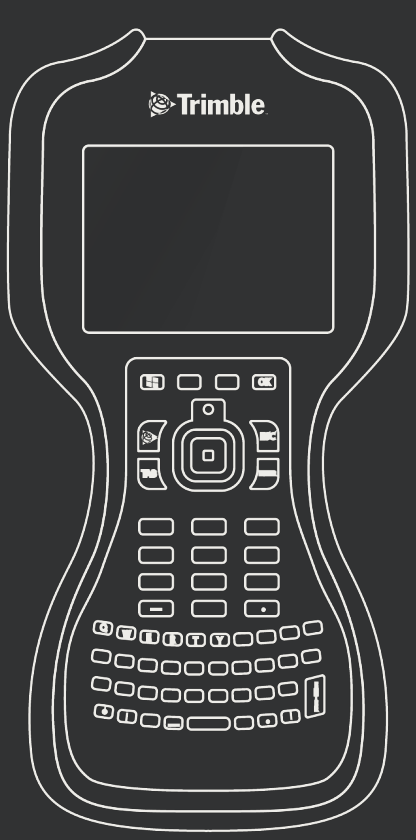
The weather was 0° Celsius as we loaded equipment into the back of his personal vehicle. The equipment he took with his was a SX10 scanning total station in a carrying case, a Trimble Tablet, tripod. 2.5 meter telescopic carbon fiber pole, a 360 degree prism, and a mini prism with poles. He was wearing a thick jacket, beanie, and thin touch capable knit gloves.

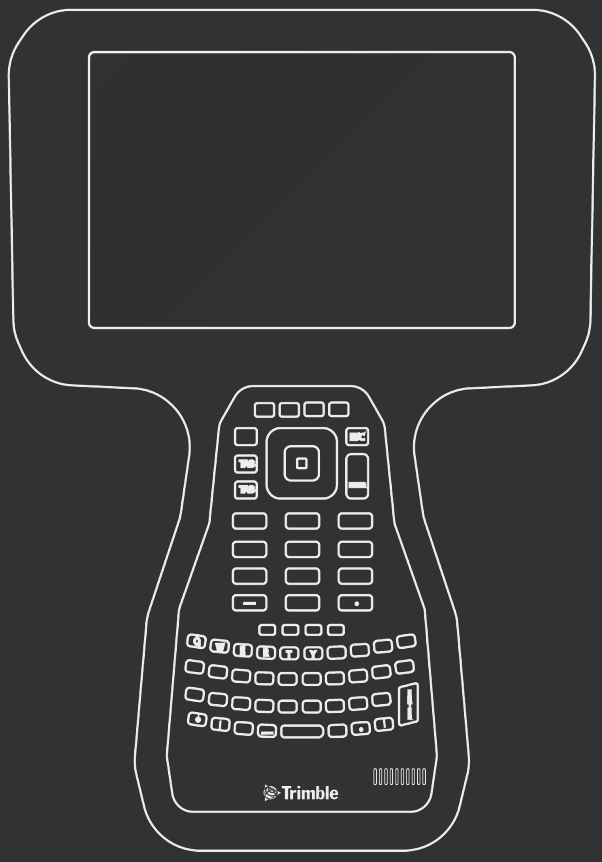
He carried all of the equipment out to the site on his own and began the station setup. There were a number of steps to initialize Trimble Access and connect to the SX10. First, he checked the current weather on his phone to input corrections

15°



ANALYSIS AND CONCLUSIONS



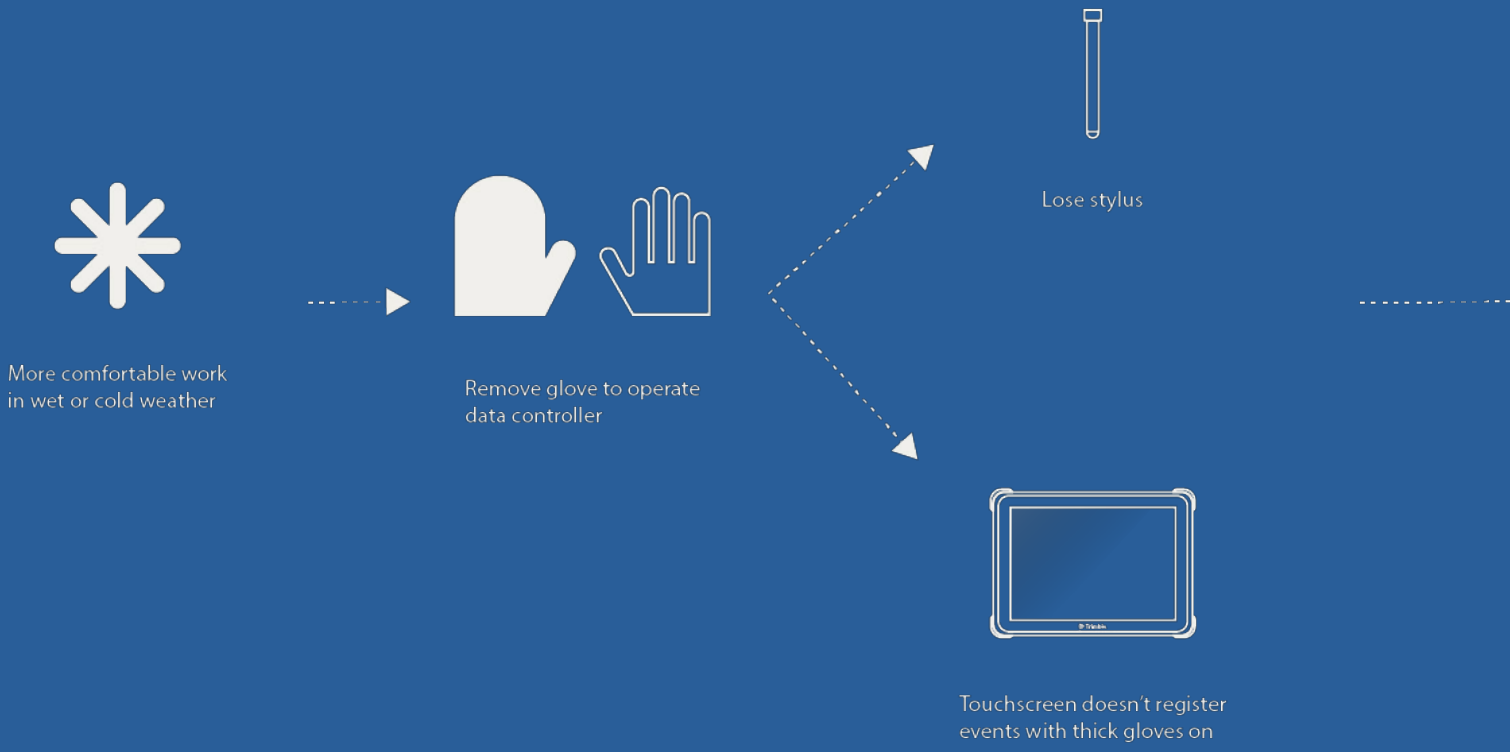


Are bigger screens the answer to
a visual based workflow?

Trimble Mixed Reality

Trimble has been researching the use of mixed reality since 1997 (trimble mixed reality.com). They have a partnership with Microsoft Hololens and Daqri and have released three mixed reality applications: Trimble Connect for reviewing design content in context on construction sites, SketchUp viewer for reviewing plans in an office, Connected Mine for viewing real-world transactional data with the virtual holographic mine. Two beta applications were released mid 2017: Trimble SiteVision overlays accurate 3D data on a video feed running on a tablet and Trimble Operations which provides information about the world that you work in.

Problem **Reason**



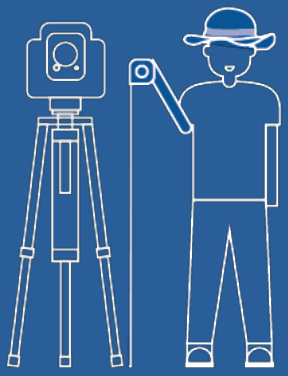
Stage 1

Keep gloves on in cold weather

Problem

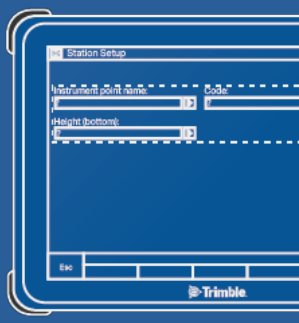
Reason

Measuring Tape



Used to determine the instrument height during setup.

Awkward postures when moving around the tripod.



Value is entered manu
into the data collector.

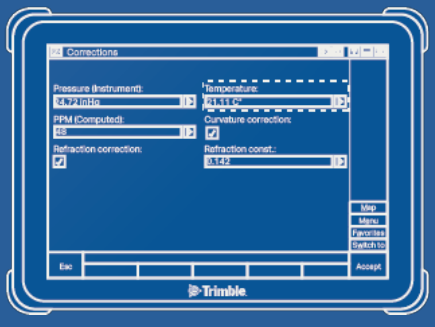
Hammer

Stakes

Prism

Analog tools that are absolutely required in the field.

Phone

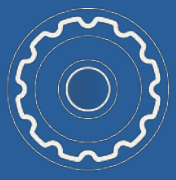


Local temperature is checked using a weather app. Value is entered manually into the data collector.

