

# EATON

## Secondary Research Report

Team Spark | Spring 2017  
Pierre Amelot, Gyuri Han, Arnita Saini,  
Neeraj Talukdar, Caroline Win

# CONTENTS

## **3 About Eaton**

- 5 Stakeholder Map
- 6 Current Problem Space
- 7 Previous Research
- 8 Empathy Map

## **9 Goals of Research**

- 10 Hunt Statement
- 11 Primary Research Questions
- 12 Research Plan

## **13 Power Management Domain**

- 14 Basics of Switchgear
- 15 Power Expert Dashboard
- 18 Competitive Analysis

## **20 Technologies**

- 21 Emerging Technologies
- 25 Analogous Domains

## **54 Conclusion**

- 55 Key Insights
- 56 Next Steps

## **57 References**

# **ABOUT EATON**

**ABOUT EATON**

**STAKEHOLDER MAP**

**CURRENT PROBLEM SPACE**

**PREVIOUS RESEARCH**

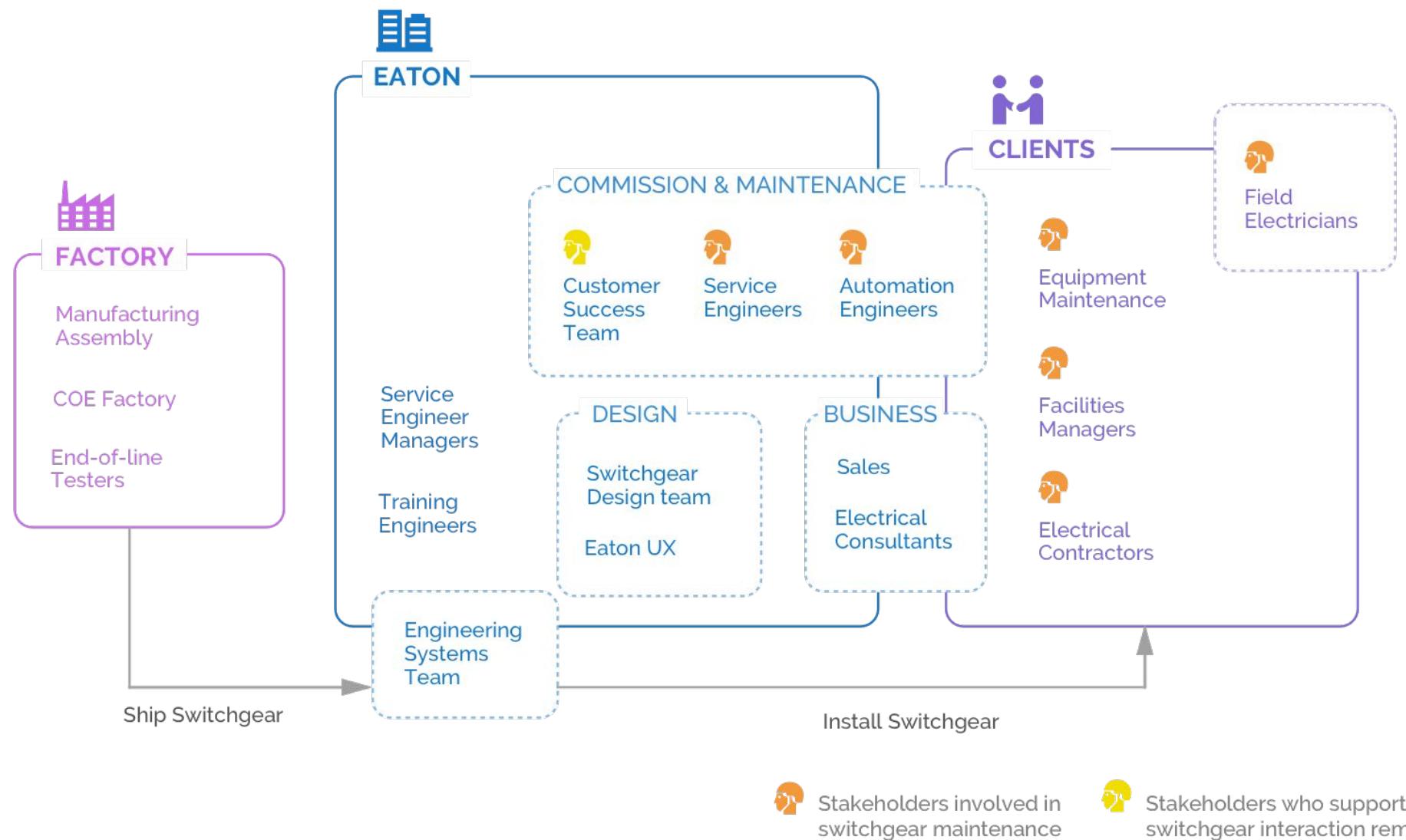
**EMPATHY MAP**

## ABOUT EATON



**Eaton Corporation Plc** is a multinational power management company that provides energy-efficient solutions to help customers effectively manage electrical, hydraulic, and mechanical power more efficiently, safely, and sustainably.

# STAKEHOLDER MAP



## CURRENT PROBLEM SPACE

Currently, many power management systems do not use data to **improve effectiveness** of power management professionals and lack **modern, consistent, and user-friendly interfaces**. Eaton sees an opportunity here where innovative applications of technology and data can be used to improve human-switchgear interaction and shift customers' experiences from reactive to proactive.

## PREVIOUS RESEARCH

Previous MHCI Capstone teams worked with Eaton to help develop a user interface to visualize real-time and historical trend information from devices in a lineup of switchgear.

**Phase 1** of the PX Dashboard focused on determining and validating user needs. The dashboard was implemented at **17 sites** across the country. Based on feedback, it has since moved on to **Phase 2**, where users will be able to access the dashboard through any web browser.

# EMPATHY MAP

Aspire to maintain Eaton's

## Brand Image



**reliable**

Achieve this by

## Implementation

quickly diagnosing problems

To bring about

## Customer Emotion

*confidence & loyalty*



**real-time &  
informative**

immediately visualizing status &  
changes in status

*expertise*



**convenient**

info readily available

*comfort & relief*



**proactive &  
predictive**

reminds when maintenance is  
needed

*secure & safe*



**cool & sexy**

utilization of emerging  
technology

*excited*

# **GOALS OF SECONDARY RESEARCH**

**HUNT STATEMENT**

**PRIMARY RESEARCH QUESTIONS**

**RESEARCH PLAN**

## HUNT STATEMENT



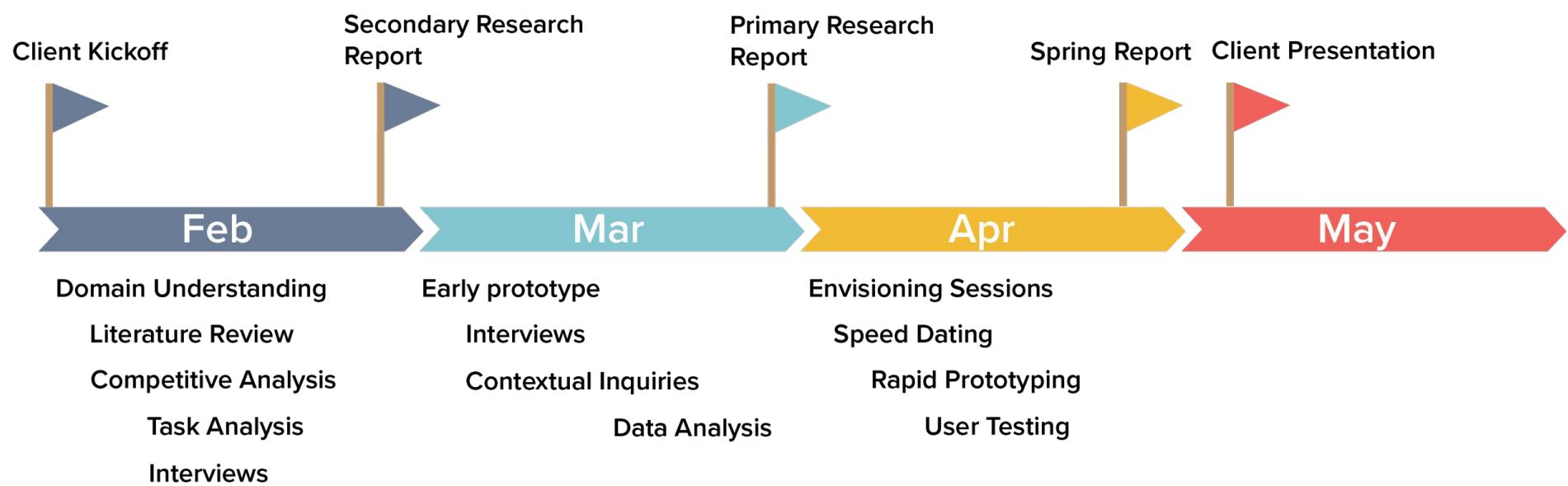
To envision the **future of human-switchgear interaction** to enhance safety, reliability, efficiency, and the human experience of power management systems using **emerging technologies**.

