WHITE PAPER

May 2019

# Augmented Reality and its Future in the Chemical Industry

FutureBridge

Augmented Reality (AR) is a virtual view of the physical, real-world environment that is augmented by computer-generated elements. AR systems can be classified under wearable and non-wearable devices.

The rising complication in terms of operation in the chemicals industry is increasing the gap between operators and processes. The need for AR becomes prominent in the chemicals sector, as operators, in certain instances, lose their ability to handle a real process due to the manipulation of operating conditions using control panels and other instruments. AR can help in reducing the chances of errors in data entry in chemical plants, which are prone to accidents arising from operator errors.

futurebridge.com

# Introduction

Augmented Reality (AR) is a technology that involves the overlay of computer graphics on the real world. It defines the field, describes problems, and summarizes the development up to a future point. Important aspects considered while designing an AR system include the following:

- Combination of the real and virtual world
- Interactive in real-time
- Registration in 3D

**EXHIBIT 1: History of Augmented Reality**

**1968**
- Ivan Sutherland, a Harvard professor and computer scientist, invented the first Head-mounted Display (HMD) system known as "The Sword of Damocles." With the help of this device, the user would experience computer graphics, which made them feel as if they were in an alternate reality. The technology used in this device may be considered closer to virtual reality than augmented reality.

**1974**
- Myron Krueger built an artificial reality laboratory known as "Videoplace" that combined a projection system and video cameras, which produced shadows on the screen. With this device, users felt as if they were in an interactive environment.

**1990**
- Boeing researcher named Tom Caudell coined the term "Augmented Reality."

**1992**
- Louis Rosenburg developed the first operational augmented reality system known as "Virtual Fixtures." This robotic system places information on top of the workers work environment to help with efficiency.

**1993**
- Steve Feiner introduced a knowledge-based AR known as "KARMA."

**1994**
- Julie Martin used augmented reality in theater production, "Dancing in Cyberspace."

**1996**
- CyberCode was the first AR system created using 2D markers.

**1997**
- Columbia University developed the first outdoor AR system, The Touring Machine.

**1998**
- Sportvision created AR during a live game; this system showed the original virtual yellow first down marker during a live National Football League game. A variation of this virtual first down marker is currently a norm in all televised football games.

**1999**
- NASA used AR in x-38 that was flown by utilizing a special AR dashboard for navigation purposes. The AR technology was used to improve navigation during test flights.
- Steve Mann created EyeTa, a device that worked both as a camera and a computer display.

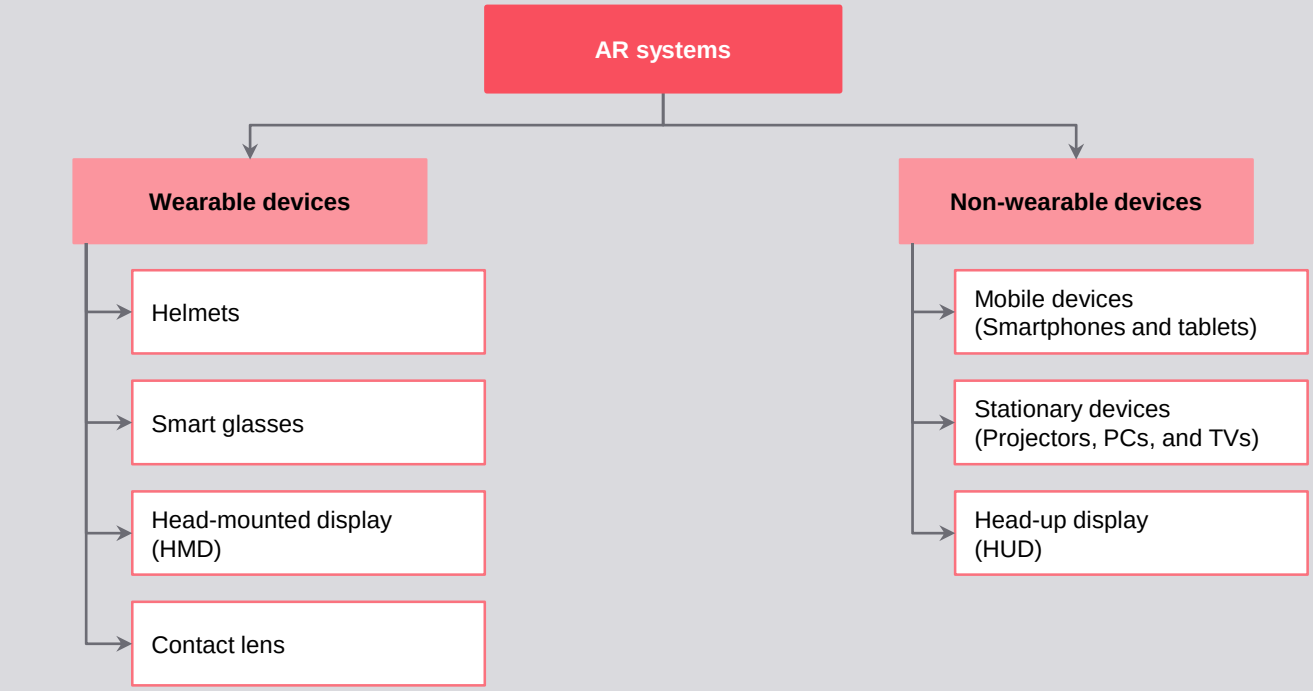
**2000**
- Hirokazu Kato created and released software known as ARToolKit. This software could capture real-world actions and combine them with interactions of virtual objects.