Problem

Reason

Ide



No optical sight

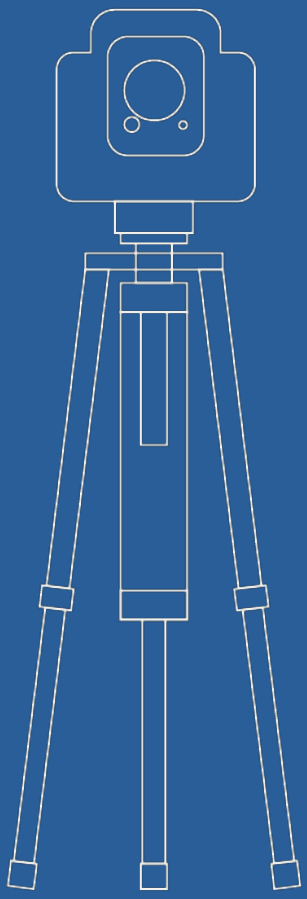
SX10 relies on
high quality video

Bigger screen

Augmented

Is accuracy
affected?

Data controllers are getting larger



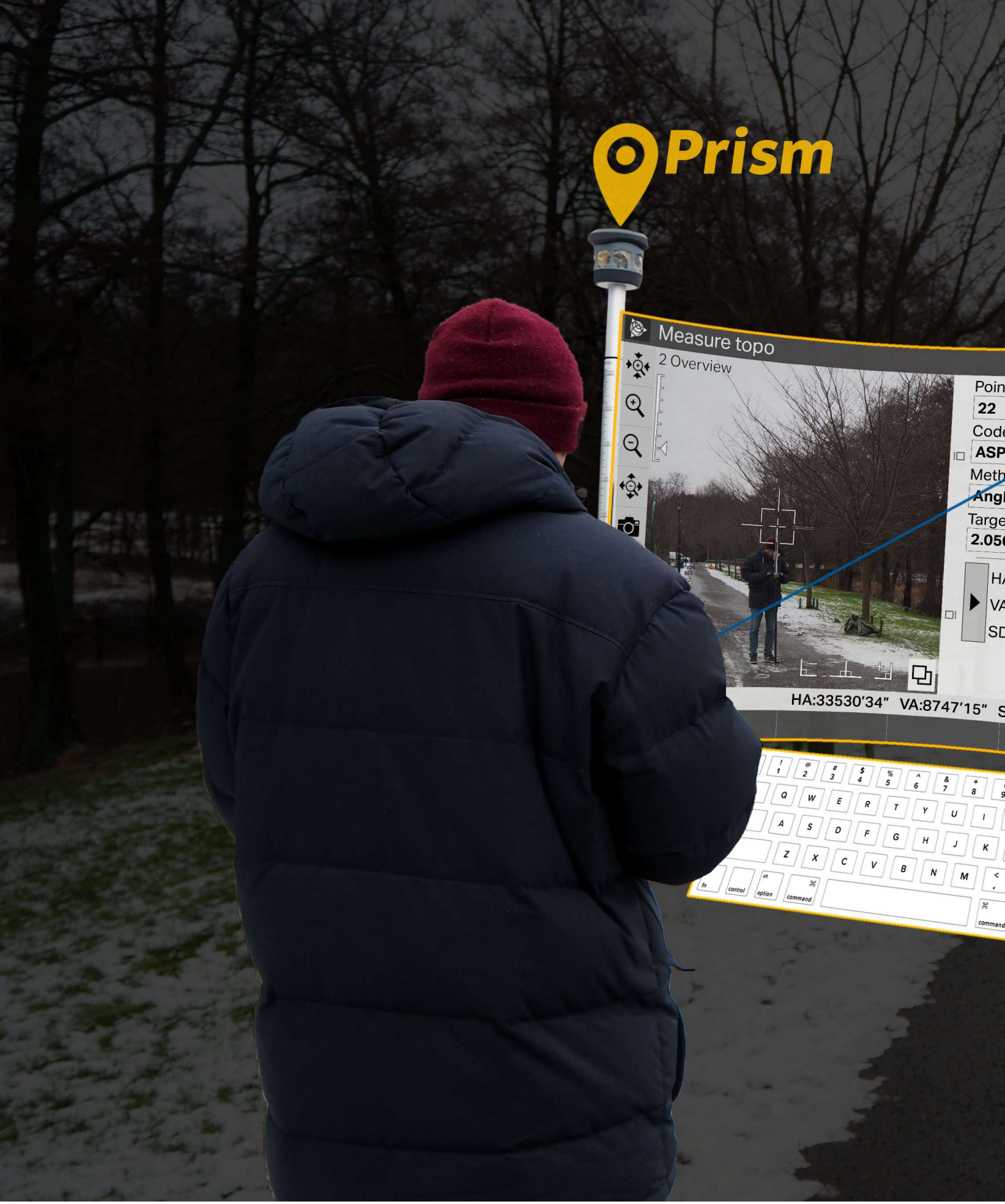
Screen size has a limit. Too big
and it will be a hinderance in
the field.

Voice

Eye t

Gaze bas

Too drastic a char
and workflow wil
frustrate conserva
them to choose o
that they are mor

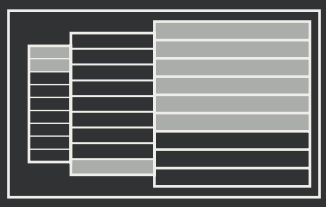

Prism
Measure topo
2 Overview
Poin
22
Code
ASP
Meth
Angl
Targe
2.050
HA
VA
SD
HA:33530'34" VA:8747'15"

TECHNOLOGY

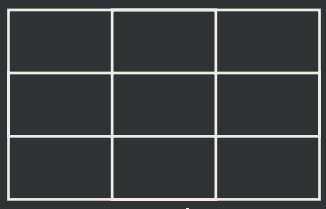
Since I wanted to create a minimum viable product concept for Trimble, I only looked at technology that is implementable today or in the near future. The technology available today is more than capable of accomplishing the tasks needed. It is a matter of choosing the right parts for a surveying application. The components need to be able to withstand harsh weather conditions like rain, snow, heat, and cold. They also need to be able to be operated while wearing gloves. This informs what kind of sensors can be used.

Validation

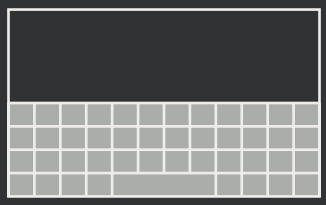
Before investing time experimenting with more specific use cases and components, I wanted to validate that the remote idea would work. I purchased an existing remote that had most of the functionality that I was looking for. There is no reason to build everything from scratch just to validate an idea. The remote was a multimedia remote for controlling presentations on a television. It had a key cap button area, touch pad, and was a small size. Navigating Trimble Access worked by swiping on the touchpad to move the cursor and tapping to make a selection. I tore down the remote to inspect the internal components. It had a very simple PCB, battery, touchpad sensor, and housing. This was an easy way to determine whether the remote concept would work for a surveying application and I continued to explore the components in more detail.



Lists



Panels

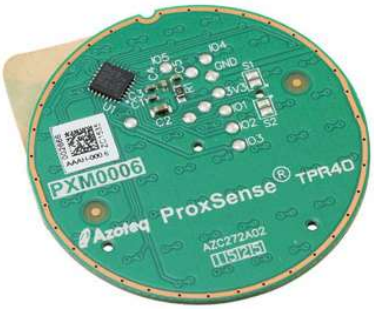


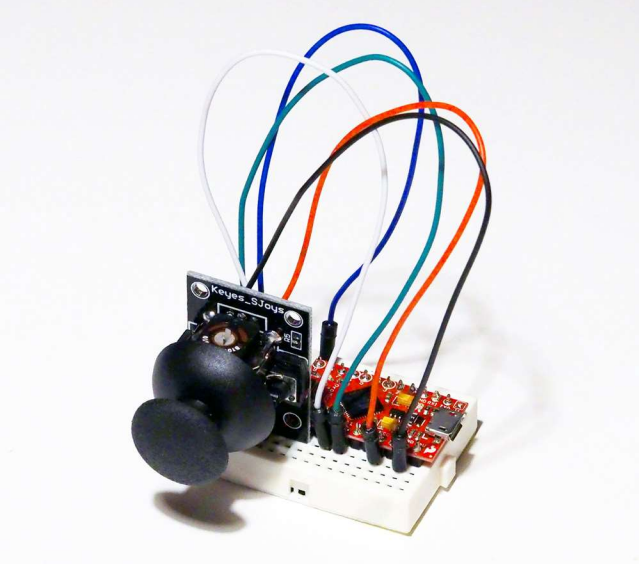
Keyboard

Select

Capacitive touchpad

There are two major manufactures of capacitive trackpads with gesture support that come in different shapes: Azoteq and Cirque. Both offer development kits for Arduino. I used Azoteq's arduino dev kit to prototype interactions on the Arduino Uno. The benefit of capacitive technology is that it can be easily sealed within a device that needs protection from dust and water. Azoteq's Proxsense has added benefits that normal touchscreens lack. While the sensor is capacitive, it also senses proximity which allows for either 3D sensing to a degree or high sensitivity. I was interested in the ability to adjust the gain to make the sensor more sensitive, this allowed the sensor to be used with off-the-shelf thick gloves on. I was able to accommodate cold weather use cases by using these sensors and surveyors can now keep their gloves on while making touch or gesture inputs.