## PRIMARY RESEARCH QUESTIONS

Questions that we would like to conduct research upon:

1. What **advantages could AR provide** if integrated along with the dashboard?
2. What **other technologies** could be leveraged to enhance the human-switchgear experience?
3. Who are **other potential users** of the system?
4. What are the **pain-points** in the day-to-day life of a technician working on Switchgear?
5. What **data** is most critical to the technicians?

# RESEARCH PLAN



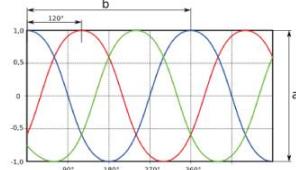
# **POWER MANAGEMENT DOMAIN**

**BASICS OF SWITCHGEAR**

**POWER EXPERT DASHBOARD**

**COMPETITIVE ANALYSIS**

# BASICS OF SWITCHGEAR



## Upstream current

- Triphase
- On copper buses
- From 35 000 to 6 000 Volts

## Switchgear

- distributes electricity to the right elements at the right power
- protects equipment downstream

## Dashboard

- Acts on breakers
- Creates alerts
- Provides information about system status, outfit to wear



## Transformer

- Decreases voltage for equipment downstream or for gear components

## Fuse

- Melts when current is too high
- Usually protects transformers
- Cheaper than breaker
- One time use

## Circuit breaker

- Contains a trip unit
- Protects equipment downstream by tripping if needed

## Relay

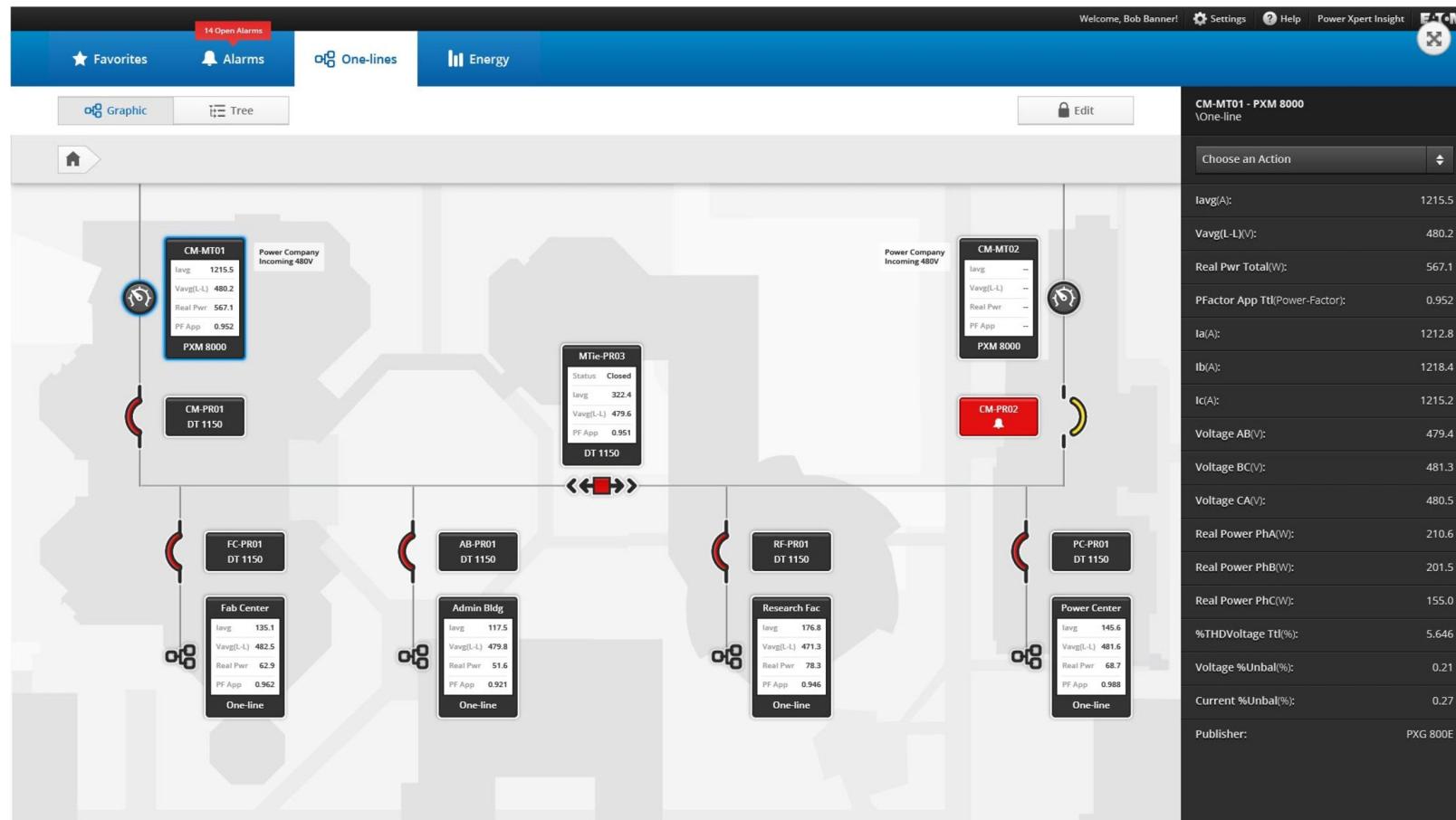
- Detects anomaly and creates an event
- Notifies the trip unit to trip

## Meter

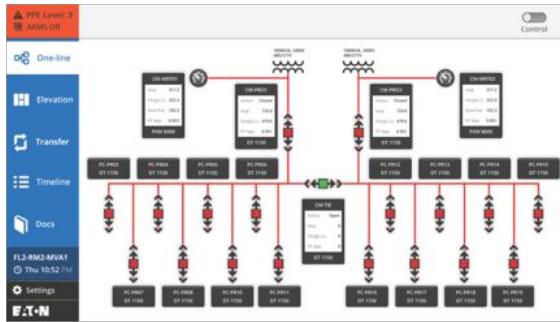
- Measure electricity values (voltage, intensity...)

# POWER XPERT DASHBOARD

Eaton's PX Dashboard allows users to **monitor and control electronic devices** installed in **low or medium voltage switchgear** assemblies and transformers as part of a unit substation.

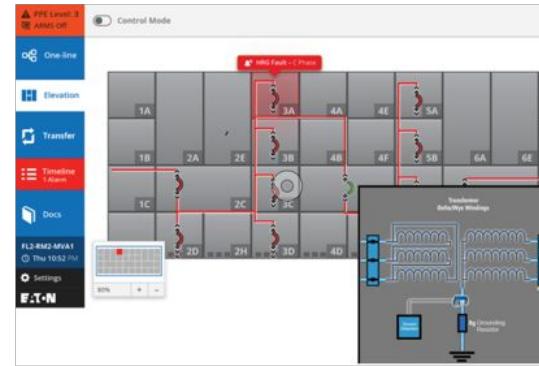


# POWER XPERT DASHBOARD



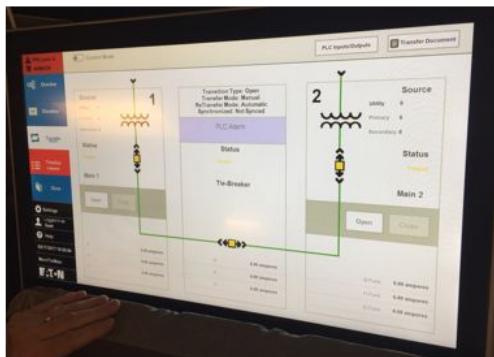
## One-Line View

shows the lineup of all the configured devices and graphical representations of the power flow between them



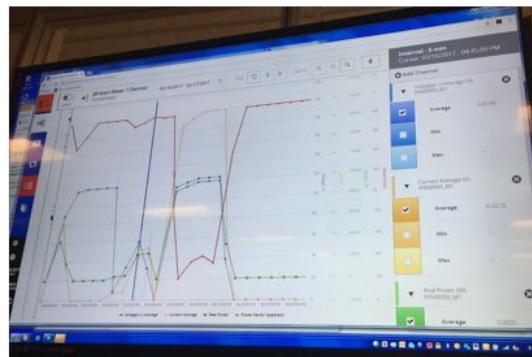
## Elevation View

shows the front view of the switchgear lineup with the status of breakers and buses



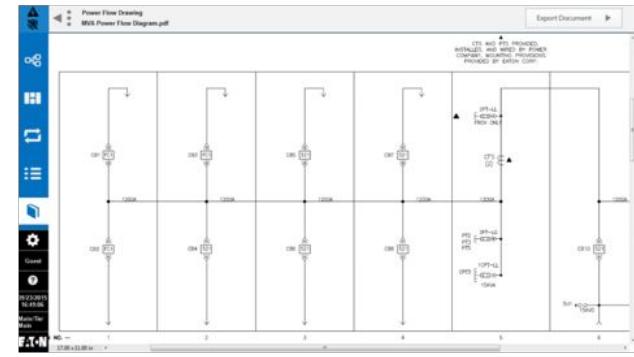
## Transfer

allows users to monitor the transfer state and see a visual indication of the transfer process