**2003**
- NFL used Skycam that was used to perform aerial views of the field to insert the virtual first down marker.
- Wagner and Schmalstieg presented the first handheld AR system on a "personal digital assistant"; this led the way for AR on smart devices.

Source: Ads Reality, 2017

## Taxonomy of Augmented Reality

**EXHIBIT 2: Types of AR systems**




Source: ResearchGate, 2017

**Helmets:** They are mostly used for industrial applications wherein these devices enable operating engineers to overlay maps, schematics, and thermal images; helmets also reduce operational complexity and increase productivity in an industrial workplace. *Source: Urban wearables (2016)*

**Head-mounted Displays (HMDs):** HMDs are used to provide a simulated x-ray vision by combining computer graphics, such as system diagrams and imagery with a technician's natural vision. In medical surgery, HMDs can be used to view a combination of radiographic data, which includes X-ray computed tomography scans and Magnetic Resonance Imaging (MRI) imaging, combined with a surgeon's natural view of the operation, wherein the patient is within the field of view. It can also provide stereoscopic views of computer-aided design. *Source: Road to VR (2016)*

**Smart glasses:** Smart glasses capture and process the user's physical environment and augment it with virtual elements. They may collect information from sensors located internally or externally. Smart glasses support wireless technologies, such as Bluetooth, Wi-Fi, and GPS. (ResearchGate, 2015) *Source: Future Lab (2017)*

**Mobile devices:** Smartphone camera uses image recognition and an innovative visual marker to produce an augmented reality when it is sensed by the camera.

**Stationary devices:** In stationary devices, projection-based augmented reality works by projecting artificial light onto a real surface, similar to the functioning of a movie projector. These devices can also be interactive with the use of sensors and 3D. *Source: Medium (2018)*