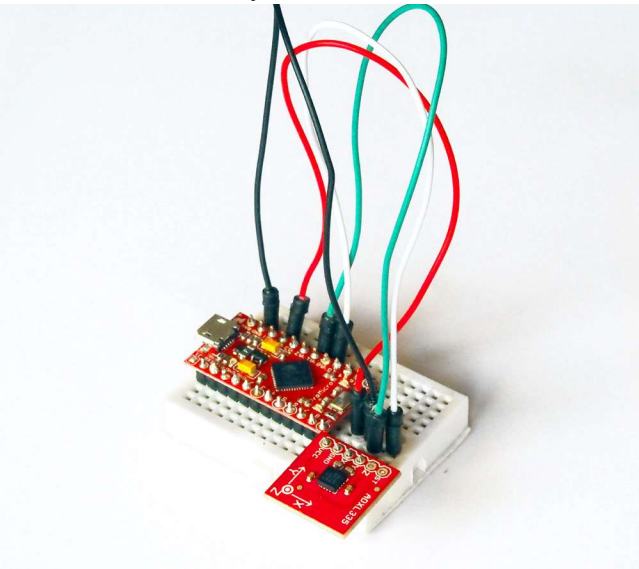




Joystick controller

Joystick

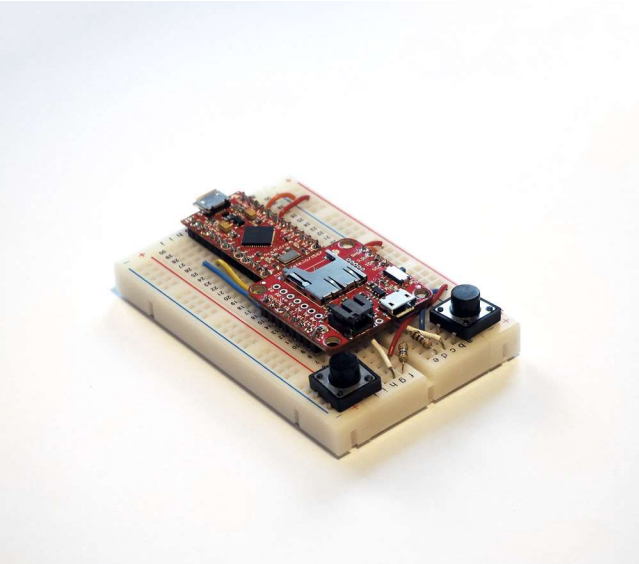
A joystick is an input device that reports values along two axes. I prototyped a joystick controller using Arduino to test how navigating a screen would feel. I gave the prototype to several people and had them move and click around a demo of Trimble Access that I built in Adobe XD. I ran similar tests with the accelerometer and IMU prototypes that I discuss next. The joystick worked but felt slow and inaccurate.



Accelerometer controller

Accelerometer

An accelerometer is a device that measure proper acceleration - the rate of change of velocity in its own instantaneous rest frame. This prototype used the values obtained when tilting along the X and Y axes to move a mouse in 2D space. It works by tilting the device in the direction that you want the mouse to move. At first users said it felt intuitive but the longer they used the prototype frustrations started to arise. They couldn't keep the cursor in the same place because the sensor was continuously moving it as it sensed the tilt.



IMU controller

Inertial measure unit controller

An IMU is an accelerometer, gyroscope, and magnetometer combined into one sensor. By fusing this data, we can calculate yaw, pitch, roll, quaternions, and eurler angles. This allows for orientation and rotation to be used to control where the mouse points. This prototype works well for controlling a raycaster in 3D space and users said it is intuitive to use - simply point at what you want to select. There are existing products that use this method, for example an air mouse for modern tv's.

Tobii Eye Tracking

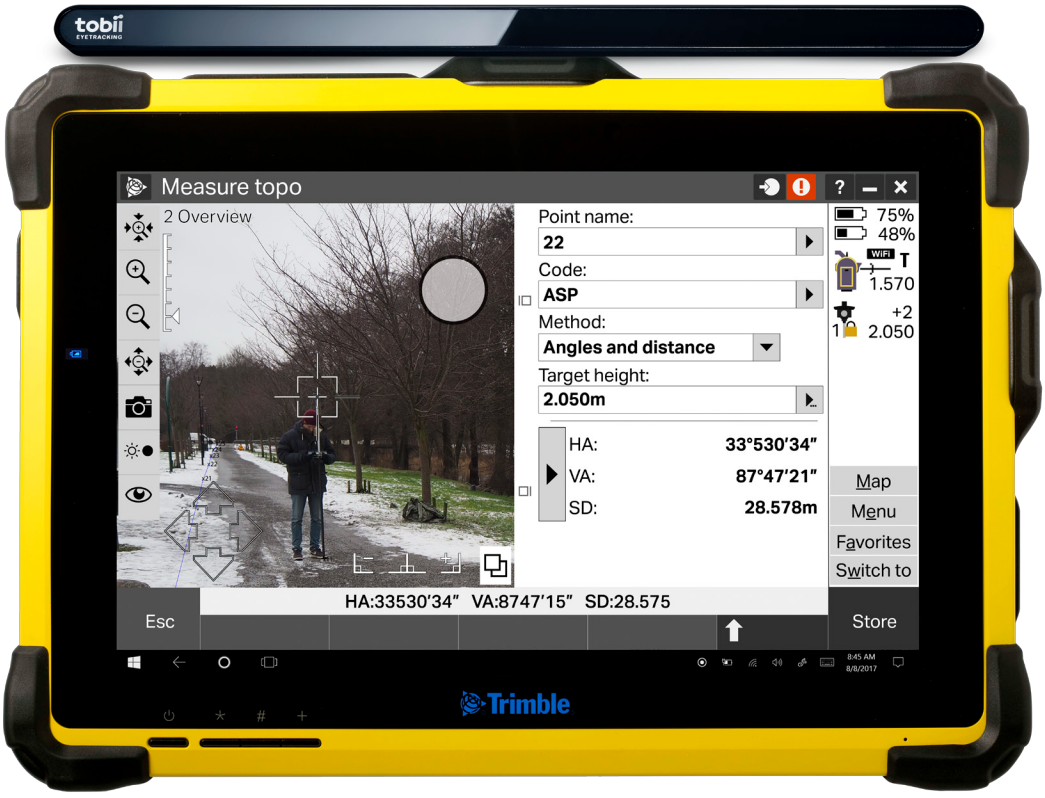
Tobii offers eye tracking technology that would allow the surveyor to move a cursor on screen with their eye movements. I had a meeting with Nina Chrobot and Ulrica Wikstrom to discuss the possibilities of integrating their technology in a data controller for hands free use. They demoed a pair of Tobii glasses and we discussed possible use cases that would benefit a surveyor workflow.

I wanted to know how their customers had been initiating click or mouse press events using their eyes. While they have tried using blinking and other techniques, the simplest method is to use a physical button to initiate the click event. For example, in the lobby they have a simple game demo where you look at incoming astroids flying towards you on screen. Your eye gaze is used to aim a canon at the asteroids and a spacebar press on a keyboard is used to shoot them down.

I continued to move in the direction of designing a remote because of this, if the surveyor still needs to press a button, that means there will be a separate physical device. I could incorporate more sensors and inputs into this separate device to make it more useful than just having a separate button to initiate clicks.

https://www.tobiipro.com/learn-and-support/learn/eye-tracking-essentials/how-do-tobii-eye-trackers-work/

Image reference



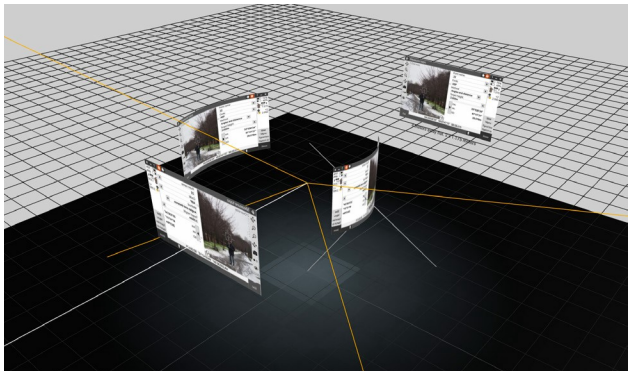
Head mounted display (HMD)

Head mounted display hardware is still in the early stages of development. There are limited options for commercially available head mounted displays. The leading products are the Microsoft Hololens, the Osterhout Group R Series glasses, Daqri glasses, and Magic Leap; see the appendix for more examples. They have limited computing power, field of view, battery life, and are bulky. However, as we saw with computers and mobile phones in the last decade, these HMD's are likely to change their form factor drastically as computing power increases and batteries get smaller and more efficient.

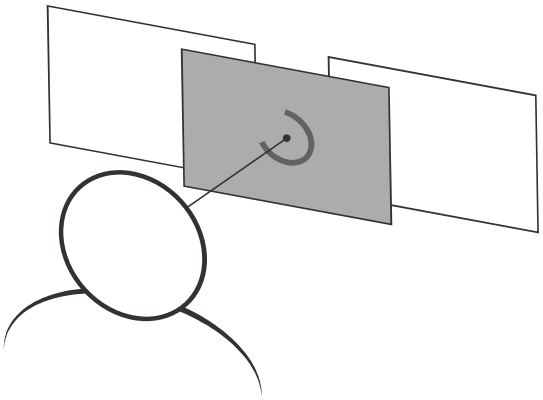
This project will aim to use an available HMD as a display that runs Trimble Access. Since Trimble Access is hardware agnostic, I will not be focusing on the technical requirements of today's available tech, the assumption is that the technology will improve vastly over the next decade - the same way mobile phone technology improved in the past decades. Instead the overall user experience of working with a display that projects over a user's field of view will be investigated.

I did not have access to a HMD and found other ways to validate the idea of using one in a surveying application. I purchased a cheap Google Cardboard virtual reality viewer and coded up test environments in A-Frame, a web framework for building virtual reality experiences. A head mounted display would solve the desire for having a larger screen while keeping the hardware size down. Since the display is projecting the user interface over the user's field of view, the display size can be the size of a billboard or the size of a tablet. I tried out different display sizes, simple interactions of moving the display out of the field of view, and what overlaying surveying data might look like.