## Timeline

lists the alarm information such as time of occurrence, value at occurrence, and all the instances of the same alarm



## Docs

lists the support documents provided with switchgear

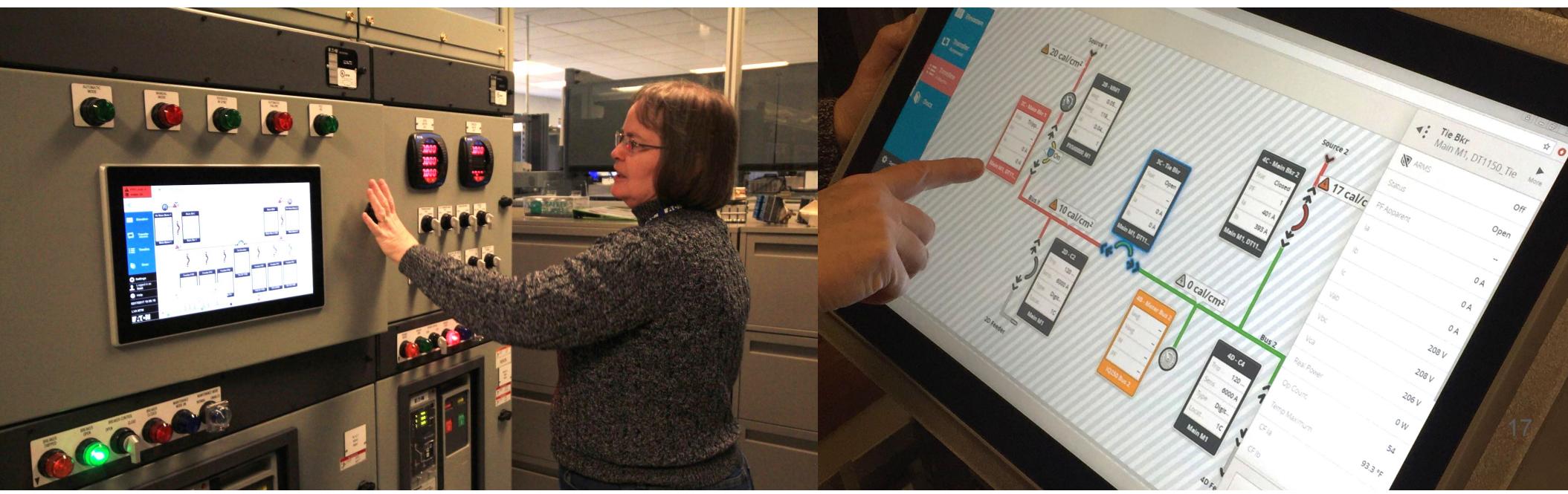
# POWER XPERT DASHBOARD

## Key Features

- Open / close circuit breakers through Control Mode
- Enable **Arc Flash Reduction Maintenance Mode** and see status
- Monitor or initiate **transfer scheme** in a Main/Tie/Main switchgear and adjust timer settings and sequence details
- Rich interface to **monitor parameters** of all devices and study the trends of those parameters

## Main Users

- Service Engineers
- Automation Engineers
- Facility Engineers at power plants, large buildings, etc.



# COMPETITIVE ANALYSIS

## Remote monitoring & control of electrical equipment

**SIEMENS**



**ABB**

**Rockwell  
Automation**

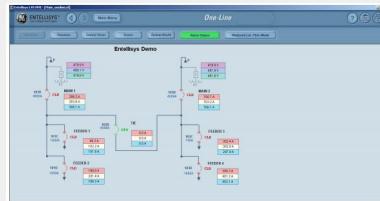
### Smart LV Switchgear



### Smart-Gear Power Distribution Solution

- **Notifies in advance** of potential problems
- Notifies when **maintenance recommended**

### Entellisys LV Switchgear



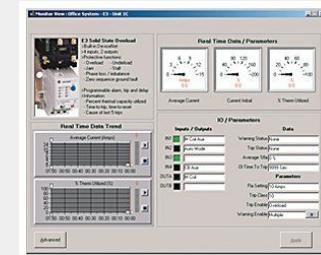
- Accessible via **web-enabled** desktops and laptops
- **Alarms & reports** to users via e-mail
- **Predictive maintenance** (% load life, % mech life)

### Ekip Smartvision



- Can control **trip units** via ethernet network
- Can **create or upload images** of assets and add tags and markers

### IntelliCENTER



- Control & monitoring of **motor control centers**

### Patent for using AR with switchgear

# COMPETITIVE ANALYSIS



## Smart Panels

- Remote real-time monitoring and control of switchgear and other equipment
- “Corrective”, “preventive”, and “predictive” maintenance
- Data accessible via Ethernet and web browsers
- Powerview, Resource Advisor, Power Monitoring Expert V8, Power-Zone 4

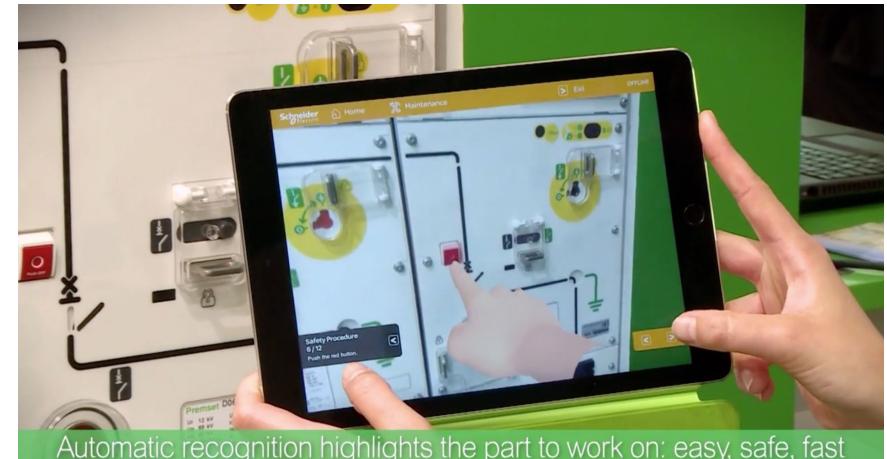
## Whitepaper on Future of Switchgear

- Exploring **augmented reality and IoT**
- Overlaying instructions and messages on switchgear
- Providing info on existing utilities lines and buried utilities
- Training and maintenance
- Visualizing, designing, and modifying equipment

## Premset Live!

### Augmented Reality App

- iPad app, proof-of-concept
- Info on designing and maintaining switchgear
- AR views explaining how to operate switchgear and providing training



Automatic recognition highlights the part to work on: easy, safe, fast



Augmented reality technology helps field operators during their daily tasks

# **TECHNOLOGIES**

**EMERGING TECHNOLOGIES  
ANALOGOUS DOMAINS**

# EMERGING TECHNOLOGIES

## Mixed Reality

**Mixed Reality** is a technology which produces environments where real physical and virtual digital objects co-exist and interact in real-time. Right now, such environments can be visualized in two ways: directly through the eyes of the user by having them wear a headset with transparent lenses, or on the screen of a tablet or a phone that the user can move around.

### Some common use cases:

1. 3D prototyping - Collaborate and interact with digital objects in 3D rather than on a screen
2. Gaming - Immersive gaming experiences which feel like they are real
3. 3D creation - Used by Artists to create 3D objects or characters
4. Learning - Teach anatomy to medical students
5. Sightseeing / Museums - Reveal more information about a place, an object
6. Architecture - Visualize a building before it is built

### Relevance

Mixed Reality can provide information attached to the real world, in context. It can also be hands free. This technology then constitutes a great opportunity to reduce the cognitive load that some technicians have to deal with by providing information they need overlaid on the component they interact with.



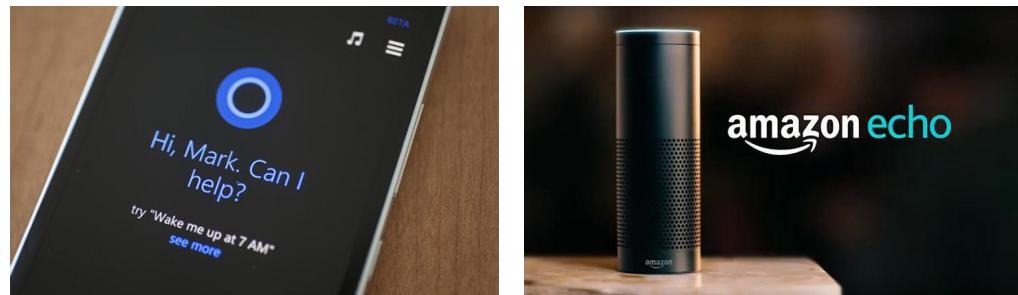
# EMERGING TECHNOLOGIES

## Conversational User Interfaces

**Conversational User Interfaces** allow a user to interact with a system through voice. Such hands free systems rely, for the most advanced ones, on speech recognition (to capture the words said by the user), natural language processing (to understand what the user meant), and machine learning (to create the most adapted response). The recent success of Amazon Echo products (and their interface “Alexa”) now makes this technology more documented, accessible, and affordable.