HELMETS

*DAQRI Smart Helmet*

HMDs

*Meta 2 AR headset*

SMART GLASSES

*Vuzix M100 Smart Glasses*

MOBILE DEVICES


STATIONARY DEVICES

*SixthSense technology*

## Working of an Augmented Reality System

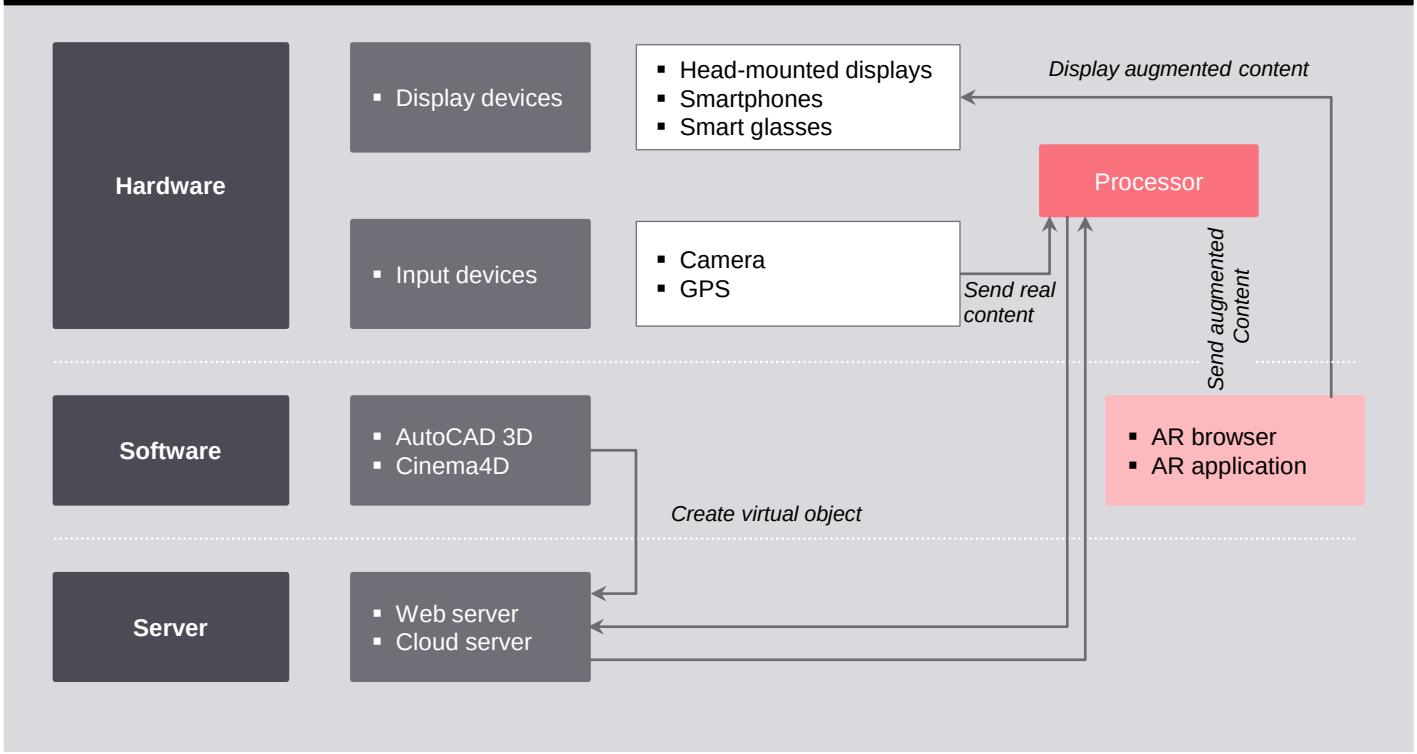
**Sensing about the real world:** Sensors help the AR system collect different forms of data regarding the world as per the user's wish to experience it. These sensors are present in the AR devices, which can either be wearable or non-wearable.

**Process in real-time:** The system analyzes inputs provided from sensors in real-time.

**Output:** Gathered and processed information is overlaid on the user's perception of the real world, which is unlike the virtual reality. This information is conveyed to the user through devices, which can be wearable and non-wearable.

**Contextual information:** The AR system provides contextual and timely information to the user, relating to what the user currently experiences.

**EXHIBIT 3: Schematic Representation: Working of an Augmented Reality System**




# Applications of Augmented Reality

Augmented reality is used in various applications such as education, medical, engineering, manufacturing, etc. AR is expected to penetrate several other potential application areas with its widespread knowledge among consumers. *Source: ResearchGate (2003)*

**Medical:** One of the most important applications of AR is the medical industry where imaging plays a pivotal role. Augmented reality helps image-guided surgeries by providing visualization of the path through the anatomy of the affected area.

**Military & aviation:** AR is used in cockpit displays that present information to the pilot on the windshield of the cockpit or on the screen of the flight helmet. The helmet-mounted screen displays show images of activities of other units participating in the military exercise.

**Entertainment:** AR is used by news channels to create realistic immersive broadcasts wherein reporters stand in front of a blue screen on which the weather on the map keeps changing. Similarly, AR is also used to display advertisements on the outfield of the stadium during matches of football, baseball, etc.

**Engineering:** Engineers take help of a physical prototype that is imaged and displayed in a conference room or outdoor. This helps engineers to walk around the display looking at different aspects of the design, thereby helping in the finalization of the best one.

**Education**: Augmented reality helps provide the real image and experience of a commercial plant during the course of study in a laboratory.