You can visit https://accessmountains.glitch.me, https://trimbleaccessscreens.glitch.me, and https://trimblear.glitch.me to try out the demos. For TrimbleAR, open the website, allow access to the camera on your phone, then point it at the HIRO marker on the page.

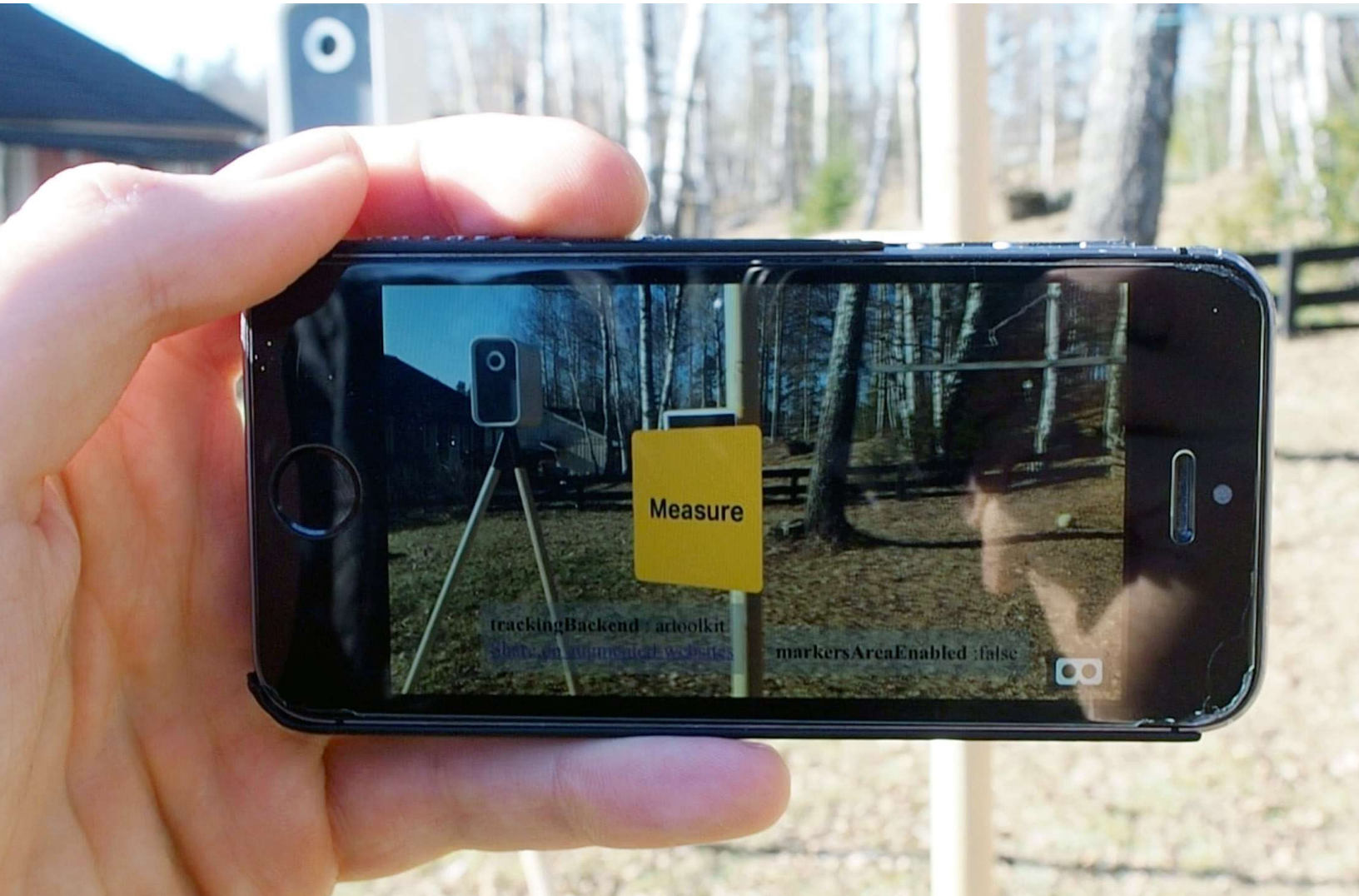


This is a screenshot from one of the virtual reality experiences that I created using A-Frame. The environment shows French mountains with points mapped out. As the user looks around the points stay in place, this was to showcase how a surveyor can quickly see where they have already measured points. Trimble Access is floating to show what a GUI would look like using mixed reality.



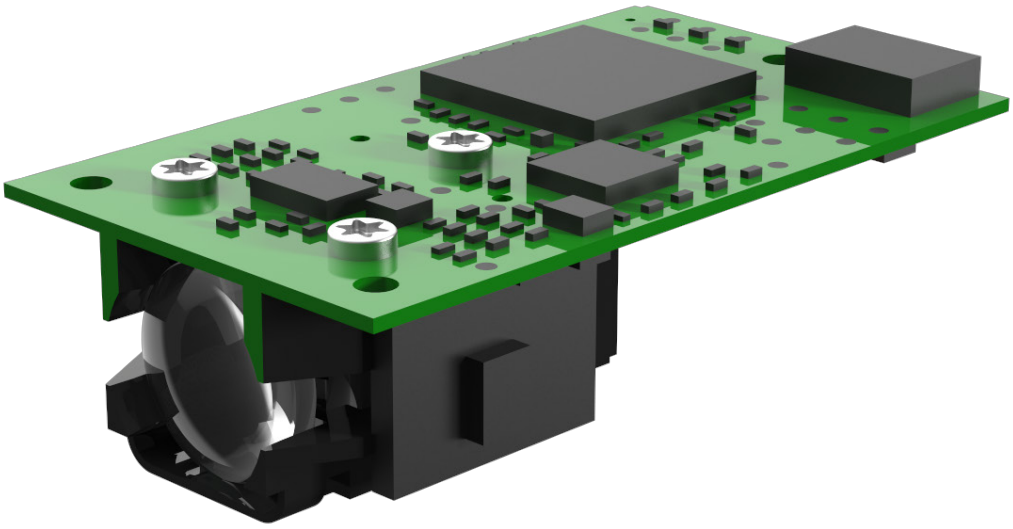
Fuse button

Measure

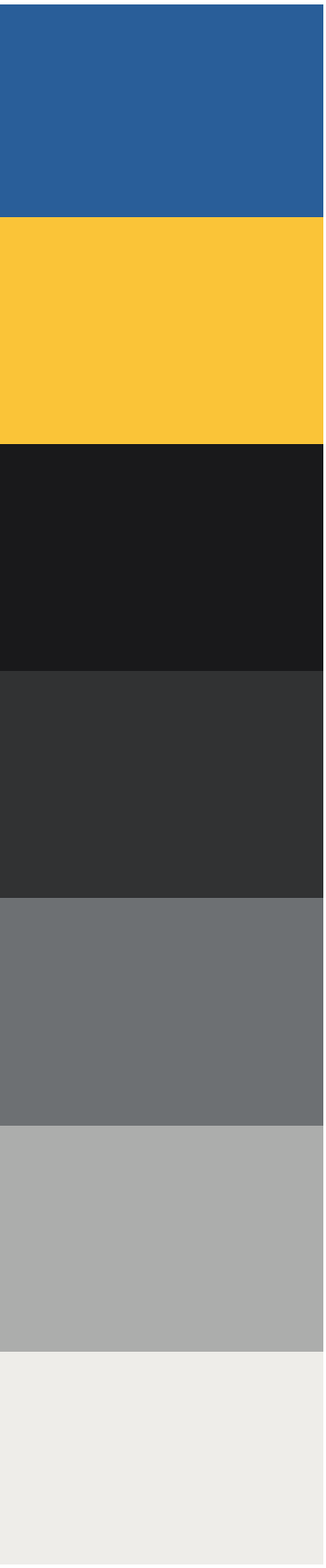

Measure
trackingBackend : arkoolkit
markersAreaEnabled : false

Electronic Distance Measurement (EDM)

This is the same technology used in the total stations. An electronic distance measurement unit shoots a laser beam and calculates the time for the beam to bounce back on the sensor to determine the distance. Small sensors are available with accuracy of roughly 3 millimeters. During station setup surveyors must measure the height of the total station and the prism height. Human error like forgetting to set the correct pole height can lead to bad data. By integrating a small EDM into the remote, station height could be measured with the press of a button and automatically input into Trimble Access. The EDM would be easier and faster to use than the standard tape measure currently used in the field, reducing equipment load and manual data input. The idea to integrate this component into the remote came very late in the process. The form of the device changed to accommodate the actual component size and mounting requirements.