### Some common use cases:

1. Online Shopping - Nordstrom
2. SmartHomes - Amazon
3. Food ordering - Gusto
4. Robotics - Jibo



### Relevance

Conversational User Interfaces can provide way to interact with a large set of data without having to browse through it. Right now, part of Eaton’s equipment troubleshooting is currently done via phone calls. A conversational User Interface could help troubleshoot users by using data available in manual, drawings, and previous issues encountered and documented by support teams.

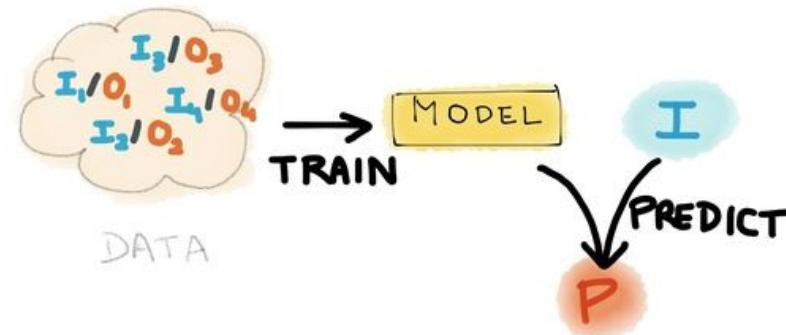
# EMERGING TECHNOLOGIES

## Machine Learning

**Machine learning** is the science of enabling computers to act without being explicitly programmed. The key is to train the computer on a significant amount of data so that it can generate a model. Using this model, the computer can make predictions on instances. For e.g. Machine Learning algorithms can be trained on a large amount of emails which have already been classified as “spam” or “not spam”, to develop a model which is used in email services such as Gmail to detect spam emails.

### Other common use cases:

1. Handwriting recognition - Venture Radar
2. Credit card fraud detection - MasterCard
3. Recommender systems - Amazon
4. Stock trading - Sentient
5. Online search engines - Google



### Relevance

Machine Learning algorithms could be used to create proactive systems which could learn over existing datasets and detect the chance of failure even before it occurs by analysing acoustic, thermal signals as well as the data transmitted from relays.

# EMERGING TECHNOLOGIES

## Internet of Things

**Internet of Things** refers to a network of connected objects with computing abilities, with the capability to store, process and transfer data over the internet. These objects could be everyday devices such as coffee machines, lightbulbs, headphones, watches or even shoes. This interconnectivity helps in facilitating smart interactions and enabling these devices to deliver an optimized user experience. A common example is that of the Nest Thermostat, which can track when the user is about to reach home and set the room temperature according to their preference.

### Other common use cases:

1. Smart lighting systems- Philips
2. Security Systems - Samsung
3. Health Monitoring - FitBit
4. Transportation Systems - Cisco
5. Logistics tracking/monitoring - DHL



### Relevance

Data flow across various switchgear in a facility and to a central hub could help in efficient monitoring and supervision.

## ANALOGOUS DOMAINS

### Mixed Reality

Microsoft      Video Calling

### Wearables

IBM      Steel plants

### Machine Learning

GE                      Equipment Maintenance  
IBM                      Medical  
M\*Modal

### Augmented Reality

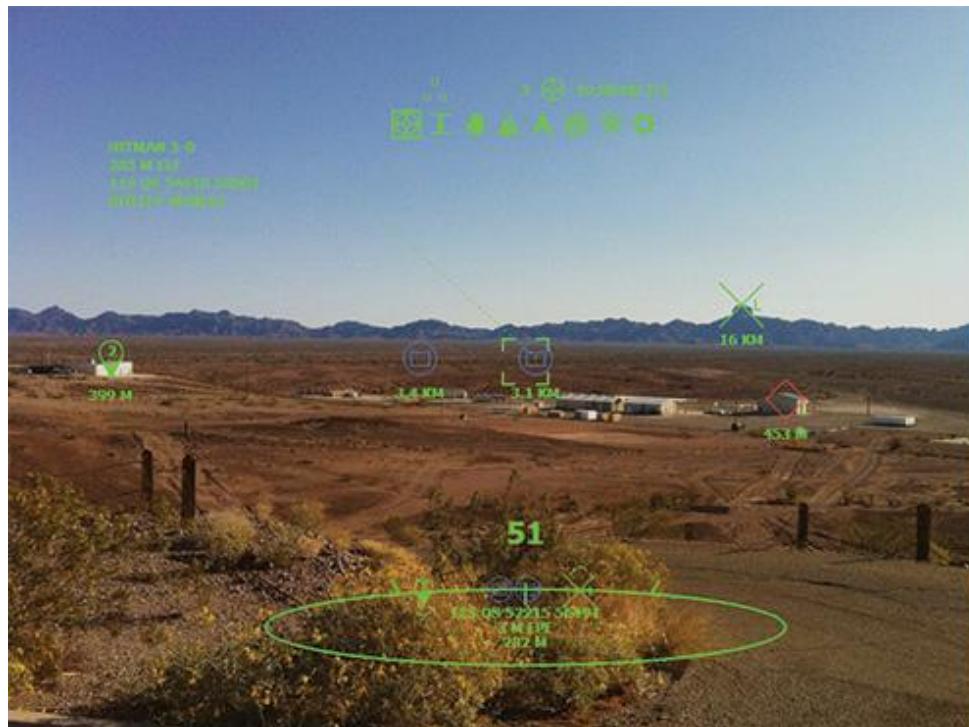
ARC4	Oil and gas
AeroGlass	Military
Microsoft	Aviation
Saab	Data Centers
Maersk	Automobile
Google	Furnishing
GE	
Ferrari	
IKEA	

### Virtual Reality

Optech4D	Oil and gas
FIFF	Energy plants
Columbia University	

## ANALOGOUS DOMAINS

### ARC4



ARC4 is outdoor on-the-move augmented reality (AR) technology that delivers **heads-up situational awareness** to the soldiers on the field.

## ANALOGOUS DOMAINS

### ARC4

#### Why?

Current information systems require soldiers to look down at physical maps or smartphone devices to access tactical information. As a consequence, their head is ‘down’ and they are distracted from what is happening directly in front of them. ARC4 enables the soldier to acquire **time-critical tactical information** with their ‘**head-up**’ and ‘**eyes-out**’ on the environment.

#### How?

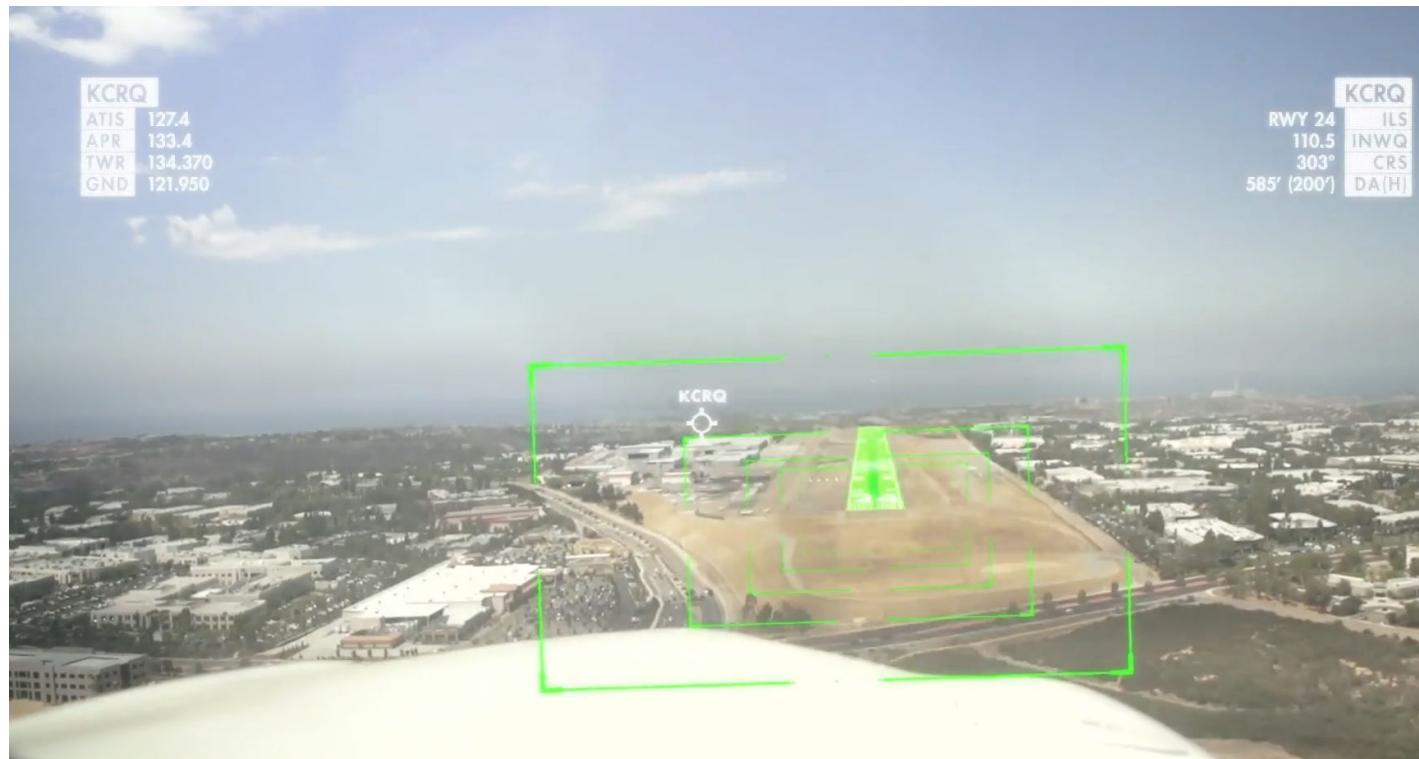
Rather than looking down at a 2D map or smartphone device, the soldier sees **virtual icons** (e.g., navigation waypoints, blue forces, aircraft) overlaid on the real-world view. It is an AR fusion engine that incorporates **advanced head tracking sensors** and **algorithms**, network management software, and an intuitive user interface to overlay iconic information on the user’s environment. ARC4 integrates with daytime see-through displays and night-vision goggles.