**Manufacturing, maintenance, and repair:** AR-based wearable devices help in displaying the image of the internal structure of equipment that has to be repaired instead of accessing several manuals when an unfamiliar piece comes up. The display would show image of the equipment with annotations and information required for the repair.

Commercially, there are some companies that have executed the use of augmented reality; one of them is GE renewable energy plant where smart glasses are worn by wind turbine assembly workers so that they can directly view the digital information superimposed on the guide parts.

## Augmented Reality in Chemical Industry

The chemical industry is becoming increasingly complicated in terms of operation and automation; this is increasing the gap between operators and processes. In certain instances, operators lose their ability to handle a real process as they manipulate the operating conditions using control panels and other instruments. This makes it difficult to understand and analyze relevant processes and emergency situations. Additionally, the chemical industry is prone to accidents arising from operator errors. *Source: Schneider Electric (2018)*

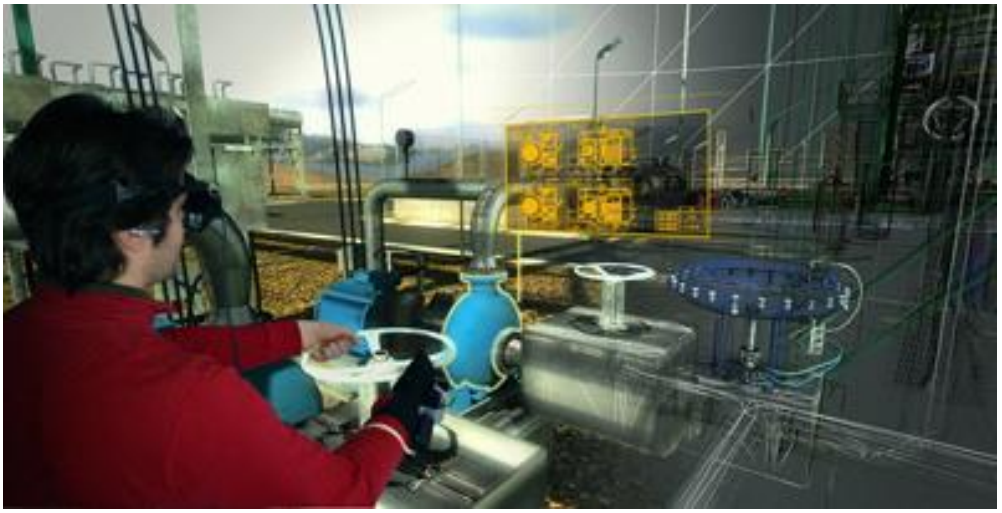
The chemical industry is also focused on the use of Industrial Internet of Things (IIoT) to digitalize factories; a step towards progressing to smart manufacturing. Augmented reality can not only help visualize the real-time image of the plant and its components within the stipulated area of land before construction but also assist in operations of a running plant. Currently, key operational data is already being captured in a digital form. AR can access this data and create virtual objects, thereby offering real-time visibility of operations.

Awareness of the entire manufacturing process can be created among all functional units of workers with the help of AR technology. This enables workers to make the right decision without necessarily having a wide span of experience to validate their decision.

*Source: Texas Instruments (2018)*

Chances of errors in data entry can be reduced using AR, which, in turn, would help in decreasing the risk in chemical plant operations. Historic trend values on non-wearable devices increase the speed of maintenance personnel operators to conduct and plan maintenance activities.

Training becomes easier with AR-based information hub by providing a real-time association between the plant machinery and newly hired operators. A good collaboration between reliability and maintenance engineers and operators is created using augmented reality, which helps increase the asset uptime.



*Source: Chemical Processing (2017)*

During an operation, augmented reality-based devices can help detect any kind of fault in the reactor. AR devices encompass a thermal camera that enables the operator to passively monitor sensitive industrial equipment.

Prior to the setup of a chemical plant, augmented reality helps transform CAD drawings and data regarding the plant from technical documentation to interactive AR applications. These applications can be used to provide interactive user support and regulate learning and education for complex machinery and processes.

During minor accidents, special thermal cameras fitted on wearable devices help in locating and evacuating workers from the accident area.