DESIGN IDENTITY STANDARDS



Trimble Blue
NCS S4550-R80B

Trimble Yellow
NCS 0970-Y08R

Trimble Black
NCS S 9000-N

Trimble Dark Grey
NCS 8004-B03G

Trimble Medium Grey
NCS 5505-B07G

Trimble Light Grey
NCS 3201-G04Y

Trimble White
NCS S 0500-N

Trimble Signature Line

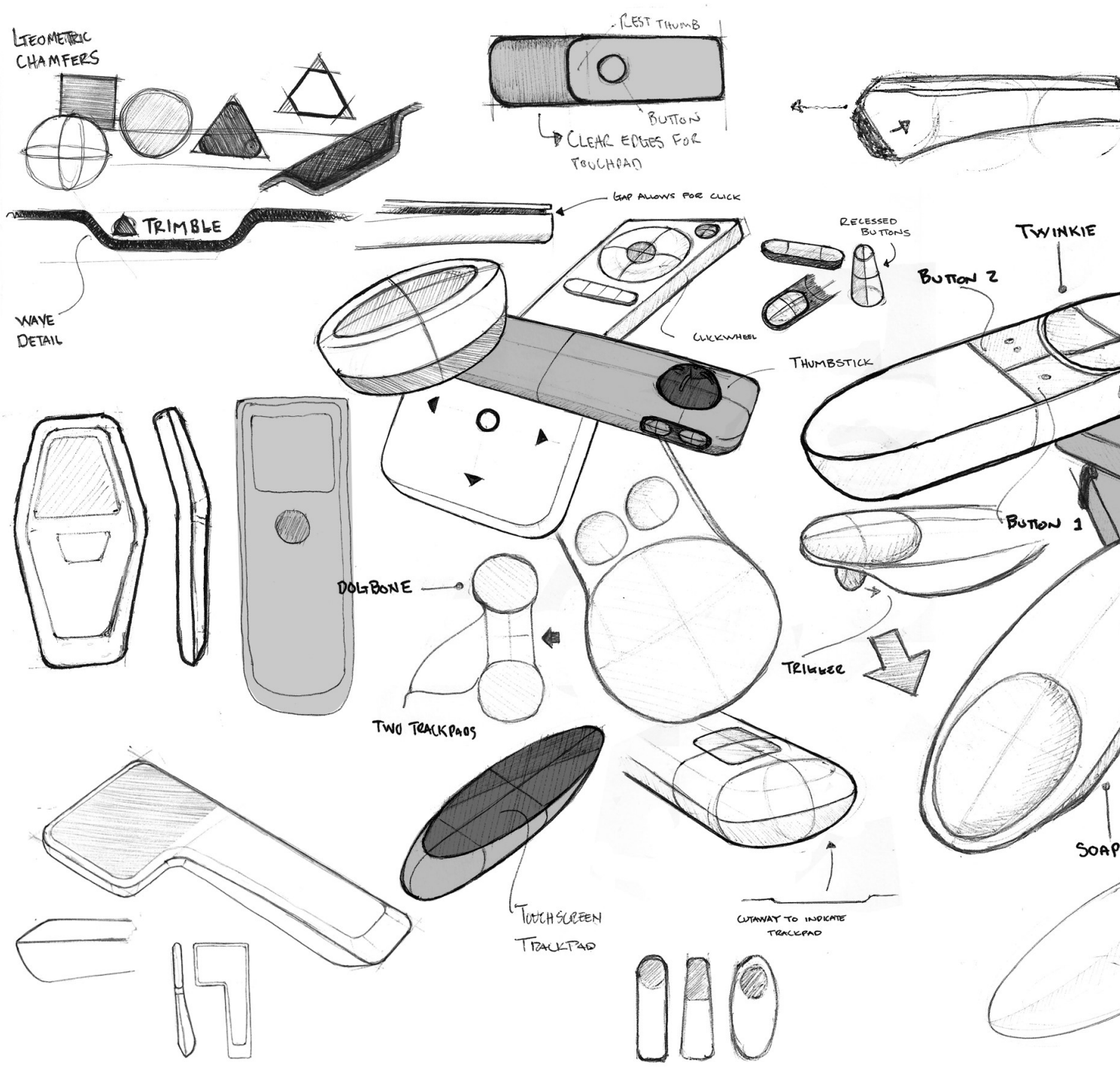
Trimble S6 Total Station - 2004

Propeller designed the S6 Total station with visibility in mind. Their design created a “recognizable statement that provides a connection to other Trimble products” - the yellow bumper.
http://www.propeller.se/work/s6/

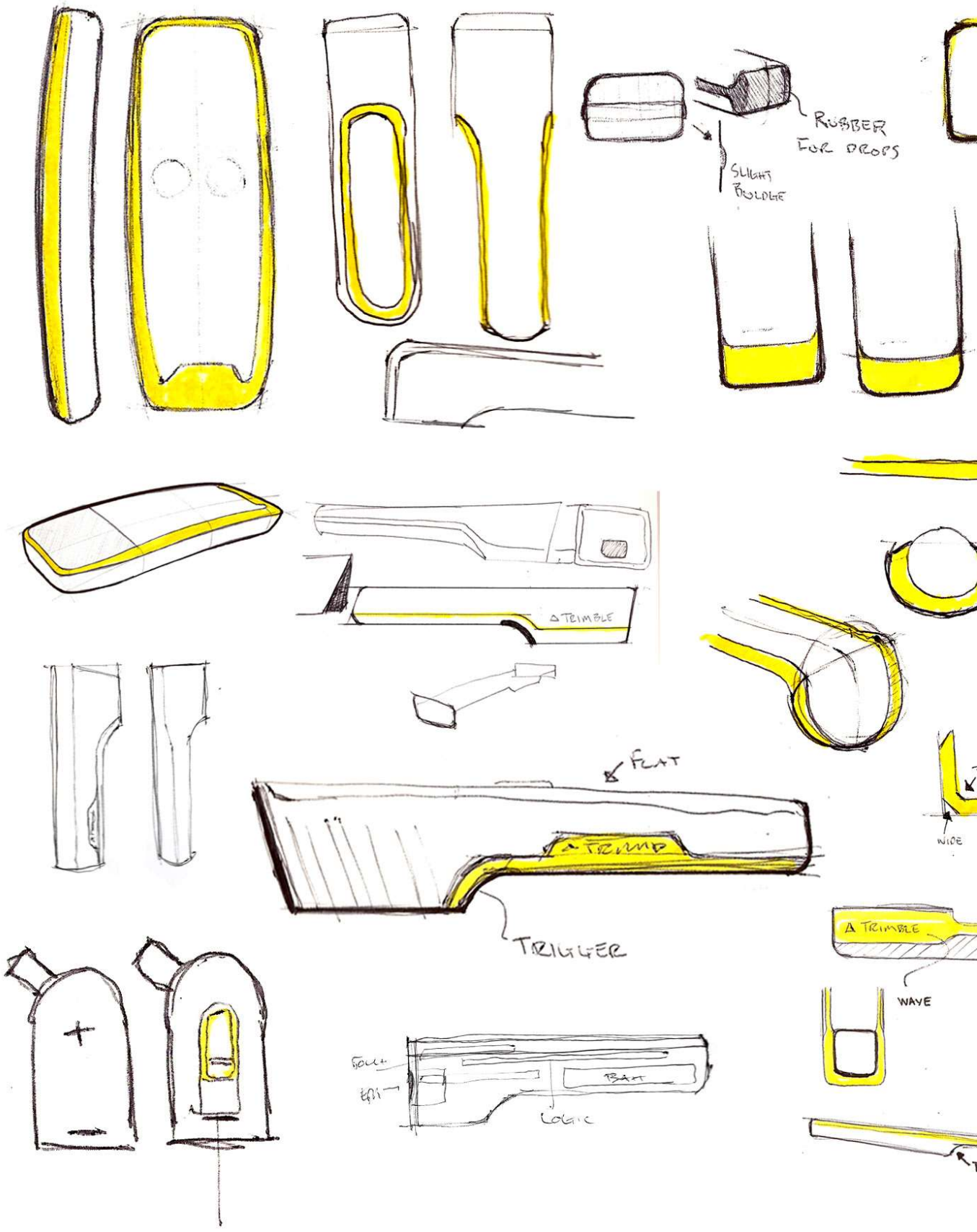
Trimble R10 GNSS - 2013

Also designed by Propeller, the R10 design was “a long term strategic design project that aimed to eventually encompass the full range of Trimble Survey products.” The bumper transitioned into the signature line, an icon of quality that would be used on all future products.
http://www.propeller.se/work/r10-gnss-