#### Key Takeaways

- AR if used along with glasses or head-mounted displays could enable workers to perform tasks hands free
- AR can be used to overlay contextual information during troubleshooting and maintenance

## ANALOGOUS DOMAINS

### AeroGlass



Aero Glass is developing technology for pilots of small aircraft that **provides safety and navigation information**, placing the data and graphics at relative distances to objects they're identifying, and oriented or aligned with them based on their position.

## ANALOGOUS DOMAINS

### AeroGlass

#### Why?

The objective is to **reduce workload on the pilot** and **increase situational awareness**. Pilots cause two-thirds of plane crashes, due to misinterpretation of complex instruments and computer systems.

#### How?

Aero Glass is based on the **R-7 augmented glasses** produced by the Osterhout Design Group. It runs on Android and is powered by a Qualcomm Snapdragon 805 processor. They use a 1080p camera to read the user's view, a 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer in order to **track head movements and orientation**, and dual 720p screens in the lenses to **project digital overlays**.

#### Key Takeaways

- AR can be used to reduce cognitive load
- AR can be used for navigation purposes on-site

## ANALOGOUS DOMAINS

### Microsoft and Saab



Microsoft and Saab are collaborating to develop a new technology which allows both trainers and trainees to **share a visually rich interactive experience** where the real world can be overlaid with digital imagery and information in the form of holograms, facilitating better communication and strategy sessions.

## ANALOGOUS DOMAINS

### Microsoft and Saab

#### Why?

The objective is to bring about a technological transformation in the Australian military, making them a “fifth-generation fighting force”, as a part of Plan Jericho.

#### How?

It is a **headset** which can offer augmented reality vision to assist in **strategy, threat management and training**. The technology will be similar to that of Aero Glass in terms of navigation and piloting, but also provide a single-point interface for the many and complex data streams available to military pilots.

#### Key Takeaways

AR can be used for training service engg. & field electricians in a safe environment

## ANALOGOUS DOMAINS

### Microsoft HoloLens - Skype application



Microsoft created a Mixed Reality version of the Skype video chat application. Apart from the video streaming aspect, the app allows a remote interlocutor to annotate and draw on the augmented world of the headset user.

## ANALOGOUS DOMAINS

### Microsoft HoloLens - Skype application

#### Why?

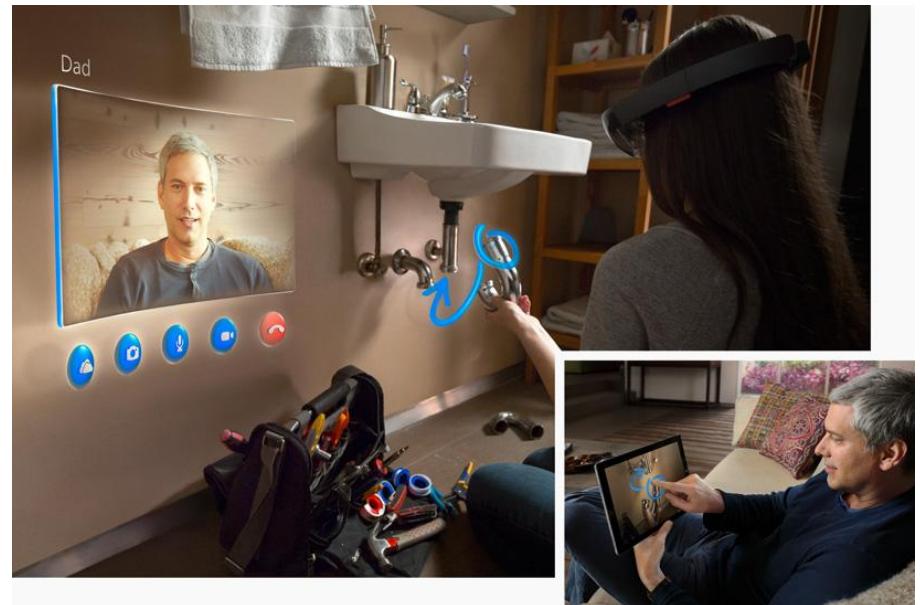
The first goal of the Skype application is to provide a video chatting tool for HoloLens AR headset users. The second is to leverage the headset technology one step further by allowing a remote interlocutor to annotate and draw in the world of the user.

#### How?

The remote interlocutor can use Skype on a regular device (tablet, computer, phone). On their screen they will see what the AR user sees thanks to the camera included in the headset. If they draw on their screen, the content will be updated in the augmented world of the user's headset.

#### Key Takeaways

Assistance can take place remotely with Augmented Reality



## ANALOGOUS DOMAINS

### Maersk Oil



Maersk Oil is working on developing a system which could help onshore experts and engineers onshore to troubleshoot in a collaborative manner.

## ANALOGOUS DOMAINS

### Maersk Oil

#### Why?

One technical expert is able to **virtually monitor** and **support several offshore** locations at once, saving manpower, time and money.

#### How?

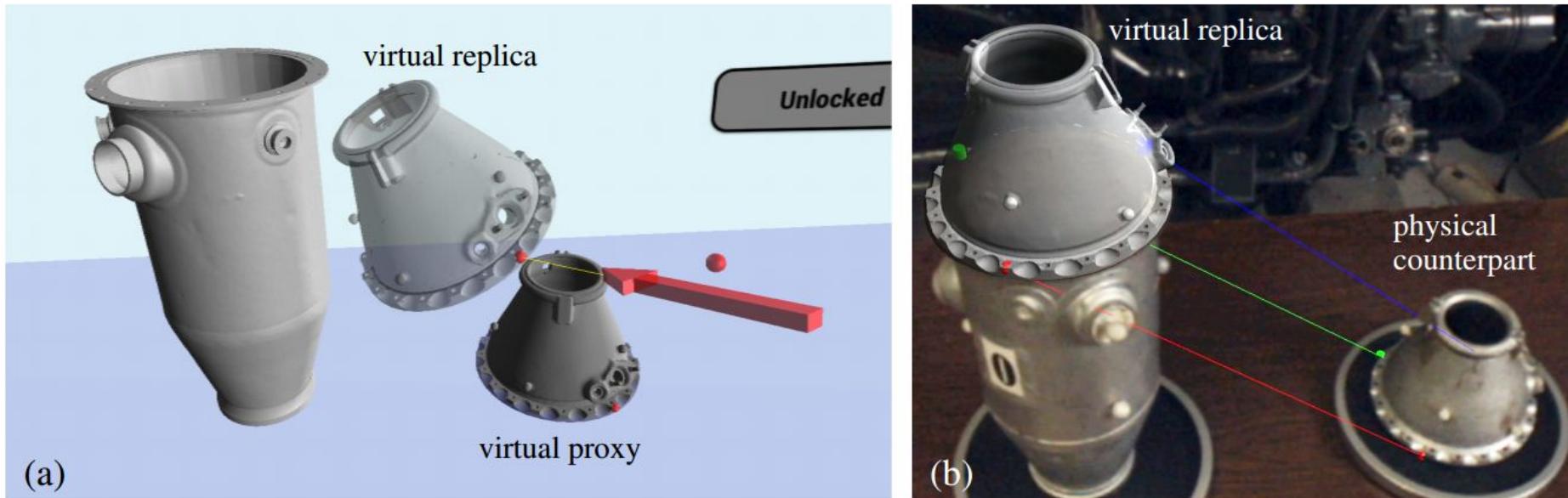
Onshore technical experts can communicate with offshore technicians and engineers via live, interactive devices like iPads. The devices' screens are layered with information and data, to help **virtually solve real time errors or issues with equipment**. They can place markers directly on the screens, accurately highlighting where problems are occurring to quickly solve technical issues in real time.