## Future of Augmented Reality in the Chemical Industry

The main function of augmented reality in the chemical industry is to prevent the downtime in the factory without affecting the production. Chemical factories usually have scheduled maintenance to keep a check on the working condition of machinery and perform repairs in case of equipment breakdown. During this downtime, there is loss of revenue to the company, as the production is completely ceased.

Augmented reality devices help detect the malfunctioning of equipment while the production process is ongoing; this helps companies to repair the equipment without wasting time by waiting for the maintenance activity of the complete plant.

Agro-chemical companies are stepping forward with the use of augmented reality at global conferences to help customers observe how seed-applied technologies, such as crop protection compounds, biologicals, and biostimulants, protect the roots and promote plant development. Augmented reality can help farmers identify the timing of irrigation so that they can deduce the volume of water to be added and gain information about the level of rainfall.

## Limitations of Augmented Reality

Despite recent advances in augmented reality, there is still a lot of work to be done in this field. There are some common problems that prevent AR from becoming a mainstream technology. As there are different standards of AR for various purposes, creating an all-purpose standard would be a challenging task.

Other challenges involve translating digital data into meaningful graphics and scaling it to fit the perspective of the visual field. AR should be able to work under several circumstances; for instance, AR, when used in mobile phones, should function with limited processing power, a small amount of memory, and limited storage. Privacy is one of the key concerns of augmented reality. The device will show key confidential data to anyone wearing it.
*Source: ResearchGate (2014)*

# Conclusion

The adoption of augmented reality in operating a chemical industry requires some time; however, the process might not be as lengthy as other industries seek for technology that offers improvements over available tools along with the reduction in manpower and time.

Some new potential applications of AR, such as farming, is currently gaining potential. Factors such as increasing population, declining natural resources, and long-term effects of climate change are making agriculture a more challenging field. Augmented reality can potentially revolutionize farming processes. Farming involves precise measurements, scheduling, and a scientific approach to acquire a high yielding harvest. AR systems can monitor the entire field in one dashboard to detect the presence of pests and insects. In the near future, there can be more advanced systems that can indicate beneficial insects and pests. Farmers can also determine crops to be sown by exploring the soil properties using an AR device. *Source: AR Post (2019)*

# References


1. Ads Reality (2017)
   http://adsreality.com/history-of-augmented-reality-infographic/
2. ResearchGate (2017)
   https://www.researchgate.net/publication/321523144_Augmented_Reality
3. Urban wearables (2016)
   https://urbanwearables.technology/wp-content/uploads/2016/01/daqri-smart-helmet-AR-technology-for-construction-workers.jpg
4. Road to VR (2016)
   https://www.roadtovr.com/meta-raises-50m-in-funding-to-accelerate-groundbreaking-ar-tech/
5. Future Lab (2017)
   https://futurelab.assaabloy.com/en/augmented-reality-in-physical-security/
6. Medium (2018)
   https://medium.com/datadriveninvestor/making-digital-work-real-7f5cc4b41fc0
7. ResearchGate (2003)
   https://www.researchgate.net/publication/277287908_Introduction_to_augmented_reality
8. Schneider Electric (2018)
   https://blog.se.com/industrial-software/2018/01/29/augmented-reality-chemical-industry/
9. Texas Instruments (2018)
   https://e2echina.ti.com/blogs_/b/thinkinnovative/archive/2018/12/24/52925
10. Chemical Processing (2017)
    https://www.chemicalprocessing.com/articles/2017/training-takes-on-an-added-dimension/

10. ResearchGate (2014)
https://www.researchgate.net/publication/261613717_Drivers_and_Bottlenecks_in_the_Adoption_of_Augmented_Reality_Applications

11. AR Post (2019)
https://arpost.co/2019/01/18/how-augmented-reality-could-revolutionize-farming/


**North America**

55 Madison Ave, Suite 400
Morristown, NJ 07960
USA
T: +1 212 835 1590

**Europe**

328-334 Graadt van Roggenweg
4th Floor, Utrecht, 3531 AH
Netherlands
T: +31 30 298 2108

**United Kingdom**

5 Chancery Lane
London EC4A 1BL
United Kingdom
T: +44 207 406 7548

**Asia Pacific**

Millennium Business Park
Sector 3, Building # 4, Mahape
Navi Mumbai 400 710
India
T: +91 22 6772 5700

futurebridge.com


FutureBridge