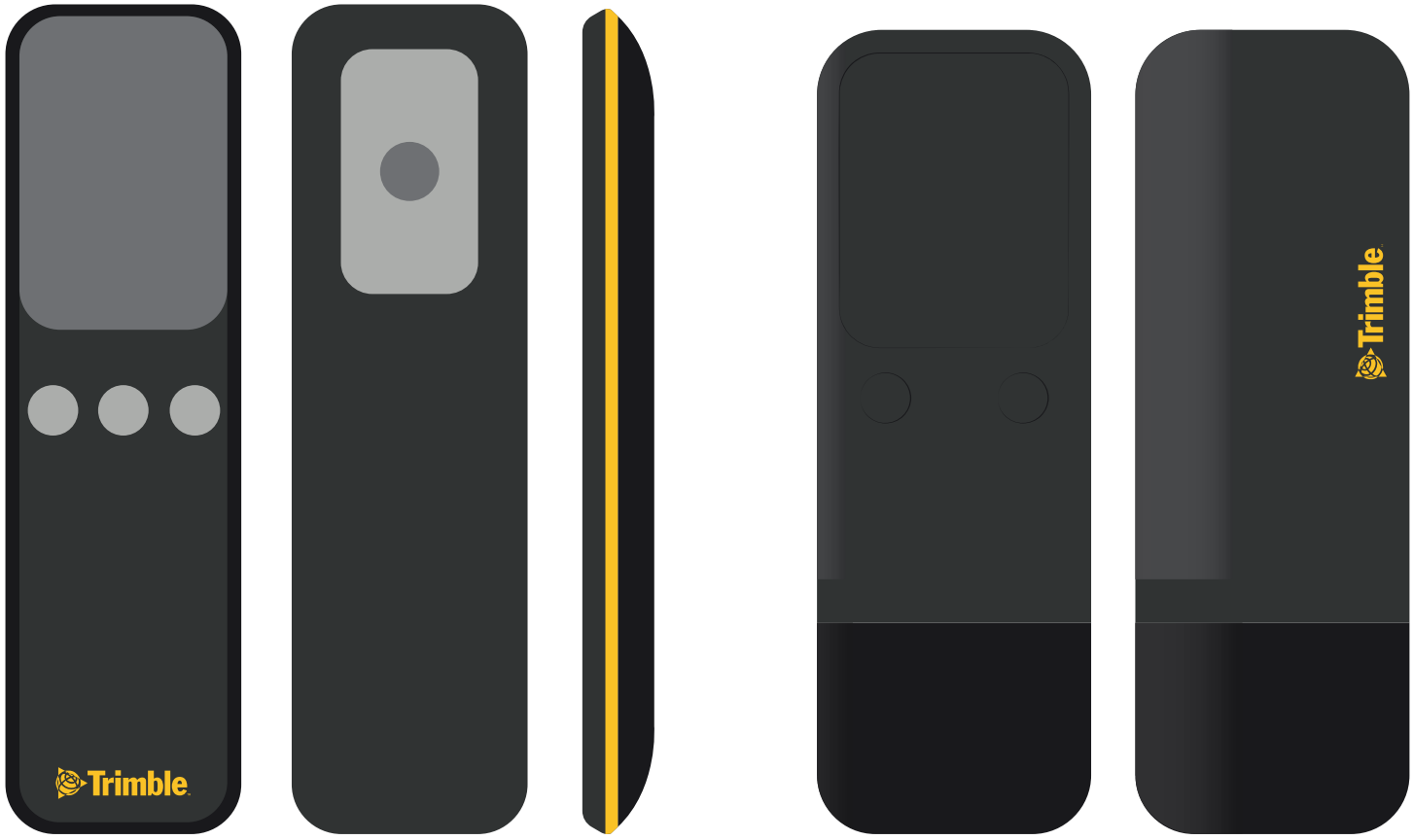
IDEATION


GEOMETRIC CHAMFERS
REST THUMB
BUTTON
CLEAR EDGES FOR TOUCHPAD
GAP ALLOWS FOR CLICK
TRIMBLE
WAVE DETAIL
RECESSED BUTTONS
TWINKIE
BUTTON 2
CLICKWHEEL
THUMBSTICK
BUTTON 1
DOGBONE
TRIGGER
TWO TRACKPADS
SOAP
TOUCHSCREEN TRACKPAD
CUTAWAY TO INDICATE TRACKPAD

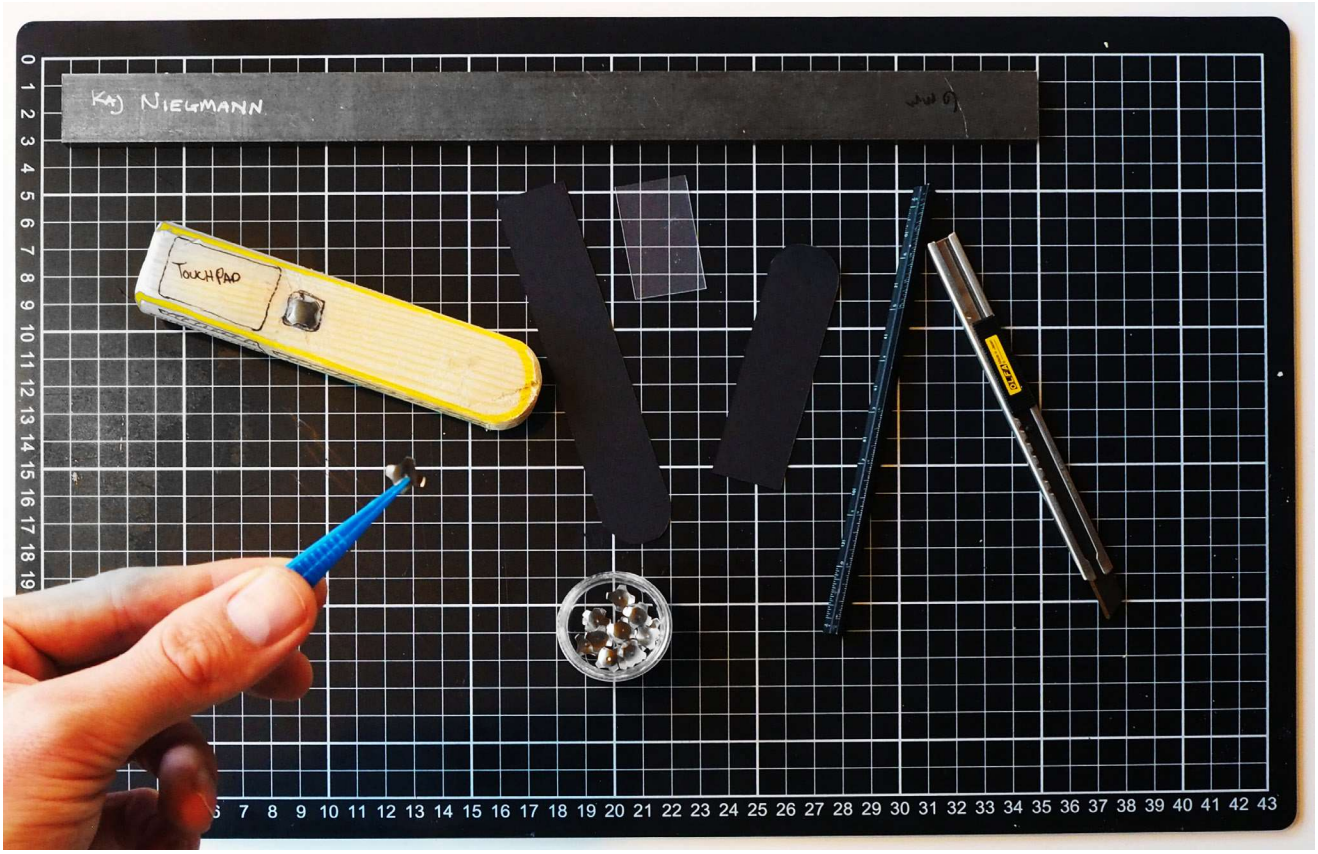
TRIMBLE
TRIMBLE
TRIMBLE
TRIMBLE
TRIMBLE


RUBBER FOR DROPS
SLIGHT BULGE
TRIMBLE
FLAT
TRIGGER
WIDE
WAVE
BATT
LOGIC

Trimble
Trimble
Trimble


Trimble
Trimble

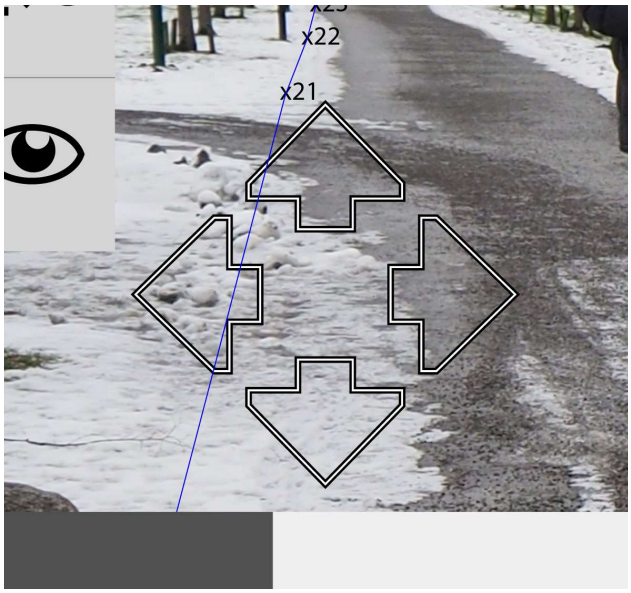
TRIMBLE
3M 468MP
TRIMBLE

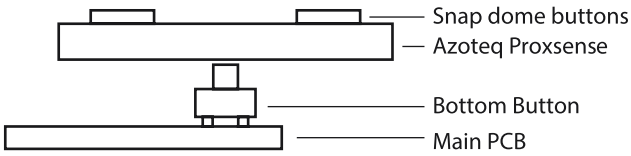

KAJ NIEGMANN
TOUCHPAD

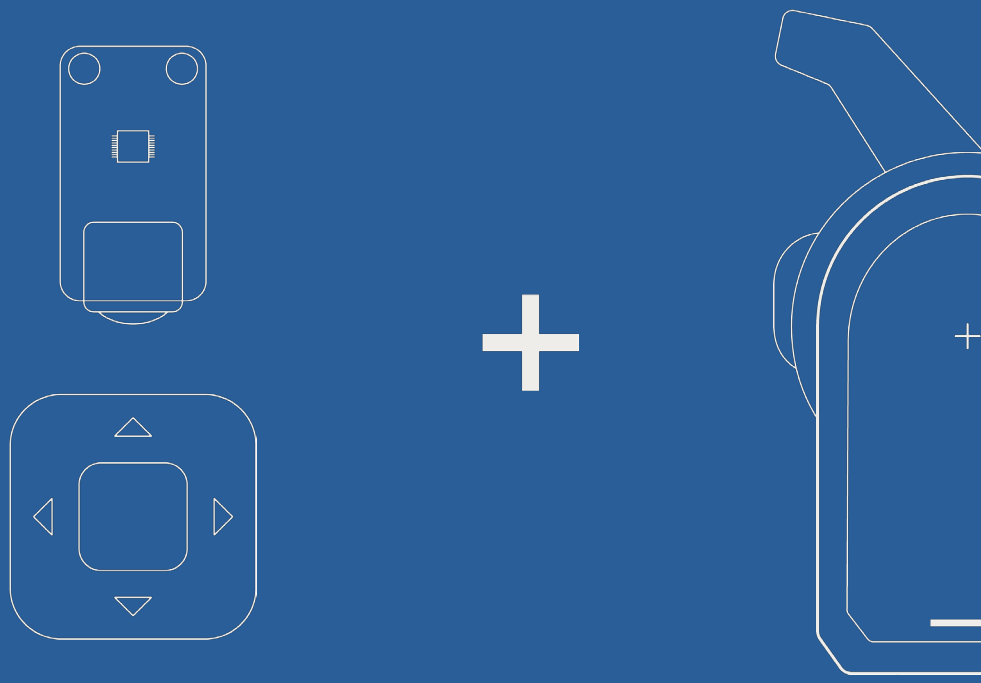
The remote input relies on the Azoteq Proxsense sensor. Physical button press feedback was important to surveyors. They appreciated the actual feeling and sound of pressing a button to know that an action had been completed.