#### Key Takeaways

- AR can be used by service engineers/Customer Success Team from a remote location to help electricians and technicians on-site in troubleshooting the switchgear
- A visual feed of the equipment on-site gives a much better understanding and helps avoid communication gap and misunderstandings that happen over call
- It could result in a huge boost in efficiency as a few personnel could handle multiple facilities

## ANALOGOUS DOMAINS

### Columbia University



At Columbia University, researchers have worked on a system for Precise Remote Assistance. While an expert manipulates, in Virtual Reality, a replica of the physical complex object, the person on-site sees in AR, and in real-time the movements performed by the remote expert.

## **ANALOGOUS DOMAINS**

### **Columbia University**

#### **Why?**

One technical expert is able to virtually show complex processes and assist on-site technicians wearing an Augmented reality headset.

#### **How?**

A remote expert wears a Virtual reality headset and is able, with controllers, to manipulate a virtual replica of a complex object which needs to be maintained or troubleshoot.

An on-site technician wears an Augmented Reality headset and is able to “digitally see”, in context, the manipulations performed by the expert on the complex piece of equipment.

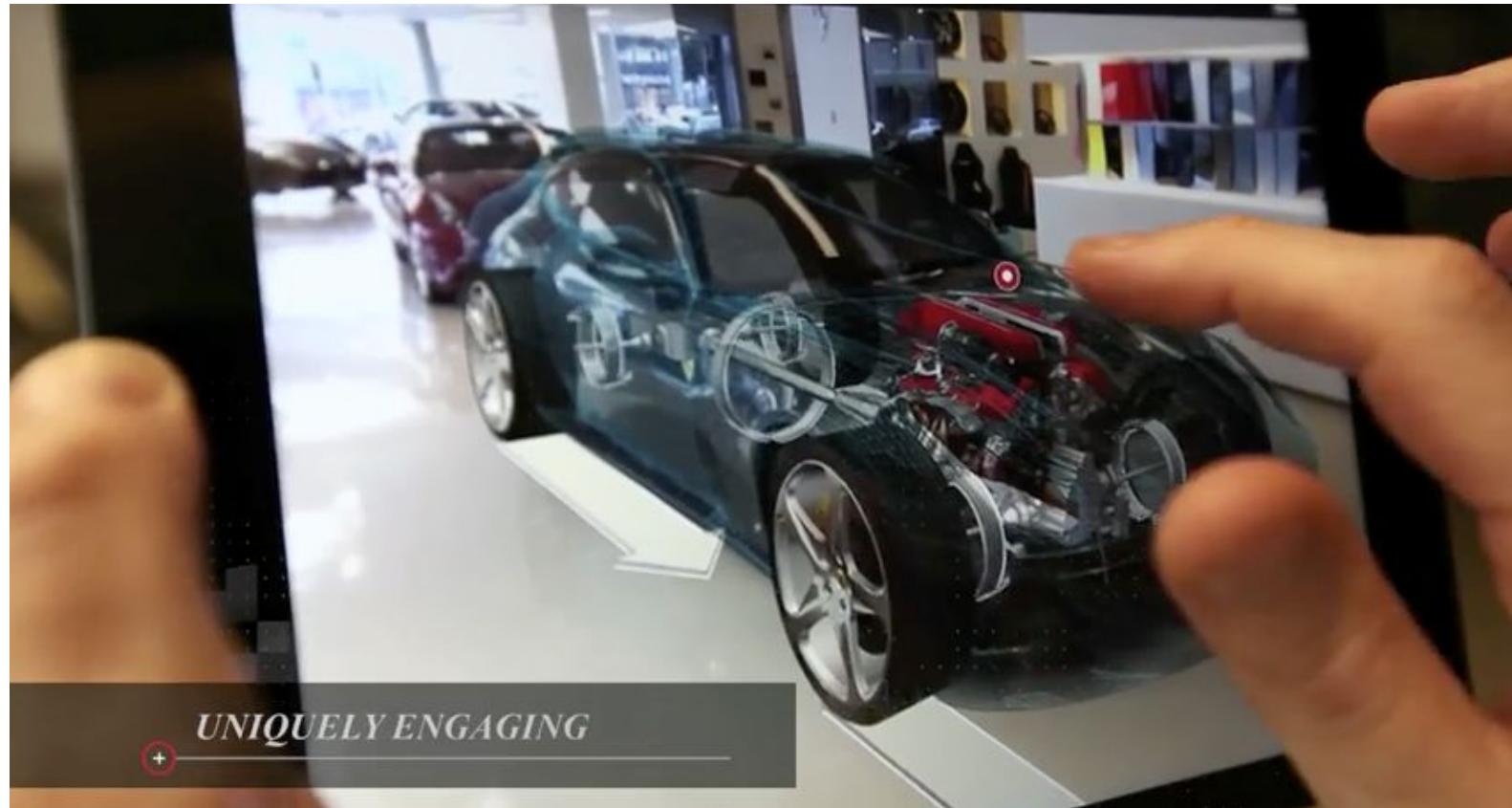
During the whole process, a phone call is also made between the expert and the on-site user so that they can have a conversation about the process.

#### **Key Takeaways**

A precise assistance can provided using both Augmented and Virtual Reality

## ANALOGOUS DOMAINS

### Ferrari and Metaio



Ferrari partnered in 2015 with the AR app provider Metaio. Metaio created an experience where potential buyers would walk around a Ferrari car dealership with a tablet and be able to see on the screen hidden information or features of the car.

## ANALOGOUS DOMAINS

### Ferrari and Metaio

#### Why?

The decision of buying a car can be influenced by many parameters. However, only the outside of the car is available to a buyer going to a car dealership. Augmented Reality can provide more information about the engine, the aerodynamics, the different color variations of the car...

#### How?

When the buyer points at a car, the tablet recognizes it and displays virtual information on the screen.

#### Key Takeaways

Augmented Reality can display information hidden behind opaque surfaces

## ANALOGOUS DOMAINS

### IKEA



IKEA created an Augmented Reality tablet application which allows a user to preview what their house would look like if they purchased some pieces of furniture.

## ANALOGOUS DOMAINS

### IKEA

#### Why?

It can be hard to envision what a space will be like when it is not furnished. Similarly, it can be hard to anticipate if some pieces of furniture will actually fit a particular space size and style.

#### How?

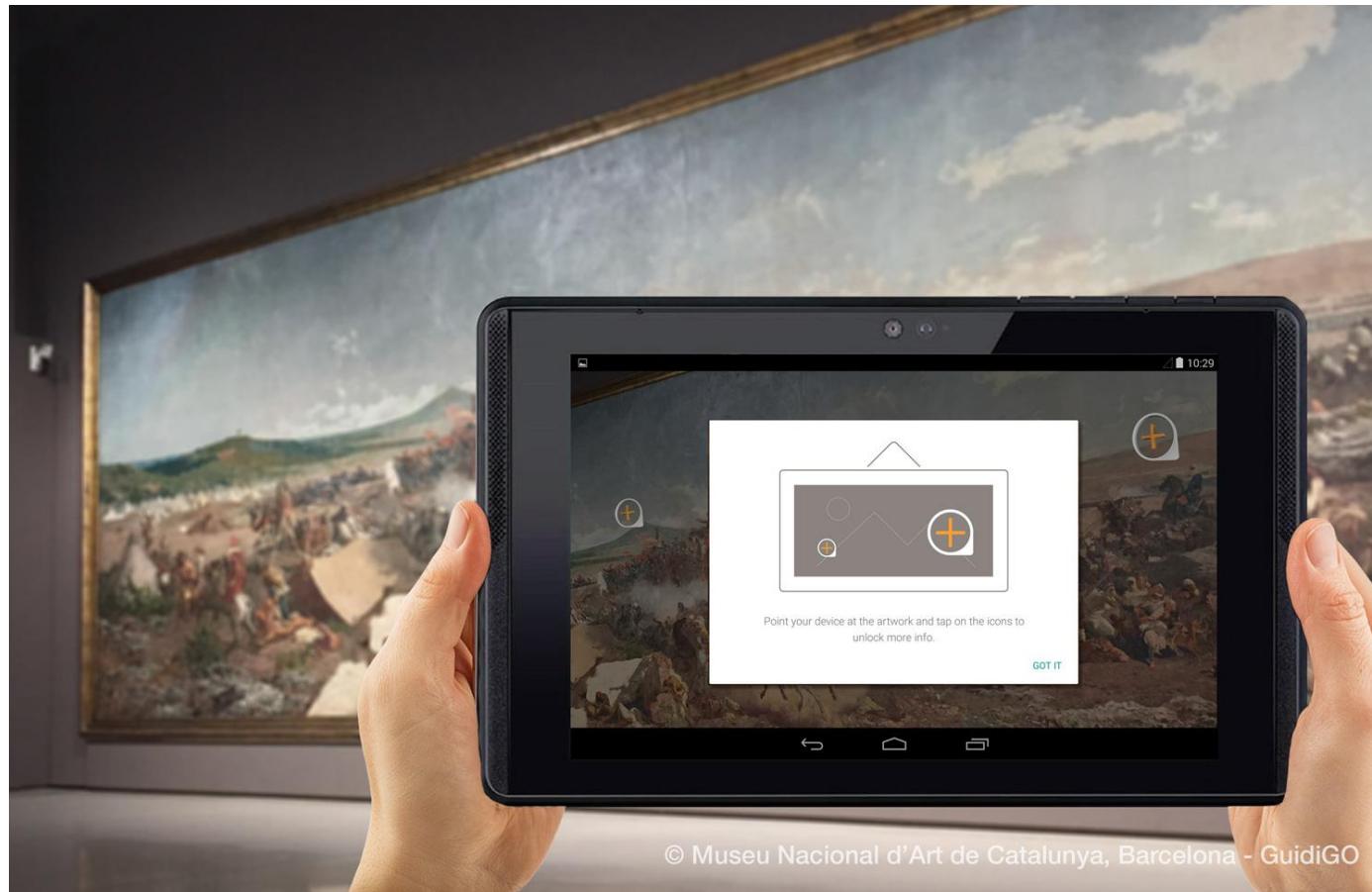
A user can choose and position furniture in an apartment thanks to a tablet which recognizes the space.