Azoteq is able to build in snap dome buttons onto their Proxsense sensors. This give makes three levels of input possible: proximity, touch, and click. This is useful for transferring the existing D-Pad function from the TSC3, TS37, Trimble Tablet, and on screen in Trimble Access to the remote. The D-Pad is often used for fine adjustment of the camera view, thus, the buttons will remain small and require deliberate action to be pressed. The snap dome on the top will have very light trip force so that the buttons can be pressed without activating the heavier trip force main click button.

Instead of making the select button a small target in the center of the D-pad, as seen on the TSC7 D-pad, the entire touchpad area can be pressed to initiate a select. This is accomplished by allowing the entire top of the plastic housing to flex and press down on a separate button mounted on the main PCB underneath the Azoteq sensor. Since clicking is the most common action, it has to require the least amount of effort to accomplish. By pressing the entire touchpad area, it makes gloved operation easy.







Interaction influences form

The final design was informed by real-world sensor sizes and the silhouette of the SX10 Scanning Total Station. By matching the form to the SX10, the station height measuring interaction subconsciously guides the user where to place the remote. The silhouettes match up when in the correct position, a half circle on top and the flat front resting on the bottom notch offset of the SX10.

FINAL DESIGN

Companion

Data controller remote

Find out more

A helping hand.

The Trimble Companion makes surveying easier and lets surveyors work with gloves on. An EDM and temperature sensor automate setup procedures like checking instrument height and setting atmospheric corrections. An advanced D-pad supports traditional press inputs as well as gesture recognition. Bringing the latest in touchpad technology, this remote makes surveying in wet or cold weather more comfortable.

Glasses

Controller display

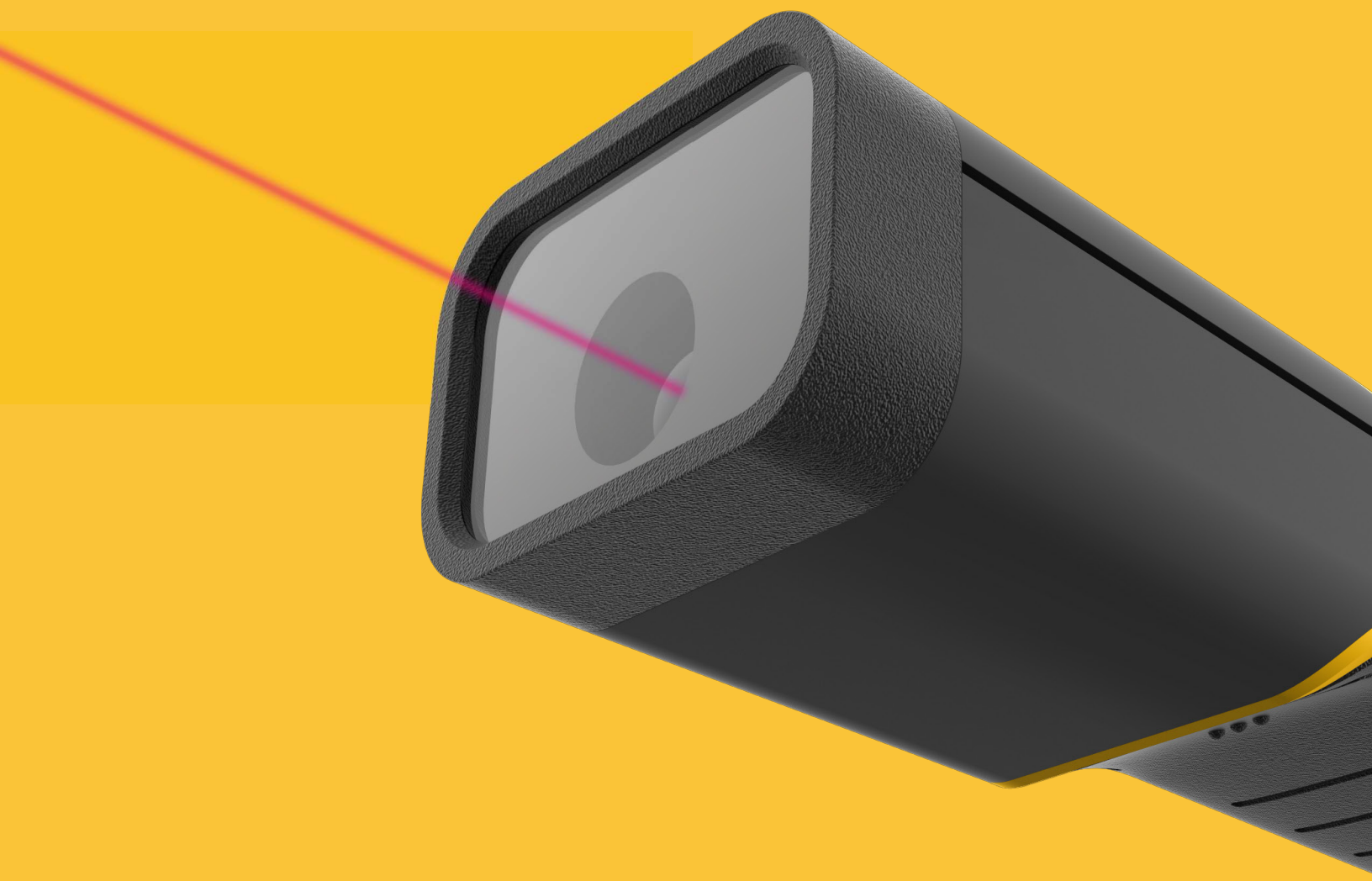
Find out more

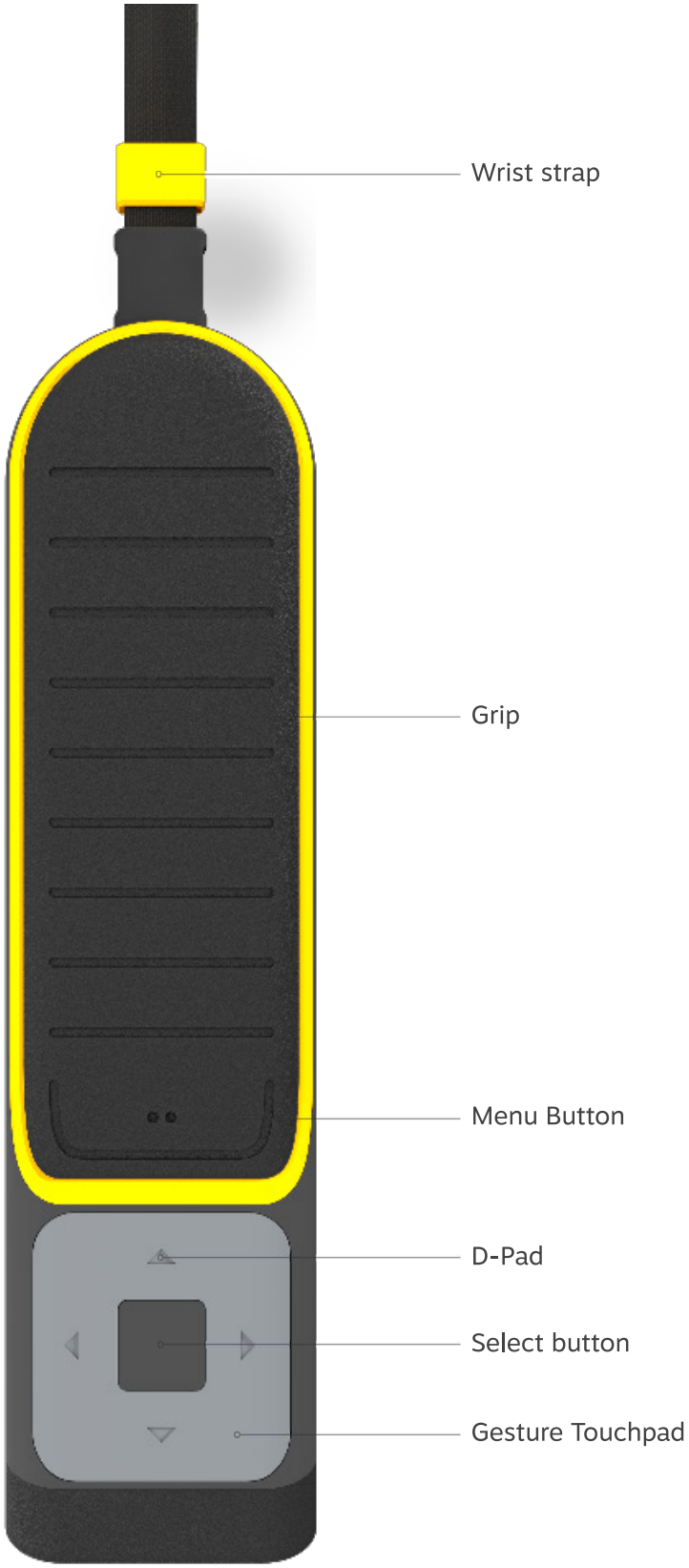
Infinite display. Future potential.