#### Key Takeaways

Augmented Reality can help plan and envision possible futures.

## ANALOGOUS DOMAINS

### National Art Museum of Catalonia



© Museu Nacional d'Art de Catalunya, Barcelona - GuidiGO

The National Art Museum of Catalonia used an AR tablet in one of their exhibitions to allow visitors to get more information about paintings.

## ANALOGOUS DOMAINS

### National Art Museum of Catalonia

#### Why?

Details about the whole or parts of a painting can be too hard to explain only with signs or sounds. Augmented Reality can display information while at the same time showing on the painting why and where it is relevant.

#### How?

Each visitor was given an Augmented Reality tablet. This tablet recognizes each painting the viewer is pointing at and displays more information about it when they click on the screen.

#### Key Takeaways

Augmented Reality can display additional information about objects

## ANALOGOUS DOMAINS

### IBM and Northstar BlueScope Steel



Sensors embedded in helmets and wrist-bands, provide **real-time alerts** to employees and their managers, enabling preventive measures if **physical well-being is compromised** or safety procedures are not being followed.

## ANALOGOUS DOMAINS

### IBM and Northstar BlueScope Steel

#### Why?

The solution can **detect hazardous combinations** that individually might have overlooked. Integrating and presenting contextual information to field workers from a wide variety of sensors **creates more aware and well informed workers**. Monitoring workers can help implement measures that lead to less fatigue, less time spent on unnecessary tasks, and more time focused on the most critical tasks. An increased awareness of heat stress and exertion has been observed in the trial users.

#### How?

By gathering and analyzing sensor data collected from **sensors embedded in helmets and wrist-bands**, the technology, IBM Employee Wellness and Safety Solution, provides **real-time alerts** to employees and their managers, **enabling preventive measures if physical well-being is compromised** or safety procedures are not being followed. For example, a combination of skin temperature, raised heart rate, and no movement patterns for several minutes could mean a person is suffering from heat stress. The same platform can be used to prevent excessive exposure to different temperatures, radiation levels, noise, or toxic gases, using sensor tags for temperature, humidity, noise, or light measurements. Gases can be detected using personal sensors enabled using Wifi or Bluetooth low energy sensors.

#### Key Takeaways

- Wearables can be used to increase work safety awareness among electricians and service engineers
- Hazardous conditions can be detected and relevant alarm/alerts could be triggered at various levels, i.e. field electrician, manager, supervisor

## ANALOGOUS DOMAINS

### Fraunhofer IFF



IFF have developed a method that visualises the processes inside energy conversion plants - including photovoltaic, wind, biogas and hydroelectric power stations.

## ANALOGOUS DOMAINS

### Fraunhofer IFF

#### Why?

The **virtual insights** facilitate engineering and therefore ensures that plants become **more efficient** and have **lower emissions**. Instead of browsing through thick instruction manuals for desired information, a technician can easily click on the appropriate representation to obtain data on a certain plant component.

#### How?

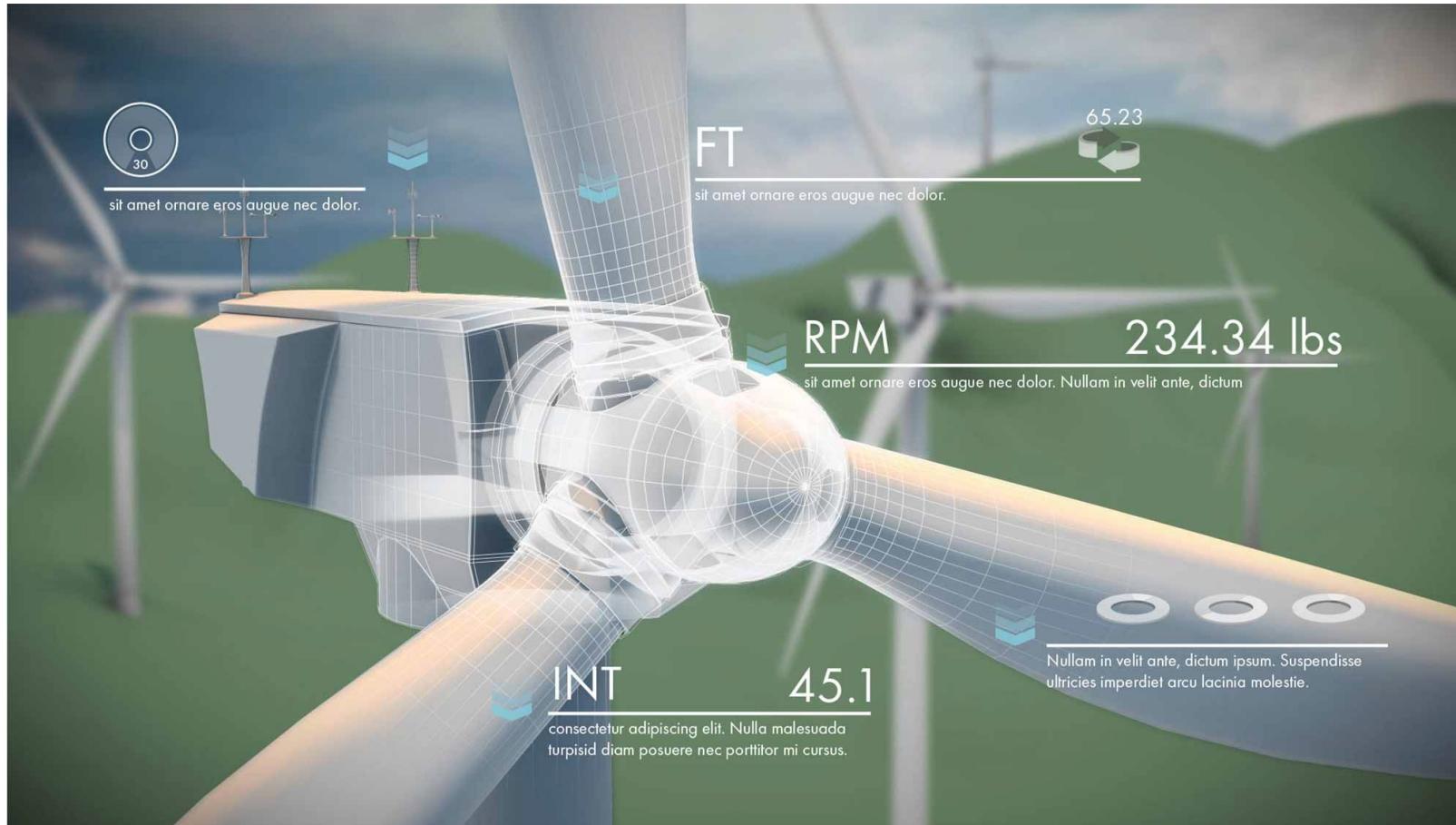
They have coupled 3D plant engineering and simulation results with a virtual reality program developed at the IFF which helps **visualise all the motion sequences**. Arrows that move through the **VR model show engineers the direction in which and speed at which fluids and gases flow through a plant**. **Coloured markings** indicate potential **weak points** such as areas where critical temperatures, deposits or erosions could occur. Is there a potential for collisions when the plant components are moving?

#### Key Takeaways

- Service engg. and field electricians could get insights about circuit diagrams and components contextually
- They could be able to visualize the electric current/voltage to get a better understanding of faults in the system

## ANALOGOUS DOMAINS

### GE's Predictive Maintenance solution



GE wants to pioneer in the future of predictive maintenance of machines. Their software solution 'Predix' can be offered to various industries such as transport, oil and gas for regular equipment maintenance.

## ANALOGOUS DOMAINS

### GE

#### Why?

Lot of industries bear huge costs due to non-functioning machinery equipment, example chemical industry plants sometimes need to be shutdown if corrosion is identified. With Predix, they can perform maintenance and keep such occurrences in check.

#### How?

GE's vision is to create a future where machines talk to each other. In pursuit of predictive maintenance it becomes imperative that various parts of the system - machinery, sensors, equipment communicate their data and status with each other and to the software. Details of implementation are not disclosed however it seems that an IoT framework would be imperative for Predix to collect data from various parts of machinery.

#### Key Takeaways

Predictive maintenance of switchgear as well as other components in the system such as power centres and sub-stations could help in reducing risks of maintenance activities and cutting down on repair related costs.

## ANALOGOUS DOMAINS

Google's patent in maintenance of data center with AR

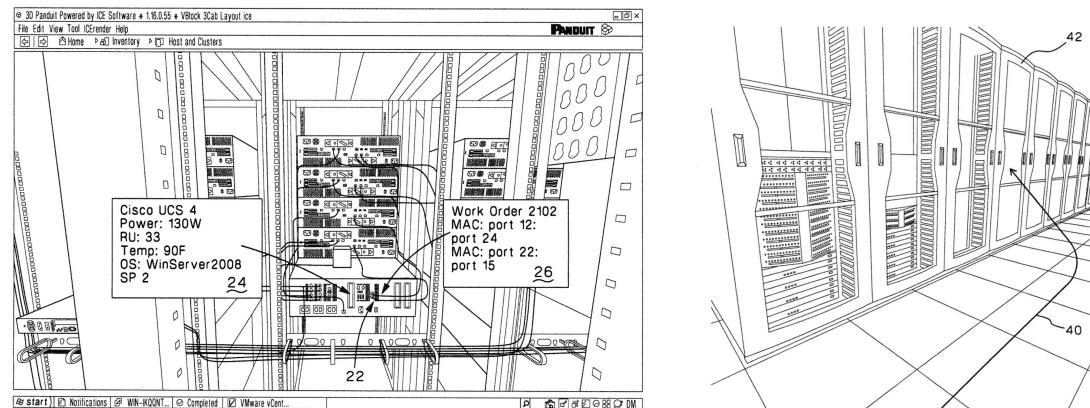


## ANALOGOUS DOMAINS

### Google's patent in maintenance of data center with AR

#### Why?

The data center is a highly dynamic environment which requires multiple disciplines and technology owners to manage. For this file systems and folders, manual data entry in spreadsheets and other static-view software tools such as AutoCad, MS Visio, and Aperture are used. Using AR relieves the need for that as required information can be dynamically overlaid depending on need.



#### How?

Every equipment in a particular data center of a particular network, communicates particular information relevant according to the user who desires to look at a particular information from that equipment. This is overlaid onto the physical premises of the equipment using markers.

#### Key Takeaways

This can be an appropriate way to offer relevant information to different types of people interacting with switchgear. Also, depending on context, different types of information can be prioritized.

## ANALOGOUS DOMAINS

### IBM Watson

Wason offers predictive data analytics, personalized services through AI and Natural language-based services via bot or voice assistants.



IBM + GE: Use AI to provide location based services



IBM + Macy's: Provide natural language based customer service via voice and text



IBM + Citibank: To offer personalized offers to customers

## ANALOGOUS DOMAINS

### IBM Watson

#### Why?

Companies want to provide their customers with personalized service experiences.

#### How?

By analyzing a lot of data about any domain, Watson first learns the terminology and key phrases associated with that domain. Thus, when it is plugged into a customer service AI agent for that domain, it knows what users mean when they ask or type in their service requests.

#### Key takeaways

- A technology like Watson could be used to improve the service workflows of Eaton's customer success team
- Knowledge base generated over time could be leveraged for better querying and providing rapid pertinent solutions to issues
- Conversational bots could be engaged for troubleshooting common issues

# **CONCLUSION**

**KEY INSIGHTS**

**NEXT STEPS**

## KEY INSIGHTS

1. **Competitors are adopting AR** to facilitate human-switchgear interaction
2. AR could help provide **contextual information** while service engineers & field electricians are operating on switchgear
3. **Safety is critical** while operating on switchgears and it could be enhanced using wearables, AR/VR
4. Predictive analytics using machine learning algorithms could help detect problems beforehand resulting in a **proactive rather than a reactive** approach
5. **Training** of service engineers & field electricians could be facilitated using AR/VR in a safe environment
6. **Awareness about the hazards** of working with switchgear could be facilitated using wearables, AR/VR
7. **Efficiency while troubleshooting could be enhanced** significantly if experts have a remote visual feed

# REFERENCES

## NEXT STEPS

- **Continue conducting primary research**
  - Electricians
  - Electrical engineers
  - Facilities managers
  - Eaton service engineers
  - Eaton customer success team
  - Eaton IT Team
  - Analogous domains
- **Analysis and synthesis of primary research**
  - Affinity diagramming
  - Walk-the-wall
  - Envisioning sessions
  - Speed-dating
  - Primary research report and presentation
  - Final report & presentation

# REFERENCES

## Eaton

<http://www.eaton.com/>  
<http://www.eaton.com/FTC/index.htm>

## Competitive Analysis

<http://blog.schneider-electric.com/smart-grid/2014/11/26/will-mv-switchgear-look-like-future/>  
[http://www.schneider-electric.com/en/download/document/998-2095-05-01-15AR1\\_EN/](http://www.schneider-electric.com/en/download/document/998-2095-05-01-15AR1_EN/)  
<http://blog.schneider-electric.com/utilities/2016/11/03/iot-based-recipe-future-substations/>  
<http://blog.schneider-electric.com/tag/switchgear/>  
<http://www2.schneider-electric.com/sites/corporate/en/products-services/product-launch/power-management-solutions/software.page>  
<http://blog.schneider-electric.com/utilities/2016/02/24/augmented-reality-expands-its-reach/>  
<http://www.schneider-electric.com/b2b/en/products/product-launch/premset/live-app.jsp>  
<http://blog.schneider-electric.com/smart-grid/2016/08/30/dream-big-safer-future-digitized-utilities/>  
<http://www.abb.com/industries/db0003db004061/55fb5220e70254e7c1257356006d725f.aspx>  
[http://w3.usa.siemens.com/us/internet-dms/btlv/PowerDistributionComm/PowerDistribution/docs\\_EABU%20docs/SIE\\_FL\\_PastFutureComparison.pdf](http://w3.usa.siemens.com/us/internet-dms/btlv/PowerDistributionComm/PowerDistribution/docs_EABU%20docs/SIE_FL_PastFutureComparison.pdf)  
<http://w3.usa.siemens.com/powerdistribution/us/en/product-portfolio/Medium-Voltage-Switchgear/Pages/Smart-Gear-Power-Distribution-Solution.aspx>  
<https://www.google.com/patents/WO2015191346A1?cl=en>  
<https://www.google.com/patents/EP3076253A1?cl=en&dq=switchgear+augmented+reality&hl=en&sa=X&ved=0ahUKEwjK6qvY0LTSAhWGPiYKHZEZBJUQ6AEIOjAE>  
<http://ab.rockwellautomation.com/Motor-Control/Motor-Control-Centers/IntelliCENTER-Software>  
<http://apps.geindustrial.com/publibrary/checkout/Entellisys-HMI?TNR=White%20Papers|Entellisys-HMIgeneric>  
[http://sandacom.com/story\\_ge\\_entellisys/animation/images/brochure\\_screen.pdf](http://sandacom.com/story_ge_entellisys/animation/images/brochure_screen.pdf)

# REFERENCES

## Analogous Domains

- <https://www.ara.com/projects/arc4-heads-move-augmented-reality-technology>
- <http://www.dailymail.co.uk/sciencetech/article-2640869/Google-glass-war-US-military-reveals-augmented-reality-soldiers.html>
- <https://vimeo.com/101826751>
- <https://glass.aero/>
- <https://www.wired.com/2017/02/drive-car-like-youd-fly-f-35-augmented-reality/>
- <http://vrscout.com/news/the-australian-air-force-is-now-testing-the-microsoft-hololens/>
- <http://vrscout.com/news/ukrainian-military-microsoft-hololens-battle/>
- <https://www.imeche.org/news/news-article/augmented-reality---useful-in-the-oil-and-gas-sector>
- <https://www.ibm.com/blogs/internet-of-things/worker-safety-and-wearables/>
- <http://optech4d.com/>
- <https://gravityjack.com/news/augmented-reality-oil-gas-industry/>
- <http://www.engineerlive.com/content/22178>
- <http://www.sciencedirect.com/science/article/pii/S0166361516302718>
- <http://ieeexplore.ieee.org/document/6428929/>
- [http://link.springer.com/chapter/10.1007/978-1-4614-7010-6\\_108](http://link.springer.com/chapter/10.1007/978-1-4614-7010-6_108)
- <http://www.theverge.com/2015/4/14/8409583/ferrari-augmented-reality-app-metaio>
- <https://www.microsoft.com/microsoft-hololens/en-us/apps/skype>
- <https://www.engadget.com/2016/02/23/exploring-barcelonas-greatest-museum-with-project-tango/>
- <http://newatlas.com/ikea-augmented-reality-catalog-app/28703/>
- <http://dl.acm.org/citation.cfm?id=2807497>