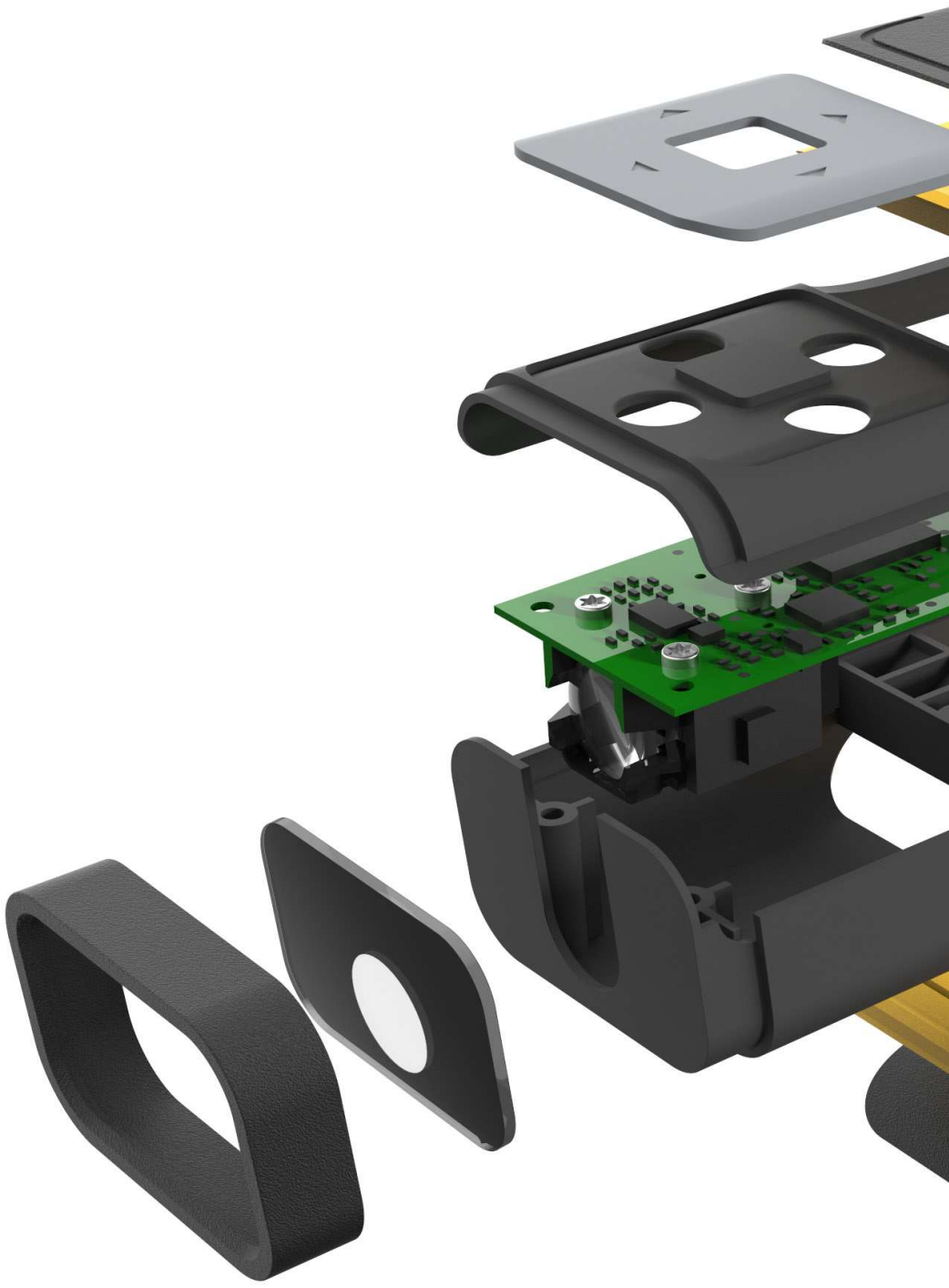
Ergonomic and modular, the Trimble Glasses bring Trimble Access off of the screen and into your field of vision. A built in centimeter accurate GNSS module allows for accurate registration of surveying data and point clouds over your vision. This makes reviewing data in the field faster, more accurate, and real.

The pairable computing pack has the power of a laptop and can be connected to external displays for traditional work flows. It clips to a belt or fits in a pocket freeing up hands to work with other equipment.

**Rebranded Daqri smart glasses*




Wrist strap
Grip
Menu Button
D-Pad
Select button
Gesture Touchpad



THANK YOU

APPENDIX

Trimble proposal

Trimble suggested looking into resolving customer issues when using their instruments in wet or cold weather. Customers had been reporting difficulties using data collectors with gloves on in adverse weather conditions. Trimble suggested two areas to explore:

Suggestion 1
A textile weather shield with a window that covers the field tablet. It would allow the user to put their hands inside a warm compartment to operate the tablet. There are existing products in this category that are used for flying RC aircraft in the cold. The idea would be to adapt the RC transmitter glove to better suit a surveyors workflow. The weather shield should mount to the Trimble rod and have compartments for heating pads.

Suggestion 2
A wireless mouse integrated in a glove that would allow the surveyor to control the graphical user interface (GUI) on the tablet. This would allow the surveyor to work in extremely cold temperatures without having to remove their gloves to operate the data collector.

Total Stations

Robotic total stations are the staple piece of equipment for a surveyor. They have made surveying much more efficient than ever before. Solo crews are becoming the norm without any detriment to the data collected and jobs are actually being completed faster. Trimble currently offers two types of robotic total stations across five models.

The line up consists of the S5, S7, S9, S9HP, and the SX10. The S series robotic total stations were first released in 2006 and have gained the trust as a top performer among surveyors worldwide. The S5, S7, S9, and S9HP have an optical eyepiece with cross hairs for viewing through the instrument. The S7, S9, and S9HP use a single camera to enable TrimbleVision which allows the surveyor to direct the survey through a live video feed on the controller. The S7 and S9 are capable of scanning at 15 points per second with SureScan (Source Total station brochure). The instruments are controlled through an attached Trimble CU or data controller. There are physical controls on the S series total stations that are used to adjust where the optical site is aimed to sight-in survey markers and prisms.

The SX10 scanning total station was released in 2016 as a revolutionary new surveying instrument. It is the world's first scanning total station that truly merges high-speed 3D scanning, enhanced TrimbleVision imaging and high-accuracy total station measurements in a single instrument (Source Total station brochure). It scans at 25,600 points per second which is high compared to the S series but low when compared to dedicated laser scanners that scan 2 million or more points per second. The key difference is that the scans are already registered in a known coordinate system because its traditional total station capabilities allow it to measure its location from a back sight. The surveyor can review the data right away on the controller to see if something is missing. The instrument lacks an optical sight and is driven solely through Trimble Vision, a live video feed shown on a data controller. This is notable because the surveyor no longer interacts with the instrument after setting it up on a tripod. A fully digital system opens up opportunities for new work flows.

Head Mounted Displays

HTC Vive Pro

FOV: 110 degrees

Battery life: Wired

Weight:

Room scale

Meta 2

FOV: 90 degrees

Battery life: Wired

Weight: 500 grams

Room scale

Microsoft Hololens

FOV: 35 degrees

Battery life: 2.5-5.5 hours

Weight: 579 grams

World scale

Daqri Smart Glasses

FOV: 44 degrees

Battery life: 2-5 hours

Weight: 312 grams + 425 grams compute pack

World scale

Data Controllers

(Make a tech specs section for weight, screen size, overall size, etc) Show a comparative infographic at the end. Trending towards bigger screens)

Operating a total station requires a data controller. The controllers run Trimble Access, a proprietary field software for performing survey work flows. Some controllers run full versions of Windows 10 so users can run popular Microsoft Office apps, e-mail, and review data, and ship deliverables to clients faster.

Currently there are three types of data controllers: the Trimble CU, the TSC series, and the Tablet series. The Trimble CU is becoming dated as new field software becomes more map centric and updated field instruments rely on Trimble Vision to be operated. The TSC series is a purpose built rugged controller that features full press-button keyboards and built in displays. The tablet series is a set of fully featured rugged tablet computers featuring the largest screens and digital keyboards.

Trimble CU

The Trimble CU is an attachable control unit that snaps into a dedicated bracket built into the S series total stations. The CU goes mobile by attaching it to a battery pack docking station for use on a rod. It was the first Integrated Survey System - a method of providing connections to multiple survey devices, seamless data transfer and the ability to combine data in a single project to create homogenous data sets (Trimble Integrated Surveying Techniques white paper) - and the oldest unit still sold. The controller features a resistive touchscreen, an alpha numeric keyboard, and keypad to input data. It has an IP55 rating and operates in extreme temperatures of –30° to +55° Celsius.

TSC3

The TSC3 is a purpose built rugged controller that makes both Integrated Surveying and Spatial Imaging (define this beforehand) jobs easier and more flexible. It features a physical QWERTY and alphanumeric keyboard, camera for documenting sites in geo-tagged photos, GPS, and a GSM cellular connection. The GSM connection allows the controller to stay synced and transfer data automatically between the field and the office. It has an IP67 rating and operates in extreme temperatures of –30° to +60° Celsius.

Kaj Niegmann

Accessories for Trimble Geospatial,

Transforming the way surveyors work